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EDITORIAL

Forensic wound age estimation: Exploring newer approaches

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Forensic Medicine speciality has been evolving continuously since its inception. This speciality covers a plethora of medico-legal work under its domain. Forensic wound examination is one such indispensable medico-legal work that involves differentiating antemortem infliction from post-mortem infliction, type of force used, a post-infliction interval of the wound, manner of infliction, correlation of injury with death or disability, etc. Estimation of wound age is one such critical task in both livings as well as dead. Dating of the wound is essential to corroborate the duration between its alleged infliction and examination.

Conventionally wound age is estimated by naked eye examination by studying colour changes and stages of healing. A superficial injury like abrasion follows a predictable healing pattern. Age can be estimated reasonably accurately unless healing is influenced by infection, foreign body impaction, or any other co-morbidity. The age of the bruise is estimated based on colour changes. However, the colour changes are also influenced by the amount and depth of the bleeding, the complexion of the person, etc. Additionally, healing of the bruises depends on the vascularity of region, size of the bruise, general health of the person, vascular disorders, etc. Incised wounds without any complications can heal with primary intention, and the course of its healing can be predicted. However, injuries like a laceration or other deep-seated injuries likely to be healed with secondary intension due to impending infection and extensive tissue loss do not help estimate wound age.

Wound healing follows sequential phases of inflammation, proliferation and maturation. The inflammatory phase is characterised by platelet aggregation and time-dependent infiltration of leucocytes such as neutrophils, macrophages, T lymphocytes. The proliferative phase is marked by epithelisation, formation of granulation tissue and angiogenesis. The maturation process involves collagen deposition, restructuring and strengthening of the wound region.[1] Histopathological examinations are routinely conducted to study these phase-wise changes as an adjuvant to gross findings to estimate age of wound.

Forensic wound age estimation methods have been making advancements from conventional techniques. First such attempt was made by Raekallio J, who studied enzyme activity by histochemistry in the central and peripheral zone of the wound. He concluded that enzyme activity is more marked in the peripheral zone, and enzymes like adenosine triphosphatase are earlier detected than inflammatory cells infiltration observed in histopathological examination.[2] With the advent of immunohistochemical techniques, newer approaches have been explored for wound age estimation. The role of the extracellular matrices, adhesion molecules, inflammatory cytokines and various growth factors in wound healing is already established. These parameters are thoroughly investigated for their utility in forensic wound age estimation.[3]

Adhesion molecules have an important role in the initial phases of wound healing. They are required for the migration of leucocytes as well as their interaction with endothelial cells. Hence, these markers are explored for age estimation of wounds inflicted within few hours. Drebler J et al., in their research, have found that P-selectin shows the earliest immunopositive reaction within few minutes of wound infliction and with positivity up to 7 hours. Other adhesion molecules like E-selectin, ICAM and VCAM also exhibit positive reactions within 1 to 3 hours.[4-6] Betz and his colleagues have explored the role of collagen in the estimation of the time of wounds. They found that the expression of collagen III can be studied in wounds of 2 to 3 days, whereas collagen V and VI are expressed in wounds of more than 3 days. Collagens for basement membrane are apparent in wounds of more than 4 days duration. Collagen I was found in the lesions of more than 5 days post inflictions. Betz and co-workers had also explored the utility of fibronectin in wound age estimation. Fibronectin has a role in the adhesion and movement of fibroblast cells. They found fibronectin expression as early as 10 to 20 minutes, with a peak at around 4 hours.[7-11]

Cytokines are inflammatory markers produced by various inflammatory cells. They have a multisystem role. Cytokines such as interleukin (IL)-1, IL-6 and tumour necrosis factor-alpha (TNF-α) are pro-inflammatory mediators. In their study on mice, Japanese researchers observed that these cytokines initially showed a positive reaction for neutrophils and later on with macrophages and fibroblast. The TNF-α and IL1β reached a peak 3 hours post infliction, and IL-1α and IL-6 achieved a peak at 6 and 12 hours, respectively. There was another peak for each cytokine at around 72 hours. Hence, it was demonstrated that these cytokines have a role in the initial inflammatory phase and later wound remodelling.[12] Chemokines are chemotactic cytokines that have a role in cellular migration. IL-8, MCP-1 and MIP-1α are important chemotactic cytokines for neutrophil, monocyte and macrophage, respectively. Kondo T et al. studied the immunoexpression of these markers. They found that wounds of age 1 to 4 days showed more than 50% immunopositive reaction for IL-8, whereas MCP-1 and MIP-1α showed positive reactivity of more than 30% and more than 40% in wounds of

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the age of at least 1 day respectively.[13-14]

Vascular endothelial growth factor (VEGF) and basic fibroblast growth factor (bFGF) have a crucial role in angiogenesis. Takamiya et al. demonstrated the utility of VEGF and bFGF for wound age estimation in their animal research (14). Hayashi et al. conducted the study on human subjects and showed that wounds of age 7 to 21 days had a VEGF-positive ratio of >50% expressed on macrophages and fibroblasts in human skin wounds.[15] TGF-α has a role in epidermal cell proliferation, whereas TGF-β1 has a role in collagen deposition. The potential role of these markers had been studied in the estimation of wound age, and they showed enhanced immunopositivity during the first hour after the infliction of injury.[16] Ubiquitin (Ub) is a heat shock protein. Researchers have explored its role in estimating the timing of wounds and found that positivity of more than 30% in wounds of age 7 to 14 days.[17] Expression of p53 gene, which is a marker of cellular apoptosis, was also investigated and p53 positive fibroblast showed increased expression in wounds of a post-infliction interval of 1 to 2 days.[18]

The focus of forensic pathologists has now shifted to study mRNA expression of various markers using RT-PCR. Meanwhile, the role of other novel markers like IL-33, FoxO1 expression, etc. is also being continuously explored in various human and animal experiments.[19-20] Wound age estimation by neutrophil migration distance is also attempted.[21]

Forensic pathologists from the western world and Asian counterparts like Japan and China have progressed leap and bounds in exploring research based on forensic wound age estimation. However, in India, we still rely mostly on conventional methods like gross examination and routine histopathology. Advanced pathological modalities are being extensively used for clinical diagnosis and management in India as well. However, same is not the case with medico-legal investigation. The expensive cost of these newer techniques, lack of funds and apathy towards medico-legal work are the possible deterrents for utilisation of newer researches in the speciality of Forensic Medicine. It is pertinent that all these advanced techniques are utilised for the medico-legal investigation to create an Indian database for the administration of justice.

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ORIGINAL ARTICLE

Radiological study of epiphyseal appearance and fusion around elbow joint on Bengali population of West Bengal

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Abstract

Determination of age and corroboration of chronological age with skeletal age is often done in doubtful situations of civil and criminal cases. Skeletal age is determined by radiological examination of different joints to assess appearance and fusion of secondary ossification centers of bones. This study was aimed to assess such findings around elbow joints with respect to valid chronological age in Bengali population. It was a retrospective study of 480 subjects' anteroposterior and lateral view of elbow skiagrams aged between 7-20 years for both male and female subjects. Head of radius, medial epicondyle of humerus, trochlea of humerus, olecranon process of ulna, lateral epicondyle of humerus were examined in each case and found to be present in all cases by 8, 10, 10, 11, 12 years in females and 10, 10, 13, 14, 14 years in males. Fusion of epiphyses was found to follow a similar sequence between 8-10 years of age in average. Majority of the fusion occurred around 13 years in female and around 15 years in male. The range of age of appearance and fusion of each bony landmark was also determined in this study. The present study is a step forward in solving medicolegal disputes of skeletal age determination in West Bengal with a standard reference range.

Keywords

Skeletal age; Radiological examination; Elbow joint; Bengali population; Age determination

Introduction

Age is an important datum for identification. Often the chronological age of a person is questioned as documentation pertaining registration of birth is incomplete for many individuals. Usually the dental, physical and radiological data is combined to estimate the age of an individual. Mostly, in children and adolescents, skeletal age and chronological age tally with each other.[1] In various civil and criminal issues, on request from appropriate authority or as per order of the Learned court, determination of age is a performed. Indian Courts often employ this principle of "ossification test" among different methods applied as ages of appearance of the secondary centers of ossification of different long bones and their fusion of epiphyses with diaphysis are considered a reliable guide.[2] But it varies with different nutritional, developmental, endocrinal factors which affect skeletal growth.

Notable works on the determination of age from the appearance and fusion of epiphyses in long bones around different joints of the body namely elbow, wrist, pelvis, knee, shoulder, ankle and others have been carried out in different parts of India and abroad. It is evident that there is significant difference in the age of epiphyseal union in different populations even within a country.[3] Radiological examination around elbow joint allows numerous secondary ossification centers to be studied in the lower end of humerus and upper end of radius and ulna, thus it is a reliable single joint helpful in age estimation. The age of appearance of ossification centers has a relatively fixed ascending chronological age sequence as published by literatures- **C**apitulum (humerus), **R**adius head, **I**nternal or medial epicondyle (humerus), **T**rochlea (humerus), **O**lecranon process (ulna), and **E**xternal or **L**ateral epicondyle (humerus). Thus a mnemonic of CRITOE or CRITOL may be formed.[4-7]

Likewise, distinct characteristics in elbow ossification may exist in the population of West Bengal, and this information is lacking comprehensively in present literature. Here, we aimed to evaluate the respective status of age and sequence of appearance and fusion of the secondary ossification centers in radiographs around elbow joint, and correlate the same with sex and known chronological age.

Materials and Methods

In this retrospective study, post approval by the Institutional Ethics Committee, the study was initiated and carried out during a 6 month period from January 2020 to June 2020. Proper informed consent was taken from all the study participants prior to the radiological examination. The inclusion criterion was boys and girls who are permanent residents of West Bengal (Bengali population), and those who underwent anterior- posterior and lateral elbow radiograph of the non-

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dominant side (e.g., left sided radiograph for right-handed subject and vice versa) and where both the skiagrams are available. The exclusion criteria consisted of cases with history of any previous injury or surgery around elbow, suspected or confirmed diagnoses of metabolic, nutritional, developmental, endocrinal or any other pathological disorder that could modify the ossification center growth & development, poor quality of skiagrams and where stated age was not known or couldn't be verified from valid documents. Subjects were grouped into categories with one year age interval. Each individual was included in one group only as per completed years of age and for those who were radiographically evaluated multiple times, only the initial exam was considered. We included young adults (18 years and above) to allow for the inclusion of patients who had achieved skeletal maturity and complete ossification and fusion of the elbow joint ossification centers. The population included 480 subjects (366 boys, 114 girls), with age between 7 and 20 years. The presence or absence and fusion or non-fusion of each secondary ossification center around elbow joint was evaluated following the classification (1a) appeared, (1b) not appeared; (2a) fusion not started, (2b) partial or incomplete fusion, (2c) complete fusion. We considered a complete fusion when the growth plate was totally obliterated and ossified. The skiagrams examination and evaluation was performed by two observers blindly and independently.[4] Radiological status of the bony landmarks were duly noted and tabulated in MS Excel spreadsheet rationally for analysis.

Results

From a total of 503 subjects' skiagrams of elbow joint, 480 subjects (male=76.25%, female=23.75%) were selected based on the inclusion and exclusion criteria. The age ranged from 7-20 years and were categorized into fourteen groups each of one year interval (Figure 1). The female population was aged between 8- 18 years and the male population was aged between 7- 20 years.

Appearance of Head of Radius: Radiological evidence pointed towards the appearance of head of radius in all 114 females (100%) aged between 8- 18 years. In male population it does not appear before 8 years of age, with majority (93.75%) showing radiological evidence of appearance beyond 8 years. Beyond 10 years, all the males showed radiological appearance. (Table 1)

Fusion of Head of Radius: Though evidence of start of fusion was observed at 8 years of age in case of one male (1/8) and two females female (2/16), in majority, the fusion did not start before 10 years (66.67%) in females and before 12 years (66.67%) in case of males. Complete fusion was observed from 11 years (2/19) in females and 13 years (3/39) in males. In majority complete fusion was observed by 13 years in female (57.14%) and 15 years in males (69.23%). We found complete fusion in all cases beyond 15 years in female and 18 years in male. (Table 1)

Table 1: Age (in years) of appearance and fusion of Head of radius (n=480)

Age (years)	Not Appeared			Appeared			Fusion not started			Active fusion			Complete fusion		
	♀	♂	Total	♀	♂	Total	♀	♂	Total	♀	♂	Total	♀	♂	Total
7		1	1		1	1		1	1						
8		1	1	8	15	23	7	14	21	1	2	3			
9		2	2	26	46	72	24	46	70	2	2	4			
10				12	51	63	4	44	48	8	7	15			
11				19	42	61	2	27	29	15	15	30	2		2
12				25	57	82		19	19	13	38	51	12		12
13				7	39	46		7	7	3	29	32	4	3	7
14				8	35	43		1	1	1	21	22	7	13	20
15				1	26	27					8	8	1	18	19
16				6	22	28					2	2	6	20	26
17				1	22	23					3	3	1	19	20
18				1	5	6							1	5	6
19					1	1								1	1
20					1	1								1	1

Table 2: Age (in years) of appearance and fusion of Medial epicondyle of humerus (n=480)

Age (years)	Not Appeared			Appeared			Fusion not started			Active fusion			Complete fusion		
	♀	♂	Total	♀	♂	Total	♀	♂	Total	♀	♂	Total	♀	♂	Total
7		1	1					1	1						
8		1	1	8	15	23	6	15	21	2	1	3			
9	1	1	2	25	47	72	14	43	57	12	5	17			
10				12	51	63	2	39	41	10	12	22			
11				19	42	61		23	23	18	19	37	1		1
12				25	57	82		20	20	14	37	51	11		11
13				7	39	46		7	7	2	30	32	5	2	7
14				8	35	43				3	26	29	5	9	14
15				1	26	27					9	9	1	17	18
16				6	22	28					4	4	6	18	24
17				1	22	23					2	2	1	20	21
18				1	5	6							1	5	6
19					1	1								1	1
20					1	1								1	1

Appearance of medial epicondyle of Humerus: There was radiological evidence of appearance in 99% (113/114) females aged between 8 and 18 years except in a single case of 9 years of age. In male population it does not appear before 8 years of age, with majority (93.75%) showing radiological evidence of appearance beyond 8 years. Beyond 10 years, all males showed radiological appearance of medial epicondyle of Humerus. (Table 2)

Fusion of medial epicondyle of Humerus: Though evidence of starting of fusion was observed beyond 8 years of age in two males (2/8) and one female (1/16), in majority, fusion did not start before 10 years (83.33%) in females and before 12 years (64.91%) in males. Complete fusion was observed from 11 years (1/19) in females and 13 years (2/39) in males, for majority the fusion was completed by 13 years in females (71.43%) and 15 years in males (65.38%). We found complete fusion in all cases beyond 15 years in females and 18 years in males. (Table 2)

Appearance of trochlea of Humerus: Radiological findings indicated non-appearance in 37.5% (3/8) aged 8 years and 7.69% (2/26) aged 9 years in female population. Beyond 10 years, all the female subjects show evidence of radiological appearance. In male population it does not appear before 8 years of age with 50% showing radiological evidence of appearance beyond 9 years of age. Beyond 13 years, all the males showed evidence of appearance of trochlea of Humerus. (Table 3)

Table 3: Age (in years) of appearance and fusion of Trochlea of humerus (n=480)

Age (years)	Not Appeared			Appeared			Fusion not started			Active fusion			Complete fusion		
	♀	♂	Total	♀	♂	Total	♀	♂	Total	♀	♂	Total	♀	♂	Total
7		1	1					1	1						
8	3	9	12	5	7	12	8	12	20		4	4			
9	2	24	26	24	24	48	17	43	60	9	5	14			
10		18	18	12	33	45	3	45	48	9	6	15			
11		5	5	19	37	56	1	19	20	18	22	40		1	1
12		3	3	25	54	79		16	16	16	39	55	9	2	11
13				7	39	46		3	3	2	33	35	5	3	8
14				8	35	43				2	21	23	6	14	20
15				1	26	27					11	11	1	15	16
16				6	22	28					2	2	6	20	26
17				1	22	23					2	2	1	20	21
18				1	5	6							1	5	6
19					1	1								1	1
20					1	1								1	1

Fusion of trochlea of Humerus: Though evidence of onset of fusion was observed from 9 years of age in females (9/26) and 8 years of age in four males (4/16), for majority fusion did not start before 10 years (75%) in females and before 11 years (52.38%) in males. Complete fusion was observed beyond 12 years (9/25) in females and 11 years (1/42) in males. In majority fusion was seen to be completed by 13 years in females (71.43%) and 15 years in males (57.69%). We found evidence of complete fusion in all cases beyond 15 years in females and 18 years in males. (Table 3)

Appearance of tip of olecranon process of ulna: Lack of radiological evidence of appearance was observed in 12.5% (1/8) aged 8 years, 19.23% (5/26) aged 9 years and one case 10 years (1/12) in female population. Beyond 11 years, all the female subjects show evidence of radiological appearance of tip of olecranon process of ulna. In male population, radiological evidence was not present before 8 years of age with majority (83.33%) showing radiological evidence beyond 11 years. Beyond 14 years, all males showed evidence of radiological appearance of tip of olecranon process of ulna. (Table 4)

Table 4: Age (in years) of appearance and fusion of Olecranon process of ulna (n=480)

Age (years)	Not Appeared			Appeared			Fusion not started			Active fusion			Complete fusion		
	♀	♂	Total	♀	♂	Total	♀	♂	Total	♀	♂	Total	♀	♂	Total
7		1	1					1	1						
8	1	14	15	7	2	9	8	16	24						
9	5	31	36	21	17	38	20	46	66	6	2	8			
10	1	27	28	11	24	35	6	49	55	6	2	8			
11		7	7	19	35	54	3	32	34	15	10	25	1		1
12		4	4	25	53	78		30	30	13	27	40	12		12
13		2	2	7	37	44		9	9	3	28	31	4	2	6
14				8	35	43		1	1	1	18	19	7	16	23
15				1	26	27					8	8	1	18	19
16				6	22	28					3	3	6	19	25
17				1	22	23					3	3	1	19	20
18				1	5	6							1	5	6
19					1	1								1	1
20					1	1								1	1

Table 5: Age (in years) of appearance and fusion of Lateral epicondyle of humerus (n=480)

Age (years)	Not Appeared			Appeared			Fusion not started			Active fusion			Complete fusion		
	♀	♂	Total	♀	♂	Total	♀	♂	Total	♀	♂	Total	♀	♂	Total
7		1	1					1	1						
8	6	16	22	2		2	8	16	24						
9	14	47	61	12	1	13	19	48	67	6		6	1		1
10	4	43	47	8	8	16	5	47	52	6	4	10	1		1
11	2	27	29	17	15	32	2	35	38	13	6	19	4	1	5
12		19	19	25	38	63		26	26	7	28	35	18	3	21
13		2	2	7	37	44		5	5		27	27	7	7	14
14				8	35	43					16	16	8	19	27
15				1	26	27					3	3	1	23	24
16				6	22	28							6	22	28
17				1	22	23							1	22	23
18				1	5	6							1	5	6
19					1	1								1	1
20					1	1								1	1

Fusion of olecranon process of ulna: Though evidence of onset of fusion was observed beyond 9 years of age in few cases of male (6/26) and females (2/48), and in 50% fusion did not start before 10 years in females and before 13 years in

71.79% males. Complete fusion was observed from 11 years (1/19) in females and 13 years (2/39) in males, and for majority complete fusion was observed by 13 years in females (57.14%) and 15 years in males (69.23%). We found complete fusion for all cases beyond 15 years in females and 18 years in males. (Table 4)

Appearance of lateral epicondyle of Humerus: In the female population, majority showed non- appearance upto 10 years of age and beyond 12 years of age all females showed radiological appearance of lateral epicondyle of Humerus. In males, non-appearance was observed prior to 9 years of age, with majority of population (66.67%) showing appearance beyond 12 years and for all cases after 14 years of age. (Table 5)

Fusion of lateral epicondyle of Humerus: Though evidence of onset of fusion was observed from 9 years of age in few females (6/26) and 10 years in case of males (4/51), for majority fusion was absent prior to 10 years (50%) in females and before 13 years (69.23%) in males. Complete fusion was observed from 9 years (1/26) in females and 11 years (1/42) in males, and for majority complete fusion was observed by 12 years in females (72%) and 14 years in males (54.28%). Complete fusion was seen in all cases beyond 13 years of age in females and 16 years in males. (Table 5)

Table 6: Comparison of age (in years) of epiphyseal fusion around Elbow joint given by various workers in India and other countries with findings of present study.

Author, year and study population	Head of radius		Medial epicondyle of Humerus		Trochlea of Humerus		Olecranon process of Ulna		Lateral epicondyle of Humerus	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Hepworth SM 1929 (Punjab)[22]	14-15		-	-	-	-	-	-	-	-
Lal & Nat 1934 (U.P.)[23]	17									
Pillai MJS 1936 (South India)[24]	14-17		14-17		-		14-16		11-12	
Galstaun G 1937 (India)[25]	16-17	14-15	16	14	11-15	9-13	17	15	11-16	10-12
Basu & Basu 1938 (Bengal)[26]		13-14								
Lall R & Townsend RS 1939 (U.P.)[27]		16		15						
Aggrawal ML & Pathak IC 1957 (Punjab)[28]				15-15.5						
DasGupta et al 1974 (U.P.)[29]	16-17	17-18	18-19	17-18						
Sahni & Jit 1995 (Punjab)[30]		16		16						
Patel et ał 2000 (Gujrat)[13]	16-17	15-16	17-18	16-17	14-15	13-14	16-17	15-16	14-15	13-14
Singh B 2007 (Manipur)[31]		18		18						
Sangma WB 2007 (North East India)[32]		16		16						
Nemade et al. 2007 (Maharashtra)[2]	17-18	14-15	17-18	15-16						
Bhise et al. 2011 (Maharashtra)[1]	16-17	14-16	16-17	14-16	14-16	14-15	16-17	14-16	15-17	14-15

Discussion

The justification for performing this study was to help medical professionals and law keeping authorities with a standard reference guideline of age range for a Bengali population. The study aimed at determining and corroborating skeletal age with chronological (stated age) age of the individual with the help of radiological examination. Attempts have been made to carry out similar studies in Manipur[8], Uttar Pradesh and Uttarakhand[9,10], western (Maharashtra, Gujrat),[2,11-13] southern (Karnataka)[3] part of Indian population in recent past, but a comprehensive study on population of East Indian planes is rare entity. In the abroad, significant research works have been published on Egyptian,[14] Burmese,[15] English,[16] Peshawari,[17] Australian,[18] Brazilian,[4] Sudanese [19] and European population.[20,21]

We studied both the radiological appearance and fusion of the ossification centers of all the bones around elbow joint including head of radius, medial epicondyle of humerus, trochlea of humerus, olecranon process of ulna, lateral epicondyle of humerus. This combined and comprehensive approach has not been attempted in any other national and international studies. Usually the appearance and fusion of these bony landmarks occurs earlier in females as compared to males.[4] In our study a similar finding was observed except for with the trochlea where an earlier appearance was observed in males (8 years) as compared to 9 years in females. Appearance and fusion of all centres in all cases completed first in females and then in males while maintaining the C-R-I-T-O-E mnemonic sequence.

Regarding the fusion of epiphyses with respective diaphysis, a comparison with other Indian and foreign researchers' findings has been tabulated in Table 6.[22-33] It is evident that very few earlier researchers analysed male and female population separately while considering fusion of all the ossification centers around elbow joints together.

Our study corroborates the findings of fusion of radial head in males with Brazillian and European populations and also with the study by Hepworth, Pillai, Patel et al., Bhise et al., Gaddewar et al. Findings of Lal & Nat on Uttar Pradesh population was on a higher side when compared to the present study. In females, most of the earlier studies estimate a higher age of fusion of radial head.[4, 11-13, 20-24]

Considering fusion of medial epicondyle in males, our study shows a lower range of age than most of the other national and international studies and higher age range than Manipuri population but somehow corroborates with the findings of Brazilian study and Choudhary et al. In females, Bengali population has a lower age of fusion of medial epicondyle.[3,4,8]

Fusion of trochlea of humerus occurs at a comparable age range when compared to other study findings in males. However in females, the age tallies with the findings of Ragui et al., Patel et al. and lower than the other studies and higher than the findings of Galstaun et al.[8,13,25]

In our study age of fusion of olecranon process of ulna in male was comparable with Brazilian population, Bhise et al., Patel et al., Pillai, Galstaun study and lower than Sudanese population. In females it tallies with Brazilian study but lower than Sudanese population, Dixit et al., Bhise et al., Patel et al., Pillai, Galstaun study findings.[4,10,11,13,19,24,25]

The age of fusion of lateral epicondyle of humerus in males is same with Manipuri population, Karnataka population, Galstaun study but lower than Brazilian and Sudanese population, Patel et al., Bhise et al., Singh et al. study findings and higher than Pillai study done earlier on South Indian population. In females, it is comparable to Pillai study and Galstaun study, but lower than all other studies.[3,4,8,11,13,19,24,25,31] (Table-6)

The discrepancies in findings may be due to geographical location or constitutional factors. But further extensive longitudinal study with wider age range may yield better results.

Conclusion

The earlier reliable documented study on Bengali population was done 82 years back on female subjects only. An in depth study was required for determining a reliable reference range of age. This study is a way towards that goal. Radiological analysis of appearance and fusion of ossification centers around elbow joint can be used for estimation of age in Bengali population in future taking the present study findings as reference.

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ORIGINAL ARTICLE

Age estimation in forensic investigations using tooth cementum annulations and pulp to tooth area ratio

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Abstract

Forensic age estimation is beneficial in the process of identification of deceased in mass disasters and in determining age for social benefits, license and legal requirements. This study aims to compare two methods of age estimation; the tooth cementum annulations (TCA), and, pulp to tooth area ratio (PTR), in terms of reliability and correlation with actual age. Mandibular first premolar teeth which were used for the estimation of age using cementum annulations, were obtained from thirty patients undergoing therapeutic extraction for orthodontic treatment. For the same patients mandibular canine and premolar radiographs were also obtained with prior informed consent and were employed for age estimation using pulp to tooth area ratio. Mandibular first premolar teeth were sectioned for visualization of cemental annulations using phase contrast microscope. Number of TCA was added to the average age of eruption to estimate the age of individual. Mandibular canine and first premolar radiographs were taken using paralleling technique and PTR was estimated using Autocad 2007 software. TCA using phase contrast microscopy was found to be a highly reliable method for age estimation in comparison to PTR (p=0.000). When all the parameters used in the study were combined by multiple regression analysis, highest accuracy of age estimation with least standard deviation of 1.86 years was obtained. Age estimation from tooth cementum annulations is more accurate when compared with pulp to tooth area ratio. The combination of different methods will provide more reliability in age estimation as compared to relying upon a single method.

Keywords

Age estimation; Tooth cementum annulations; Pulp to tooth area ratio

Introduction

Forensic odontology is that branch of dentistry which, in the interest of justice deals with a proper handling and examination of dental evidences and with evaluation and presentation of dental findings.[1] Its pivotal role is in the identification of living or deceased individual which is usually done by extracting triad of information that constitute age, sex and population affinity.[2]Forensic age estimation is beneficial in the process of identification of deceased in mass disasters and in determination of age for social benefits, licenses and as a proof of legal majority.[3]Teeth are the most reliable tools in estimation of age as they are highly resistant to physical and chemical destruction.[4]Different methods of age estimation can be grouped as radiographic, histological, biochemical and visual methods.

Accuracy, precision, reliability and simplicity are the cardinal requirements of any age assessment method.[5] The present study aims to compare two methods of age estimation, the Tooth Cementum Annulations (TCA), and, Pulp to Tooth area Ratio (PTR) in terms of reliability and correlation with actual age. Major objectives of this study were determination of correlation between actual age and estimated age by tooth cementum annulations using phase contrast microscopy; and determination of correlation between actual age and estimated age using pulp to tooth area ratio of the mandibular first premolar, and mandibular canine. The study objectives also included comparison of pulp to tooth area ratio and tooth cementum annulations in terms of correlation between actual age and estimated age, and determination of correlation between actual age and estimated age from combination of above parameters. The parameters were combined as follows:

1. By combination of pulp to tooth area ratio of mandibular first premolar and pulp to tooth area ratio of mandibular canine.
2. By combination of all the three variables which are tooth cementum annulations method, pulp to tooth area ratio of mandibular first premolar and pulp to tooth area ratio of mandibular canine.

Materials and Methods

The research was approved by Institutional Ethical committee. Mandibular first premolar teeth which were used for the estimation of age using cementum annulations, were obtained from patients undergoing therapeutic extraction for orthodontic

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treatment. From the same patients mandibular canine and premolar radiographs were also obtained with prior informed consent and were used for age estimation from pulp to tooth area ratio. A total of 30 mandibular first premolar teeth and 30 radiographic images were obtained from all the subjects for assessment of tooth cementum annulations and pulp to tooth area ratio respectively.

Inclusion criteria: Therapeutically extracted mandibular first premolar teeth for examination of cementum incremental lines, sound mandibular canines and first premolars to take intra oral peri apical radiographs for estimation of pulp to tooth area ratio.

Exclusion criteria: Periodontitis affected teeth, teeth affected by dental caries, pulpitis or periapical pathologies, teeth affected by attrition, abrasion or erosion, teeth with any developmental anomalies, foreshortened or elongated radiographic images.

Materials used for the assessment of tooth cementum annulations included: 30 teeth (mandibular first premolar teeth) from 30 different subjects along with clinical history records, 10% formalin, model trimmer, modeling wax, Arkansas stone, glass slides, cover slip and mounting medium, Olympus Trinocular research microscope model BX41with Phase contrast attachment and Nikon Coolpix L21Digital Camera

Materials used for the assessment of pulp to tooth area ratio included: 30 Intra oral peri apical radiographs of mandibular canines of all these subjects with the written consent form signed by all these subjects, X ray unit, scanner machine, Adobe photoshop CS7 image editing software, AutoCAD 2007 software.

After general clinical examination study subjects were selected taking exclusion and inclusion criteria into consideration. Intraoral Periapical radiograph of mandibular canine and first premolar were taken using paralleling technique. Later teeth were also collected from study subjects when they underwent therapeutic extraction of mandibular first premolar. Methodology followed to estimate the age of the study subjects from TCA and PTR are depicted in the Table 1. The results were subjected to statistical analysis. Karl Pearson Correlation coefficient and linear regression analysis was done to assess the relationship between actual age and age estimated using selected study variables. From the regression analysis new formula was derived for age estimation using each variable. All the variables were combined by multiple regression analysis and a formula was derived combining all the three parameters. Radiographic variables (pulp to tooth area ratio of mandibular canine and mandibular first premolar) were also combined to derive a new regression equation. Age estimation was also done using all the new regression equations derived.

Results

Age estimation using three different methods

The correlation between actual and estimated age was found using Pearson's correlation coefficient and p value was obtained to assess the reliability of this method in terms of correlation with actual age. Correlation analysis showed r value (Pearson's correlation coefficient) to be 0.66 and p value=0.000 when tooth cementum annulations were used, which indicates a highly significant correlation between actual age and estimated age (Figure 1).

When pulp to tooth area ratio of mandibular canine was considered correlation coefficient (r value) was found to be -0.52 and p value=0.004 and for mandibular first premolar, r value and p value obtained were -0.36 and 0.05 respectively. (Figure 2 and Figure 3).

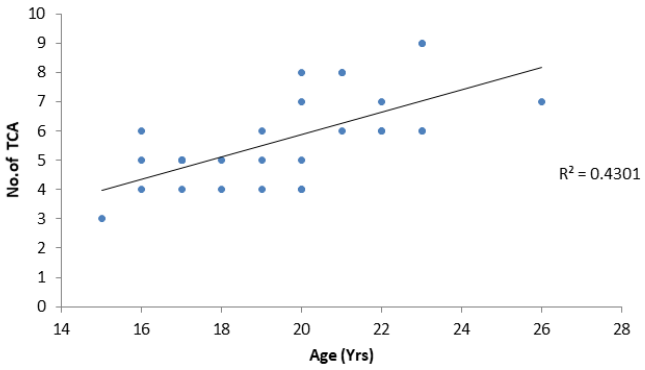

Figure 1: Correlation between Age and Tooth cementum annulations

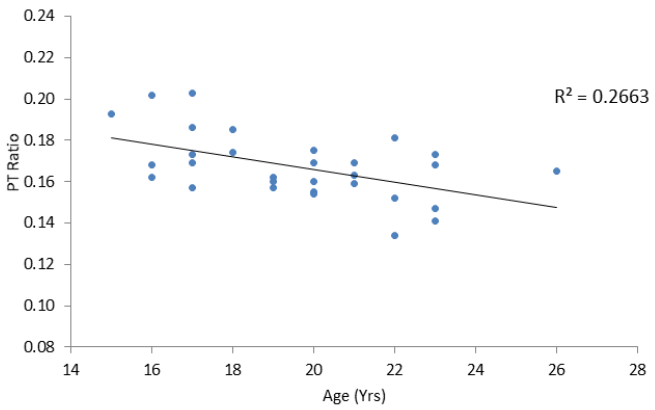

Figure 2: Correlation between age and pulp to tooth area ratio of lower canine

Comparison of all the three methods

The present study shows correlation with actual age and estimated age when all the three methods are used. Highly significant correlation is obtained when tooth cementum

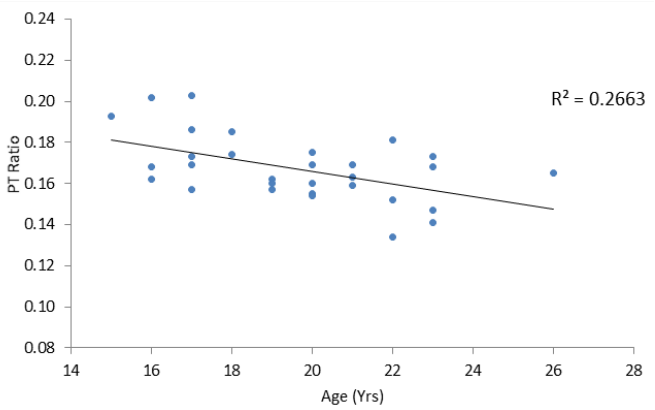

Figure 3: Correlation between Age and Pulp to tooth area ratio of Mandibular first premolar

Table 1: Methodology followed to estimate the age of the study subjects from TCA and PTR

Age estimation from tooth cementum annulations	Age estimation from pulp to tooth area ratio
• Transverse ground sections of mandibular first premolar teeth prepared • Clearing in xylene done • Mounted on a neat glass slide using DPX mountant. • Examined under phase-contrast microscope • Photographs were captured using digital camera • Distinct cementum annulations were seen which were counted manually. • Age estimation done by the following formula • Estimated age = Number of Cementum Annulations + Average Age of Eruption of the Tooth	• Mandibular canine and premolar IOPA radiographs were obtained • Scanned and digitalized the radiographs. • Scanned radiographic images were opened in Adobe Photoshop CS7 image editing software. • Pulpal and tooth outline were marked • Tooth and pulp area were separately estimated using AutoCAD 2007 software. • Age was estimated for each subject using the formula given by Acharya et al: 64.413 – (195.265 x PTR) PTR: Pulp to tooth area ratio (pulp area/ tooth area)

Table 2: Linear regression models to estimate age

Variable	Model	P-value	Standard Error
PTR – Mandibular canine	Age=34.2-87.1(PTR)	<0.05	2.57
PTR-Mandibular first premolar	Age=33.3-74.5(PTR)	<0.05	2.35
Combined mandibular canine and premolar PTR	Age = 33.6-90.7(PTRLC) + 6.1(PTRLFPM)	<0.05	2.4
Combined PTR and TCA	Age= 20.9+1.0 (NO. of TCA) -83.2 (PTRLC)+37.3 (PTRLFPM)	<0.001	1.86

PTR – Pulp to Tooth area Ratio, TCA- Tooth Cementum Annulations, PTRLC- Pulp to Tooth area Ratio of Lower Canine, PTRLFPM- Pulp to Tooth area Ratio of Lower First Premolar

annulations method is used, followed by pulp to tooth area ratio of mandibular canine and pulp to tooth area ratio of mandibular first premolar.

Age estimation by statistically derived new regression equations

New regression equations were derived for age estimation using pulp to tooth area ratio of mandibular canine and first premolar through regression analysis as depicted in Table 3. All new regression equations provided significant correlation between actual and estimated age. Another regression equation was derived by combining these two variables (Pulp to tooth area ratio of mandibular canine and first premolar) and age estimated using this equation provided a better correlation between actual age and estimated age with a standard error of 2.4 years as shown in Table 2. Combination of all the three variables through multiple regression analysis was also performed to obtain a combined regression equation as given in Table 2 which was highly reliable in terms of correlation between actual and estimated age with standard error of only 1.86 years.

Discussion

Age estimation is of paramount importance, being second to sex determination in the identification of human remains and the scientific basis of age estimation is the genetic control of odontogenesis, which delimits the temporal variation of developmental stages.[6, 7] Enamel is the hardest tissue of the body with extreme resistance to physical and chemical injuries.[7]

There are several methods of age estimation in forensic odontology which are grouped as clinical, radiographic, biochemical and histological methods. However there is no methodology that is 100% accurate in dental age estimation.[8]

The present study was aimed to compare two methods of age estimation: the tooth cementum annulations, and, pulp to tooth area ratio in terms of accuracy in estimating the age of an individual.Tooth cementum is laid down in layers with alternate dark and light bands and one layer corresponds to one year of life, making it useful as a reliable guide for age estimation in forensic dentistry. Various studies conducted by different researchers show significant correlation between actual age and estimated age when tooth cementum annulations method was employed.[9-12]

In accordance with various previous studies conducted by Bojarun et al., Avadhani et al., and Pundiret al., for age estimation from tooth cementum annulations, the present study also showed a highly significant correlation with actual age and estimated age with $p<0.001$.[9-11] This highly significant correlation obtained in the present study may be attributed to the younger age and absence of periodontitis in the subjects considered. This is in accordance with the study conducted by Dias et al. who reported that counting of cementum incremental in periodontitis affected teeth gave an underestimation of age.[12] As indicated by Avadhani et al. the transverse ground sections

of teeth is better in predicting age than longitudinal ground sections and the highly significant correlation obtained in the present study also concur with the same.[13]

The other parameters considered in the study for age estimation were pulp to tooth area ratio of mandibular premolar and mandibular canine. Pulp to tooth area ratio was used for age estimation initially in an Italian population by Cameriere et al. Later this method was employed for age estimation in Mexican, Egyptian, Portuguese Brazilian and Indian populations.[14-17] On applying Camiriere's formula for these populations, the authors found more deviation from actual age. So population specific formulas were derived in each study. A specific formula for age estimation in Indian population was derived by Acharya et al. using pulp to tooth area ratio of mandibular canine tooth from Periapical radiographs. The linear regression formula derived in their study was 64.413 - (PTR x 195.265).[18] The same formula was applied in the present study for age estimation using pulp to tooth area ratio of canine and premolar and a significant correlation between actual age and estimated age was obtained with a p value of 0.004 and 0.05 respectively. Mandibular canine gave better correlation with actual age than mandibular premolar. Even though there was a significant overestimation of age when individual subjects where considered. Thus a new linear regression equation was derived from this study for both mandibular canines and premolars which can be used for this population. This equation when applied, gave age estimation with lesser deviation from actual age.

The present study showed a higher correlation between actual age and estimated age with a standard error of 2.4 years, when both premolar and canine were combined through multiple regression analysis to get a common regression equation which is in accordance with the study conducted by jeevan et al, in which the combination of upper and lower canine were found to be more reliable with a mean residual error of 2.70, than when single tooth was used. [19]

All three parameters of tooth cemental annulations, pulp to tooth area ratio of mandibular canine and pulp to tooth area ratio of mandibular canine, were combined through multiple regression analysis to obtain a regression equation. Such an equation obtained showed highly significant correlation between actual age and estimated age with a standard deviation of 1.86 years which is lesser than those of all other formulas derived in the present study. This is also in accordance with the study conducted by Vodanovicet al. who combined methods like palatal suture closure, occlusal tooth wear, tooth root translucency and pulp/tooth area ratio to derive a multiple regression equation which gave higher correlation between actual and estimated age when compared to the use of single method.[20]

Thus the present study points towards the population based variations in age estimation even when similar methods are employed. So it is advised to use population specific formulas when age estimation is undertaken. It is always preferable to use a combination of different methods for age estimation as concluded by the present study.

Conclusion

The present study concludes tooth cemental annulation using phase contrast microscopy, pulp to tooth area ratio of mandibular canine and pulp to tooth area ratio of mandibular first premolar are reliable methods for age estimation. The cemental annulations using phase contrast microscopy is a more accurate method for age estimation when compared to pulp to tooth area ratio. The study result also emphasizes the use of a combination of methods for more accurate age estimation than relying upon a single method.

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ORIGINAL ARTICLE

Assessment of the fusion of the sternum and the medial clavicular epiphysis for the purpose of age estimation: A conventional radiographic study

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Abstract
Age estimation from radiological study of bones is often required in medicolegal practice. Correct age is essential in legal medicine, medical, social and administrative matters to validate documents. In this study, fusion of xiphoid process and manubrium with body of sternum, and the fusion of medial end of clavicle was studied in 100 individuals (53 males & 37 females) of 20 to 70 years age group. It was observed that the xiphoid process starts its union with body of sternum at the age of 36 years and is fused completely by the age of 44 years in all cases. The manubrium begins to unite with the body of sternum at about 47 years and shows complete fusion at about 54 years in males, however in females the fusion appears delayed commences at the age of 47 years and completely fuses at the age of 57 years. It is concluded from the present study that the complete epiphyseal union at medial end of clavicle in population of Jodhpur region occurred at the age of 22 years, in both males and females.

Keywords
Age estimation; Medial clavicular epiphyseal fusion; Xiphoid process; Manubrium

Introduction

Age estimation from radiological study of bones is often required in medico legal practice. In individuals of age less than 22 years many landmarks for references are available which help in estimation of age with close approximation. However, after the epiphysis of long bones have fused with metaphysis, the task of age estimation becomes very difficult. Correct age is essential in legal medicine, medical, social & administrative matters (i.e. pension settlement, senior citizen behavior, validity of marriage, entrance examinations). Age estimation also essential to validate documents, many times due to illiteracy /corruption documents are forged or misplaced at that incident we need to produced estimated age. There are other criteria also by which we can give estimated age like dental, body growth, secondary sexual characters but we need more reliable or precise method.

Sternum has been studied by few regarding its utility for estimation of age reports, in this regard, studies are conflicting because of variable results of these studies. Rentout & Smith, Reddy, Parikh[1,2,3] describe fusion of xiphoid process with mesosternum at "very old age" i.e. 55-60 years. However few researchers like Jit &, Singh et al[4,5]. have disagreed with assumption on the

basis of variable results of their studies. The epiphyseal union at medial end of clavicle indicate that medial end of clavicle unites at about age of 22 years, according to K.S. Narayan Reddy[2]. The development of medial clavicular epiphysis and its fusion with clavicular shaft has been subject of medical research since the second decade of this century.

The present study aims at investigating the age-related changes of both sternum and medial clavicular epiphysis and their utility as multifactorial approach to age estimation.

Materials and Methods

In the present study, 100 cases were selected between the study period i.e. June 2018 to June 2019 visiting to MLC OPD at MG & MDM Hospitals, Jodhpur, who were fulfilling the selection criteria were selected and after proper history taken in relation to age estimation, availability of certificate indicating the age of birth, or any such relevant document, and physical examination, skiagraphy was conducted after informed consent. The thorax of all the participants were radiographed in an antero-posterior/ lateral view to study the age-related changes of the sternum and the medial clavicular epiphyses. The participants were made to stand with their right shoulder touching the cassette in a true lateral position, with centering done at midpoint from the xiphisternum. The X-ray tube was kept at 36 inches distances. The results were classified into four categories Group A -Union not yet commenced, Group B-Union commenced, Group C--Union incomplete and Group D -Union complete. All the observations were noted on a common standard proforma and later they were tabulated to draw necessary conclusions. Descriptive statistics of the continuous variables were calculated.

All individuals from both sexes of 20 to 70 years age group,

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attending MGH/MDM Hospital OPD & their attendants were included in the study. Out of these, those consenting for skiagraphy and history taking were included in the study. Cases showing any disease having major endocrinal and metabolic disease or damage in respect to anterior chest wall were not considered, and patients on medication (steroids, hormonal therapy, having chronic or with congenital deformities were also excluded (based on history taken from subject).

Results

The sternal and clavicular fusion of 100 participants (53 males, 47 females) was investigated in the present study. The age-group wise distribution of the study participants is shown in Table 1.

Table 1: Age and gender wise distribution of study participants

Age (years)	Male	Female	Total
21–30	7	7	14
31–40	14	9	23
41–50	9	11	20
51–60	5	8	13
61–70	4	6	10
71 & Above	14	6	20
Total	53	47	100

Table 2: Fusion of xiphoid process to body of sternum in males

Age (years)	n	Non-union	Partly united	Complete fusion
21–30	7	7	0	0
31–40	14	1	12	1
41–50	9	0	2	7
51–60	5	0	0	5
61–70	4	0	0	4
71 & Above	14	0	0	14
Total	53	8	14	31

In age group 31-40, for males total number of cases were 14, out of them 12 cases were showing in process of fusion, 01 fused and 01 not fused, for females total number of cases were 09, all of them cases were showing in process of fusion. In the age group 41-50, for males total number of cases were 09 out of them completely fused were 07, in process of fusion were 02 cases, for females total cases were 11, completely fused were 08 and in process of fusion were 03 cases. The earliest instance of xiphisternal fusion was observed to be at the age of 36 years

Table 3: Fusion of xiphoid process to body of sternum in females

Age (years)	n	Separate	In process of fusion	Fused
21-30	7	2	5	0
31-40	9	0	9	0
41-50	11	0	3	8
51-60	8	0	2	6
61-70	6	0	0	6
71 & Above	6	0	0	6
Total	47	2	19	26

Table 5: Fusion of manubrium to body of sternum in females

Age group in years	n	Separate	In process of fusion	Fused
21–30	7	7	0	0
31–40	9	5	4	0
41–50	11	2	9	0
51–60	8	0	7	1
61–70	6	0	1	5
71 & Above	6	0	1	5
Total	47	14	22	11

Table 4: Fusion of manubrium to body of sternum in males

Age group in years	n	Separate	In process of fusion	Fused
21–30	7	7	0	0
31–40	14	14	0	0
41–50	9	2	7	0
51–60	5	1	3	1
61–70	4	0	1	3
71 & Above	14	0	0	14
Total	53	25	10	18

Table 6: Fusion of medial end of clavicles

Age group in years 21-30	n	Center not appeared	Center appeared but no union	Union starts but not fused	Union
Male	7	0	0	2	5
Female	7	0	0	2	5
Total	14	0	0	4	10

in males, and 37 in females. The mean ages for complete xiphisternal fusion were 44 and 46 years respectively for males and females (Table 2). For manubriosternal fusion, in age group 51-60, for males total number of cases were 05, out of them 01

case was showing complete fusion and 03 cases were in process of fusion and 01 case was separate, for females total cases were 08 out of them 01 case was completely fused and 07 cases were showing in process of fusion. For age group 61-70, for males total cases were 04 out of them 03 were completely fused and 01 case was showing in process of fusion for females total cases were 06 out of them 05 cases were completely fused and 01 case was showing in process of fusion. The earliest instance of manubriosternal fusion was observed to be at the age of 54 years in males, and 57 years in females. The mean ages of the fusion were observed to be 64 and 67 years in males and females respectively (Table 3). The earliest instance of complete medial clavicular epiphyseal fusion was observed to be 22 years in both males and females (Table 4).

Discussion

The earliest instance of xiphisternal fusion was observed to be at the age of 36 years in males, and 37 in females. The mean ages for complete xiphisternal fusion were 44 and 46 years respectively for males and females. The earliest instance of manubriosternal fusion was observed to be at the age of 54 years in males, and 57 years in females. The mean ages of the fusion were observed to be 64 and 67 years in males and females respectively.

The maximum age for stage B was found to be 20.4 years in females which was similar to that reported in the study of Brown et al.[6] The maximum age for males at this stage was also 20.4 years which is less than 24 years. The onset of the partial fusion was noted at 20 years in females and 20 years in males. This varied from the time of onset reported by Schmeling et al.,[7] who reported an onset age of 16 years for both males and females and also from Brown et al.,[6] who reported it to be 17 years and 18 years respectively for females and males. Our results are similar to 20 years for males as reported by Singh et al[5]. but quite different from 16 years for males and 17 years for females Bhise et al.[8] According to Stevenson[18], in both males and females earliest union occurred at 18 years. This stage of partial fusion continued until 24 years in females and up to 25 years in males in the present study. Although the upper age limit of the study group was 25 years so conclusive comment cannot be given for the age limit until which the stage of partial fusion continues in case of males. This stage lasted until 30 and 31 years in females and males respectively as reported in the studies by Brown et al.[6] Mckern & Stewart[19], Webb & Suchey[20], Flecker[21], Jit and Kulkarni,[4] Kreitner et al[22]., Schmeling et al.,[7] Schulz et al. and Kellinghaus et al[23]. The variations to these studies are due to different study populations on which the studies compared to have been performed. Furthermore, different technique used to assess epiphyseal union at medial end of clavicle can give different results as the studies as the studies of Krietner et al[22] Schulz et a1. and Kellinghaus et al[23]. were conducted using computed tomographic images.

Conclusion

The present study investigated the sternal fusion and the medial clavicular epiphyseal fusion in an Indian population. It was reported that the xiphisternal fusion starts at the age of 36 years, and gets completed by 44 years of age in both the sexes. Manubriosternal fusion begins at the age of 47 years and shows complete fusion by the age of 54 years in males and 57 years in females. The complete epiphyseal union at medial end of clavicle occurred at the age of **22 years,** in both males and females. Hence, epiphyseal union of medial end of clavicle can be used as a parameter to ascertain age between 20-25 years along with other bony parameters. From the study fusion of sternal elements and medial end of clavicle, we can determine the decade of age in the living. A more precise measure of determination of age in the living would be either invasive procedure or higher radiation exposure (CT scan) which is both not desirable and less feasible.

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ORIGINAL ARTICLE

Sex estimation through mandibular ramus flexure using Orthopantomogram and Lateral Cephalogram – A comparative study

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Abstract

Mandible is one of the largest and strongest bones in skull. It is sensitive to adolescent growth spurt and holds many dimorphic traits that could be useful for the sex estimation. A retrospective study was done to analyse the reliability of mandibular ramus flexure for sex estimation in Indian population and to observe, compare and evaluate the sex discriminant potential of mandibular Ramus flexure by using digital Orthopantomogram (OPG) and Lateral Cephalogram (LC). The study was conducted on 200 samples (90 males and 110 females) with aged 10-30 years, by using both standard digital OPG and LC for each study sample. The radiographs were visualized using Planmeca Romexis software 2.9.2.R. A tangent line was drawn on the posterior margin of ramus and the orientation line were drawn on the occlusal plane on mandibular molars extended to the ramus body, which predicted the sex by viewing distinct ramus flexure and later compared with actual sex. Sex was accurately determined in 60 out of 90 males with a prediction accuracy rate of 67.4%. 90 out of 110 females were identified correctly with a prediction accuracy rate of 81%. The overall accuracy rate was 74.25%. Similar results were obtained from both OPG and LC analysis. The result of the present study proved that the mandibular ramus plays a major role in sex determination due to its unique high sexual dimorphism. Hence, we advocate the use of mandibular ramus flexure as an aid for sex estimation by using either OPG or LC.

Keywords

Mandibular Ramus Flexure; Digital Orthopantomogram (OPG); Lateral Cephalogram (LC); Sexual dimorphism; Sex determination.

Introduction

Sex estimation plays as an important role in the identification of human skeletal remains as this markedly influences the determination of the age of death, stature, and ethnic background for males and females. [1, 2] When the entire skeleton presents for examination, forensic anthropologists are able to estimate sex of the remains with 90–100% accuracy. [3] However, it can be difficult to conduct an analysis when incomplete or fragmentary bones are found such as in cases of mass disasters and/or natural calamities. [4, 5]

Mandible is one of the largest and strongest bones in the skull and sensitive to adolescent growth spurt. It houses many dimorphic traits that could be employed for the sex estimation. [6, 7] One such feature is the mandibular ramus flexure. The distinct flexure in the posterior border of ramus at the level of occlusal surface of the molars, has reported a high accuracy of 90.6–99.0% for sex estimation in African Blacks. However, a prerequisite is the complete mandible and molar teeth for this morphological evaluation. [8,9]

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Loth & Henneberg (1996), questioned the predictive accuracy and reliability of the mandibular flexure as an indicator of sex. Authors of previous studies have pointed out that using the mandibular flexure for predicting sex does not yield a high confidence level, and therefore, it should be coupled with other indicators of sex dimorphism. [8]

It becomes difficult to evaluate the sexual dimorphism of mandibular ramus flexure by morphological analysis of the ramus alone. Several studies advocate the use of additional features of ramus length, maximum ramus height, bigonial breadth and bicondylar breadth to generate discriminant functions which may further be employed in sex estimation studies. As discriminant functions generated from these measurements are population specific and cannot be used for other populations, [10, 11] it is needed to evaluate the potential of mandibular ramus flexure in estimating the sex of individuals using both OPG and LC for an Indian population.

Materials and Methods

A retrospective study was conducted on randomly selected 200 samples (90 males and 110 females), aged between 10-30 years, by using both standard digital OPG and LC. Cases with known sex, availability of Orthopantomogram and Lateral Cephalogram radiographs for each sample with presence of mandibular molars, with right head alignment, contrasting and clearly visible posterior ramus borders were employed. Radiographs which indicated any pathological lesions,

congenitally missing molars and other artefacts were excluded from the study. The collected radiographs were archived in the Department of Oral Medicine and Radiology, Mysuru. Prior to commencement of the study Institutional Ethical Clearance was obtained. At the time of analysis each radiograph was assigned a code that did masked the patient's sex in order to avoid bias. Subsequently these radiographs were viewed in Planmeca Romexis viewer software 2.9.2.R. A tangent line was drawn on the posterior margin of ramus and the orientation line were drawn on the occlusal plane on mandibular molars extended to the ramus body which predicted sex by viewing the distinct ramus flexure, thus by aided in the determination of sex by the presence or absence of a distinct flexure or angulation of the posterior margin of the mandibular ramus at the level of the occlusal plane, which appears to be an extraordinarily accurate predictor of sex when compared with actual sex.

The OPG images were examined and analysed according to the guidelines described by Loth & Henneberg (1996). [8] Similarly LC images were also analysed for the same samples.

For Male – Ramus flexure present at the level of occlusion

For Female – Ramus flexure sometimes absent (looks straight), if present, may be above or below the level of occlusion.

To facilitate the identification of the ramus flexure on an OPG, two reference lines were traced. One as a tangent to the posterior border of the mandibular ramus and the other along the cusp tips of the molars to mark the occlusal plane as per the methodology described by Badran et al. [16]

All the images of OPG and LC for each sample were analysed and compared and all the variables obtained were re-evaluated by Oral Radiologists so as to minimize inter-and intra-observer variability. The data was then entered into Microsoft Excel Spreadsheet and a comparative analysis was done using SPSS Software version 23.0

Results

Sex was accurately estimated in 60 out of 90 males yielding a prediction accuracy rate of 67.4% and in 90 out of 110 females with an accuracy rate of 81.1%. Similar results were obtained from both OPG and LC analysis (Table 1). A kappa value of 0.489 indicates moderate agreement between examiners.

Table 1 represents sex estimation through Orthopantomogram (OPG) analysis. A kappa value of 0.489 implies that there is fair agreement between the actual and predicted sex (p=0.000).

Table 1 also represents sex estimation using the Lateral Cephalogram (LC) analysis. A kappa value of 0.489 implies there is sufficient agreement between the actual and predicted sex (p=0.000). The overall prediction percentage obtained is 74.25%.

Table 1: Prediction percentage for sex estimation using OPG and LC

	Females			Males		
Method of analysis	**Number of correctly identified individuals**	**Total number of participants**	**Prediction percentage**	**Number of correctly identified individuals**	**Total number of participants**	**Prediction percentage**
OPG	90	110	81.1%	60	90	67.4%
LC	90	110	81.1%	60	90	67.4%

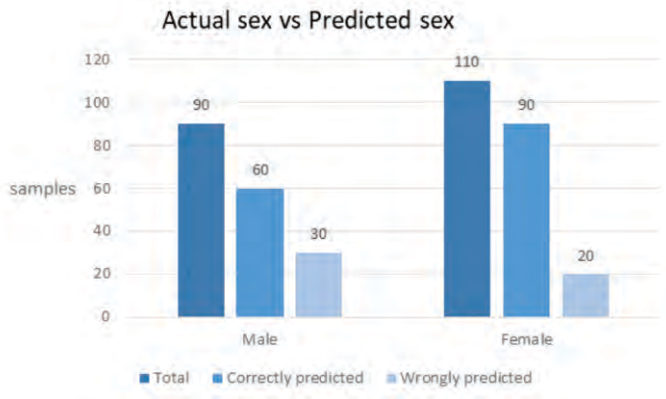

Figure 1: Actual sex versus Predicted sex pf sample population

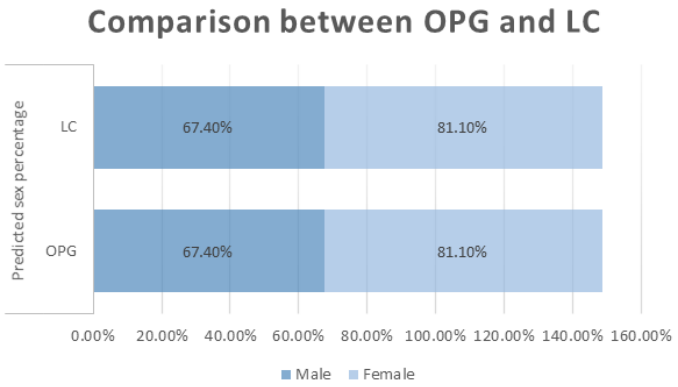

Figure 2: Comparison of obtained accuracy between OPG and LC
OPG = Orthopantomogram; LC = Lateral Cephalogram

Figure 3: Orthopantomogram (OPG) showing Ramus Flexure at the level of occlusion indicative of males

Figure 4: OPG showing absent or straight Ramus Flexure indicative of females

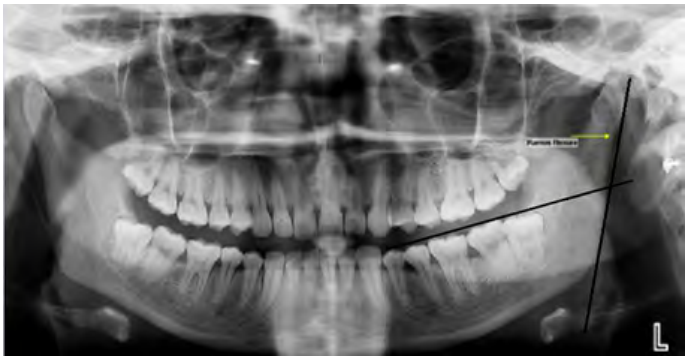

Figure 5: OPG showing Ramus Flexure at the neck of the condyle (above the occlusal plane) indicative of females

Figure 6: OPG showing Ramus Flexure below the level of occlusion indicative of females

Figure 7: Lateral Cephalogram (LC) showing Ramus Flexure at the level of occlusion indicative of males

Discussion

Following Loth & Henneberg suggested use of using mandibular ramus flexure as a morphologic trait for identification of sex in 1996, there have been a number of studies that have critically appraised the method. [16] Several researchers attributed the differences in their findings to population specific factors and other environmental functional variables such as chewing habits and food type. [16] The present study does not confirm this validation. On the other hand it shows that comparable results can be obtained from studies conducted on samples of other populations that are geographically distant from each other. The results obtained herein were similar to the findings of Suazo et al. [17]

The results of the present study showed an overall predictive accuracy of 74.25%. This is substantially lower than those previously reported by Loth & Henneberg (1996) [8], Balci et al., [3] Saini et al., [5] but was higher than the overall predictive accuracy reported by Badran et al., [16] and Suazo et al. [17] The differences among researchers in the reported value of the overall predictive accuracy of ramus flexure could be attributed primarily to the differences in the nature of the employed samples by different investigators. [16] In other words, the degree of expression of the morphologic trait could also be sex-linked and controlled by the influence of hormonal changes. It is known that changes in the shape of the mandible are affected by

the forces of muscles, particularly the elevator muscles, which plays a determinant role in the modelling of the mandibular ramus.[18]

Prior to the age at which growth at the temporomandibular joint ceases marks a period of active growth. The expression of the shape of mandible including ramus flexure moulds in response to hormonal influences and is governed, in both sexes, by the forces exerted by the masticatory muscles. Secondly, it was stated that "the high level of dimorphism in ramus may arise in response to sex-specific hormones" (Loth & Henneberg, 1996).[8]

The creation of the flexure is likely to result from a change in the size, strength or angulation of the muscles of mastication, especially the masseter and the medial pterygoid muscles, which attach just below the level of flexure on the ramus. In males, where rugosity of the medial pterygoid muscles attachment is noticeably more pronounced than that of the masseter, the ramus appears much more vertical. The temporalis and the lateral pterygoid muscles attach well above the flexure (Loth & Henneberg, 1996),[8] which increases the risk of misdiagnosis and compromises the accuracy of sex prediction. Thirdly, it may also be attributed to the subjective location of flexure of the posterior margin of mandibular ramus.[16] The present study showed similar results using both OPG and LC, which identified females with an accuracy of 81.1% and males with an accuracy of 67.4% (Figure 2). This implies either of the two methods can be employed for sex estimation.

Conclusion

Mandibular ramus flexure may be useful in sex estimation. Our results showed that it provides a fairly acceptable overall predictive accuracy and could be considered as an aid rather than a definitive means of sex estimation. In sexing unknown skeletal remains, it is necessary to apply as many methods or traits as possible instead of relying on a single morphological trait.

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ORIGINAL ARTICLE

Sex estimation using discriminant function analysis of the maximum length of clavicle: An autopsy-based study in Central India

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Abstract
Identification is the determination of the individuality of a person based on certain physical characteristics. Clavicle is one of the bones which is less explored but has drawn considerable interest in this field, particularly in relation to sexual dimorphism. The purpose of this research was to evaluate the sexual dimorphism of clavicle, based on measurement of the maximum length of dry clavicles. The study was conducted in the mortuary of the Department of Forensic Medicine, Gandhi Medical College, on 100 cases (50 males; 50 females) in which post-mortem examination was done. Clavicle bone of deceased aged between25 to 60 years were collected during autopsy, dried and then examined for the study. Approval of the Institutional Ethics Committee was obtained prior to the commencement of the study. Maximum length of clavicle was found to be larger in males as compared to females in dry clavicle. By discriminant function analysis, sex can be estimated with an accuracy of about 75%. However, these values were found to be more accurate in males with accuracy of 80% for males and 70% for females. Determination of sex by means of maximum length of clavicle can be considered a reliable indicator in dried state of the bone and the accuracy rate was high for males than females.

Keywords
Identification; Sexual Dimorphism; Maximum length of clavicle; Dry bone

Introduction

The primary characteristics of human identification are sex, age, and stature estimation.[1] The human long bones have been under study in different parts of the world by different researchers since ages. Considerable interest has been shown by Anatomists and Forensic experts on the analysis to determine their sex, age, stature and race etc. Often an expert has to extract as much information as possible from such limited and heterogeneous materials available in the form of fragmentary skeletal remains; then even a single bone like clavicle becomes important from a forensic anthropological view point. The present study was designed to identify these morphological features (predictors) and examine the sexual dimorphism of adult clavicle in the population of Central India (Bhopal region), applying linear discriminant function analysis. As the skeletal remains that are usually bought for anthropological examination are in the dried and fragmented state, this study was conducted on dry clavicle.

Materials and Methods

The study was conducted on 100 clavicles (50 males, 50 females) recovered from the medicolegal autopsies conducted in the Mortuary of Department of Forensic Medicine and Toxicology, Gandhi Medical College, Bhopal. Cases with known age and sex in between the age group of 25-60 years were taken for the study. Cases below 25 years and above 60 years and with any chronic illness, metabolic disorders, congenital anomalies, bony deformities, fracture of clavicle in Road Traffic Accidents or by any other reason were excluded. After obtaining informed consent, the thorax was opened and the right clavicle was recovered using routine standard autopsy technique. The gap was packed with cotton and body contour was restored. The clavicle was then cleaned to remove soft tissues. It was then tagged with a numbered plastic disc. These bones along with their plastic discs bearing the number were buried in the ground and left over for sufficient time (about 1 month), so that the bones were completely separated from the soft tissue. The bones were then cleaned and dried at room temperature. Measurements were taken in the dry state.

Maximum length of clavicle (MCL): The straight maximum distance between the sternal and acromial end was measured by placing the clavicle in horizontal plane on the Osteometric board. Precautions were taken to ensure that the sternal end and concavity of acromial half of clavicle are placed in the same line. Three observations were made and the average was recorded. The data was summarized as mean and standard deviation and was analysed using SPSS software. Discriminant function analysis was done to examine the dimorphism and how the variables could correctly assign the bones to the proper sex. Data was analysed using SPSS software, Student's t-test was applied to test sex differences. P value of less than 0.05 was considered significant.

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Results

The length of male clavicle ranged between 135.9mm to 166.0mm and that of female clavicle ranged between 122.2mm to 150.2mm (Figure 1)**.** Table 1 shows the descriptive statistics of the maximum clavicular length of both males and females. Different peak values of maximum length of clavicle for males and females with significant difference in the mean of both groups were noted. Mean of maximum length of clavicle (MCL)was significantly higher in males (Mean= 148.72, S.D. = 6.65) as compared to females (Mean =136.88, S.D. = 8.51). Overlapping of few values for both the sexes was also observed. Independent t-test showed statistically significant differences were observed between male and female maximum clavicular length (p-value < 0.05)

The discriminant function coefficients reveal that maximum clavicle length contributes to single variant effect. The following Discriminant function equation is obtained from the discriminant coefficients:DF= 0.131MCL – 18.685. The Cut-off score is '0'. In cases where the DF scores was less than '0' the clavicle is that of a female. For values of discriminant score above 0, the clavicle is that of a male.

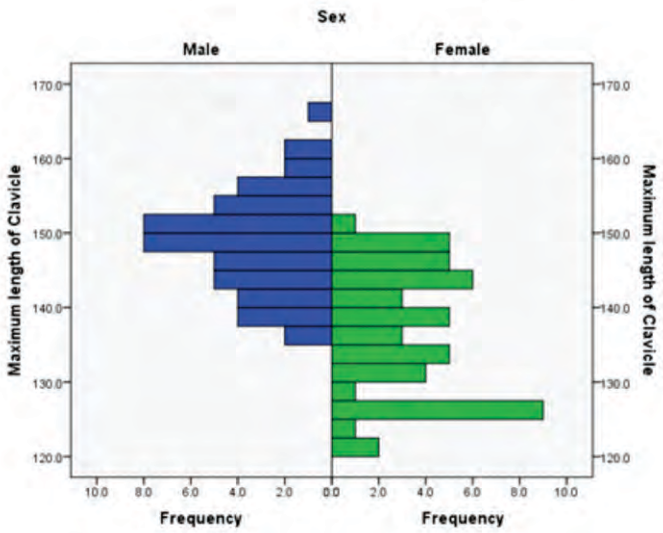

Figure 1: Histogram showing frequency-distribution of the maximum length of clavicle of both the sexes

Table 1: Descriptive statistics of maximum length of clavicle in males and females

Sex	N	Min (mm)	Max (mm)	Range (mm)	Mean (mm)	SD (mm)
Male	50	135.9	166.0	30.1	148.716	6.6522
Female	50	122.2	150.2	28.0	136.886	8.5184
Total	100	122.2	166.0	43.8	142.801	9.6520

It is observed that 75% of original grouped cases [40 among 50 males (80%) and 35 females from 50 (70%)] were correctly classified by this DF score. It implies that criteria for Maximum length of clavicle can be used with 75% accuracy for sex discrimination. (Table 2)

Table 2: Classification results for Maximum clavicular length (using the discriminant function coefficients)

		Sex	Predicted Group Membership		Total
			Male	Female	
Original	Count	Male	40	10	50
		Female	15	35	50
	%	Male	80.0	20.0	100.0
		Female	30.0	70.0	100.0
75.0% of original grouped cases correctly classified.					

Table 3: Comparison of studies on Maximum length of Clavicle (MCL) associated with Sex

Literature	n	Age (years)	Year	Male (mm)	Female (mm)	Region	Accuracy
Akhlaghi et al[2]	120	-	2012	-	-	Iran	73.3-88.3%
Sehrawat et al[3]	263	17-94	2016	148.52±8.88	135.22±8.27	Chandigarh (India)	M-75.9% F-83.8%
Frutos et al[4]	97	-	2002	-	-	Guatemala	85.6-94.8%
Alcina et al[5]	77	20-92	2015	155.12 ±10.1	132.38±7.96	Madrid (Spain)	90.9%
Haque et al[6]	257	-	2011	143.21 ±11.13 >176.60mm-male <109.82mm-female		Nepal	M-13.33% F-4.44%
Shobhaet al[7]	155	-	2014	142.1±11.70	131.7±12.22	Karnataka (India)	M-62% F-63.30%
Ashish et al[8]	40	-	2014	138.71 ± 8.66		Telangana (India)	Not useful for sexing
Bindhu S. et al[9]	50	-	2015	144.3 ± 7.2	128.0±10.1	Mangalore (India)	-
Bagal et al[10]	120	-	2016	138 mm	120 mm	Maharashtra (India)	-
Thulasi et al[11]	120	-	2017	134.57mm	120.53mm	Kerala (India)	-
S. Ishwar et al[12]	100	-	2016	152.49±9.85	139.36±6.76	Durban	-
Present study	100	25-60	2017	148.72 ± 6.65	136.88±8.51	Bhopal (India)	M-80% F-70%

n = Sample size; M = Males; F = Females

Discussion

The results of the present study are compared with the those reported in literature in Table 3. In our study, the accuracy of maximum length of clavicle in relation to sex was observed to be 80% for male and 70% for female clavicle which is nearly similar to Akhlaghi et al.[2] with a sample size of 120 and accuracy of 73-88% in Iranian population and Sehrawat et al.[3]

with accuracy of 75.9% for males and 83.8% for females in 263 individuals of age group 17-94 year in Chandigarh. The accuracy in present study was more for males but the inverse trend was seen in study by Sehrawat et al.[3]

Frutos et al.[4] noted the accuracy of 85.6-94.8% in Guatemala population by the study conducted on 97 individuals which is almost the same sample size as the present study but with a higher accuracy rate. Alcina et al.[5] observed the age group of 20-92 year in Spanish population and found the accuracy of90.9% which is higher than our study. On the other hand, in the study conducted by Haque et al.[6] on 257 Nepalese individuals the accuracy was found as 13.33% in males and 4.44% in females. Study by Shobha et al.[7] in Karnataka region over 155 individuals show accuracy of 62% in males and 63.3% in females. Comparing to present study, the sample size is more in these studies but the accuracy is found to be less.

The study by Kamdi et al.[8] done on 40 individuals in Telangana concludes that maximum length of clavicle is not a useful indicator for sexual dimorphism. In India, studies by Bindhu and Blessina[9] in Mangalore, Bagal and Takale[10] in Maharashtra and Thulasi et al.[11] in Kerala report the mean of maximum length of clavicle in males and females but do not comment on the accuracy with which the sex can be determined. In Durban, a study by Ishwarkumar et al.[12] with a sample size of 100, only the mean of maximum length of clavicle is observed.

The overall observation suggests that even in a single country, variations are seen with regard to estimation of sex with the help of clavicle. The causes for this can be environmental, socioeconomic, geographical, heredity and growth patterns. The worldwide variation also comes in both extremes.

Conclusion

Based on the observations and results of the clavicle measurements, it can be concluded that mean of maximum length of clavicle is higher among males as compared to the females in Bhopal. Also, male clavicle can be sexed with a higher accuracy rate; when only clavicle is received for examination. Discriminant function (DF) score was calculated as DF= 0.131MCL – 18.685whereby merely placing the values of MCL measurements in the discriminant function analysis equation; if the DF score < 0 then it is a female clavicle and if > 0 then a male clavicle with accuracy of 75% in Bhopal (Central region). Maximum length of clavicle can be a reliable indicator for sex determination in dried state of the bone.

Ethical clearance: A prior approval was obtained from the Institutional Ethics Committee

Conflict of interest: None to declare

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ORIGINAL ARTICLE

A post mortem study on estimation of stature from humerus in a North Kerala population

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Abstract
The identification of a dead body is required in cases of sudden and unexpected death, fires, explosions, railway or aircraft accidents and decomposed skeletal remains. Estimation of stature is an important parameter like age, sex, and ancestry in medicolegal and forensic examinations. Regression formulae derived from the major long bones are considered to be more accurate and highly correlated. There is a need to derive a regression equation and multiplication factor for estimation of stature from length of humerus in North Kerala population. The present study was conducted on 160 male and 160 female dead bodies brought for medicolegal autopsy in the Department of Forensic Medicine, Government Medical College, Kozhikode during the period of January 2012 to November 2012. Body length and humerus measurements of the cadavers were recorded after obtaining permission from institutional ethics committee. The regression equation derived from the study is that the stature in males is 35.93 + 3.973H cm with SE of 4.598 and stature in Female is 55.33+ 3.265H cm with a SE of 4.272. The various regression equations from different population are compared to the present study. Humerus to stature ratio in males found to be 19.459 and 19.389 in females. This ratio is higher than the ones given in all other studies. The Multiplication Factor obtained for males is 5.14 and females is 5.16, both of which are less than the what is reported in the available studies on Indian populations.

Keywords
Stature; Humerus; Linear regression; Multiplication factor

Introduction

Stature is one of the important criteria for establishing identification of unknown person during autopsy. It is usually measured as standing height of the individual but evaluation of stature is difficult when dead bodies are mutilated, burnt or skeletonized. Estimation of stature has a significant importance in the field of Forensic anthropometry. Many different body parts can be used in the estimation of stature. Certain long bones and appendages can be aptly used in the calculation of height of a person. One critical role of stature estimation today lies in the identification of crime victims and missing persons.[1]

At present, there are two major methods used to estimate stature: The Mathematical method and the Anatomical method. The Mathematical method takes advantage of the high linear correlation between long bones and stature.[2] With a long bone as the dependent or independent variable, one can utilize a regression equation that reflects the relationship between an individual's stature and the chosen long bone. The Anatomical method, more commonly referred to as the "Fully method", it reconstructs stature by summing the measurements of the skeletal elements that contribute to height and adding a correction factor for soft tissue.[3] The obvious advantage of mathematical method is that a single bone can be used to estimate the stature of an individual. The main disadvantage of the Mathematical method is that different regression formulae are required for different populations, for each different bone and also separately for each sex.[4]

Regression formulae derived from the major long bones are generally considered to be more accurate and highly correlated than those utilizing other bones such as the skull or hand and foot bones. There were several research studies conducted across the world. Initial research was carried out by many investigators from the 1700s like Sue (1755), Orfila (1821), Beck (1823), Rollet (1888) and Manouvrier (1893). In 1899, Karl Pearson developed the first formal stature regression formulae.[4]

For many years the formulae of Trotter & Gleser have been used most frequently for stature estimation.[5,6] However, many researchers have cautioned that formulae used to estimate stature should be specifically derived for each different population.[4] There is necessity of having formulae for the specific groups, when reliable results are required. It is obvious that there are no universally applicable formulae for stature estimation from the length of long bones as the relationship between them is influenced by the race, sex and age of an individual. Thus, the need for race, age and sex specific stature estimation formulae is proved beyond doubt. A number of multiplication factors and regression equations have been developed to reconstruct stature from long bones throughout the

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world.[7] Even within our vast homeland of India there are many different ethnic populations with their own variations.

Very few studies are available in India and studies are lacking in North Kerala setting. The present study was conducted with an aim of deriving a linear regression equation and multiplication factor for estimation of stature using the length of humerus in a Northern Kerala population.

Materials and Methods

The objective of this study was to derive a separate regression equation and multiplication factor for estimation of stature from length of right humerus in males and females, in the age group of 20 to 60 years among North Kerala population. This is a descriptive study conducted on 160 male and 160 female dead bodies brought for medicolegal autopsy in the Department of Forensic Medicine, Government Medical College, Kozhikode during the period from January 2012 to November 2012. The selection criteria were dead bodies without any apparent skeletal deformities and age group between 20 to 60 years. Any dead body with Injuries / deformity/ pathological condition affecting the vertebral column, skull, pelvis and bones of lower limbs, bodies with any injury /deformity/ pathological condition affecting right humerus, bodies with history of endocrine diseases affecting growth of bones and Individuals outside North Kerala population were excluded from the study. This study was conducted after obtaining the permission from the research committee and ethical committee of the institution.

An observation proforma which included PM No, date, name, age, sex, place, occupation, education, income, questions to rule out previous bone fracture, chronic illness and hormonal diseases of the cadaver was constructed. This proforma included space to record the measurements of the length of the body and the length of the right humerus.

The measurements were taken in two steps. First step was to measure the stature which was done by keeping the cadaver on a flat table, and measuring the distance between the vertex and the sole of the foot near the heel by using a device which is designed for the same. The device has got a long limb measuring two meters and two short limbs each measuring sixty centimeters at the both ends. One short limb is permanently fixed at one end of long limb. The other short limb can be moved through the long limb for adjusting the length of the body. The long limb is calibrated using a measuring tape with millimeter gradation. The measurement of body was taken by placing the fixed short limb touching the vertex and adjusting the height by sliding the movable limb through the long limb (Figure1).

An incision of length five centimeters is put on the front of right shoulder joint just below the top of shoulder and the soft tissues removed to expose the most proximal end of head. Most distal point on trochlea is exposed using an incision of length five centimeter vertically, on the posterior aspect of right elbow joint by keeping elbow in semi flexed position. The length of the humerus is measured from the most proximal end on the head (Caput humeri) to the most distal end on the trochlea humeri**.** The length of humerus was measured using a spring calliper (Figure2).

Figure 1: Measuring the length of the body

Figure 2: Measuring the length of humerus using spring caliper

The data collected was coded and entered in MS Excel. The data were rechecked and analysed using SPSS 16 Software. Quantitative data is presented as mean, standard deviation and qualitative as proportions. Statistical association were assessed using linear regression.

Results

Mean stature for males (N = 160) was observed to be 163.84 cm with a standard deviation of 7.088 and mean stature for females (N = 160) was observed to be 150.73 cm with a standard deviation of 6.178. Minimum height recorded among males was 146 cm and among females was 139 cm. Maximum height recorded among males was 186 cm and among females was 169 cm. Mean length of right humerus for males was 31.875 cm with a standard deviation of 1.636 and that for females was 29.223 cm with standard deviation of 1.503. Minimum length of right humerus recorded among males was

28.2 cm and among females was 26 cm. Maximum length of right humerus recorded among males was 37.2 cm and among females was 33 cm. Statistically significant correlation (p-value < 0.05) was observed between the length of humerus and the stature, with r = 0.87 for males and r = 0.89 for females.

Humerus to stature ratio was calculated as length of humerus multiplied by 100 and divided by the length of the body. This ratio is the humerus length which expressed as the percentage of stature. For males this ratio was observed to be 19.459, and for females it was observed to be 19.389. Multiplication factors to estimate stature were calculated by dividing the mean length of the study population by the mean length of the population's humerus. It was observed to be 5.14 and 5.16 for males and females respectively.

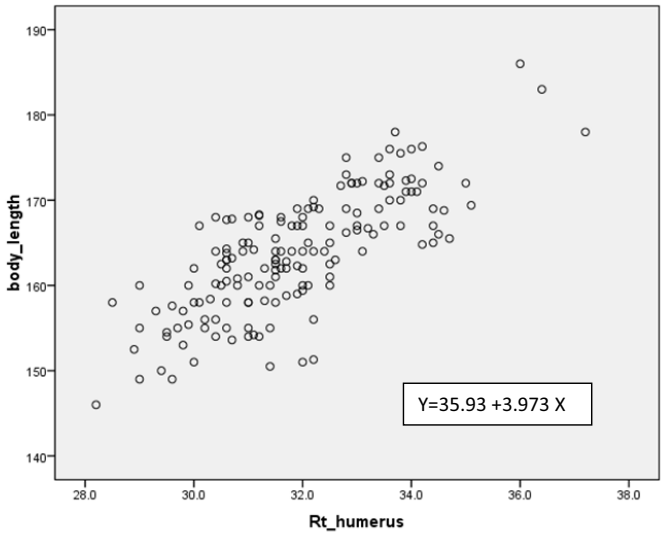

Figure 3: Regression model for estimating stature using humerus length in males

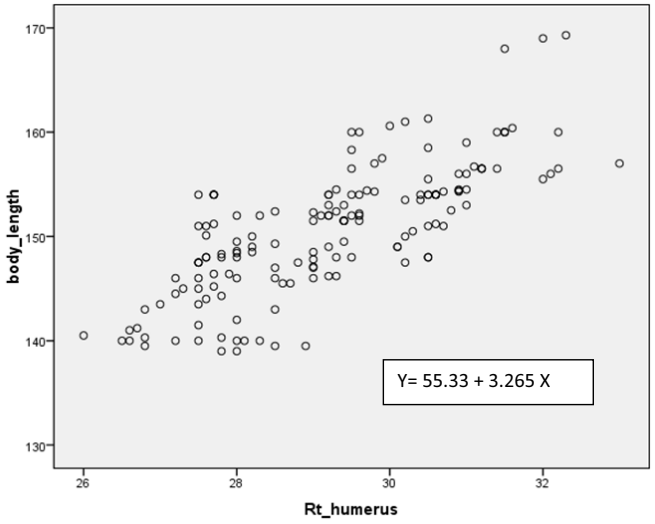

Figure 4: Regression model for estimating stature using humerus length in females

Linear regression models were generated to estimate stature using humerus length. The model to estimate stature of males is: Stature (cm) = 35.93 + 3.973 X (length of right humerus in cm) and for female it is: Stature (cm) = 55.33+3.265 × (length of right humerus in cm). Coefficient of determination (r^2) for males was observed to be 0.757, and for females it was observed to be 0.79. Standard error was observed to be 4.598 and 4.272 for males and females respectively. The graphical representation of the regression models for males and females are shown in Figures 3 and 4 respectively.

Table 1: Comparison of regression models for estimation of stature using humerus for males of the present study with those given in literature

Author	Race	Regression Equation
Pearson (1899).[2]	French	70.641 + 2.894 H
Stevenson(1921).[12]	North Chinese	81.5115 + 2.8131 H
Breitinger (1937).[13]	German	83.21 +2.715 H
Telka(1950).[14]	Finns	169.4 + 2.8 (H-32.9)
Dupertuisand Hadden(1951).[15]	White	98.341 + 2.270 H
Dupertuisand Hadden(1951).[15]	Negros	50.263 + 3.709 H
Trotter and Gleser(1952).[5]	American White	70.45 +3.08 H
Trotter and Gleser(1952).[5]	American Black	62.10 +3.26 H
Trotter and Gleser(1958).[6]	White	78.10 +2.89 H
Trotter and Gleser(1958).[6]	Negros	75.48 +2.88 H
Trotter and Gleser(1958).[6]	Mangoloids	83.19 +2.68 H
Trotter and Gleser(1958).[6]	Mexican	73.94 +2.92 H
Lundy (1983).[11]	Africans	61.02 + 2.88 H
Present study	North Kerala	35.93+3.973H

Table 2: Comparison of regression models for estimation of stature using humerus for females of the present study with those given in literature

Author	Race	Regression Equation
Pearson (1899).[2]	French	71.475 + 2.754 H
Telka (1950).[14]	Finn	156.8 + 2.7 (H-30.7)
Dupertuis and Hadden (1951).[15]	White	56.727 + 3.448 H
Dupertuis and Hadden (1951).[15]	Negros	69.978 + 3.035 H
Trotter and Gleser (1952).[5]	American White	57.97 +3.36 H
Trotter and Gleser (1952).[5]	American Black	64.67 + 3.08 H
Lundy (1983).[11]	Africans	45.65 + 3.30 H
Present study	North Kerala	55.33+3.265H

Table 3: Comparison of humerus to stature ratio of the present study with those given in the literature

Name of study	Male ratio	Female ratio
Dupertuis and HaddenWhites.[15]	19	18.8
Dupertuis and HaddenNegros.[15]	19.3	18.9
Pearson's (French).[2]	19.8	19.3
Hrdlicka's AmericanWhites.[16]	19.31	18.97
Hrdlicka's AmericanBlacks.[16]	19.80	20.34
Present study (Indian)	19.459	19.389

Table 4: Comparison of multiplication factors for estimation of stature using the length of humerus provided in different studies

Population	Sex	Multiplication Factor
East Indian-Hindus.[18]	Both	5.34
East IndiansUnited Provinces.[19]	Both	5.30
North Kerala (Present study)	Male Female	5.14 5.16

Discussion

The mean stature for males (N = 160) is 163.84 cm ± 7.088 and for females (N = 160) is 150.73 cm ± 6.178. This is comparable to a study by Goswami et al. where the mean stature in male subjects was 163.5408 ± 5.217 cm and 155.6904 ± 10.127 cm in female subjects[6] and higher than the study by Geetha et al. done in a rare tribe of Kerala.[9]

The estimation of living stature can be done from the humeral length in the absence of more appropriate long bones as the femur or the tibia.[10] Regression analysis is an appropriate method for defining the relationship between the length of the long bones and the living height of individuals.[11] The usefulness of regression equations is generally assessed on the basis of their standard error of estimates. A comparison of the standard error of estimates for the different bones used in stature estimation indicates that the long bones provide more accurate estimates.[4]

Regression models for males and females were derived after analyzing their humeral lengths. The various regression equation derived from different population are given in Table 1 and 2. The range of error in male subjects were found to be -4.94 to 4.86 and were seen consistent with the standard error of 4.598, which obtained from present study. The range of error in female subjects were found to be -7.4 to 2.3 and the standard error which we arrived at the regression equation was 4.272.[2,5,6,11-15]

Humerus to Stature ratio of present study is compared with the Dupertuis and Hadden's, Pearson's and Hrdlicka's (1898-1902) studies (Table.3).[2,15,16] In present study males found to be 19.459 and in females it is 19.389, which is higher than all other studies except Hrdlicka's American Blacks (20.34). In males it is less than Pearson's (19.8) and Hrdlicka's (White-19.31 and Black-19.80) studies. The multiplication factor is a handy tool and proves vital in situation where the forensic investigator is not well versed with complex mathematical equations or where the investigator is dealing with number of cases like mass disaster or people affected in terrorist attacks etc.[17] Comparison of Multiplication Factor of Humerus for estimation of stature among different Indian population given below (Table 4). In males, it was found to be 5.14 and females it was 5.16. Both of which are less than the studies of Pan (1924) and Nat (1931).[18,19]

Conclusion

Regression models and multiplication factors to estimate stature using humerus length were derived for males and females of a Northern Kerala population. Standard error for these regression models were observed to be 4.598 and 4.272 for males and females respectively. The results of our study concluded that it is possible to estimate the stature from the length of humerus with relative accuracy. Our study may help in forensic, anthropometric and archaeological investigations for the identification of the remains of unknown bodies by using regression equations in North Kerala population.

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ORIGINAL ARTICLE

An autopsy-based study on developing standards for estimation of stature from percutaneous length of femur in female population of Madhya Pradesh, India

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Abstract

Identification of an individual is very important in criminal cases like assault, murder, rape, disputed paternity, impersonation etc. and in civil cases like marriage, inheritance, disputed sex, etc. Identification of isolated extremities is an issue of great significance and plays a vital role in the investigation of the identity of victims in mass disasters and fatal assaults. The aim of the present study was to find the correlation between anthropometry of percutaneous length of femur and stature in females and to derive a regression equation formula and multiplication factor to estimate the stature from percutaneous length of femur anthropometry in the Central India region (M.P.). This cross-sectional study was carried out on 250 deceased females of age between 20-60 years, brought for postmortem examination to the mortuary of Forensic Medicine Department, M.G.M. Medical College and M.Y. Hospital, Indore (M.P.). The mean right and left percutaneous femoral length was 38.57 ± 1.70 cm and 38.57 ± 1.70 cm, respectively, whereas the mean stature was found to be 158.27 ± 5.68 cm. In this study, the maximum stature in females was found to be 172.0 cm and the minimum stature was found to be 143.80 cm. The correlation between percutaneous femoral length and stature was found to be positively correlated and the association was highly significant. The multiplication factor for percutaneous femoral length was found to be 4.10. Multiplication factors become essential in cases of forensic analysis when only limb or fragmented body part with soft tissue is available for analysis.

Keywords

Identification; Anthropometry; Stature; Percutaneous Femoral Length

Introduction

Reconstruction of stature is one of the important aspects of various parameters of identification for establishing individuality of the person. Under the circumstances, where Mutilated, decomposed or fragmentary skeletal remains are recovered, the stature of an individual may be estimated by adopting Anatomical Method.[1] Estimation of stature and sex is considered the main parameter of personal identification in forensic examinations. In Medico-legal autopsies, establishing personal identity of the victim is often required. In the recent times, due to natural disasters like earthquakes, tsunamis, cyclones, flood and manmade disasters like terror attacks, bomb blasts mass accidents war plane crashes etc, establishing identity of the remains has become important for both legal as well as humanitarian reasons. Stature of a person is an important parameter for the identification. Height or Stature estimation is central dogma in anthropo-forensic examination. It aids in personal identification of individual.[2,3]

Anthropometry is the systematic measurement of the physical properties of the human body, the primary dimensional descriptors of body size and shape.[4,5] Anthropometry helps in reconstruction of the biological profile of the deceased based on characteristics such as age, sex, ethnicity and stature.[6]

It is a known fact that the different population groups exhibit variation in their body proportions as a result of which correlation of one bone length to stature not only varies from population to population but also between sexes. In the past, many studies have been conducted on estimation of stature from various measurements on different parts of human body. The relationship between humerus, radius, ulna, tibia, fibula, foot and clavicle with the stature have been topics of research interest for decades.

The lower limb length is the greatest contributor to the standing height, hence the most predictive equation are based on length of lower limb, the femur, Tibia and fibula. Femur is ideal in this example as it is longest bone of body & resists erosion and keeps its phonotypical shape for long even after burial.

The aim of the present study was to find the correlation between anthropometry of percutaneous length of femur and stature in females and to derive a regression equation formula and multiplication factor to estimate the stature from percutaneous length of femur anthropometry in the Central India region (M.P.). The data presented in this study will be of benefit for fellow researchers in forensic medicine, investigators and legal experts to aid in stature determination of a person from the dimensions of the Percutaneous Length of Femur.

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Materials and Methods

The present cross-sectional study was carried out on a sample of 250 deceased females brought to the mortuary of the Department of Forensic Medicine, Mahatma Gandhi Memorial Medical College and M.Y. hospital, Indore (M.P.) after obtaining approval from the Institutional Ethics Committee. In the present study females of age between 20 to 60 years were included. Bertillon system is based on the principle that after the age of 20 years the dimensions of the skeleton remain unchanged and also that the ratio in size of different parts to one another varies considerably in different individuals. As such, this is applicable only to adults. The study was carried out from July 2018 to June 2019 for a period of one year. In the study population, the subjects included are irrespective of caste, religion, dietary habits and socioeconomic status. Subjects with skeletal abnormalities, deformities, amputated lower limbs, mutilated and decomposed bodies were excluded. Written informed consent of the relatives was taken prior to the research after giving detailed information regarding the study.

Firstly, detailed history was taken both regarding the incident and complete clinical history, including operative procedures. Detailed individual demographic data including the height, sex, age etc. was also recorded on the pre-structured proforma prepared for the study.

Anthropometric measurements of percutaneous length of femur were taken independently of the left and right side of each individual. Stature of each subject was also recorded. All the measurements were taken in daylight. The measurements were taken twice for accuracy, using standard anthropometric instruments in with graduations in centimeters to the nearest millimeters. Proper care was taken to avoid any excessive compression of underlying tissues and to record the measurements precisely.

Stature- It is measured as the vertical distance between the vertex and the heel in mid sagittal plane, where the vertex is the highest point on the head when the head is held in Frankfurt Horizontal (FH) plane. Stature was measured using the standard measuring tape in centimeters, which was held vertically in front of the subject in mid sagittal plane. Precautions were taken not to exert pressure as that may affect the contact measurement. The measurements were taken on autopsy table.

Percutaneous Length of Femur- Straight distance between the upper most prominent point on greater trochanter to the lower most point palpable on lateral femoral condyle by using a standard measuring instrument [Sliding caliper] (position: hip joint kept extended) as shown in Figures 1 and 2.

The mean values & standard deviation (SD) of percutaneous femoral length dimensions were calculated. Paired sample t-test was performed to find the right and left side differences in percutaneous femoral length dimensions. The significance of results was tested using Student's t-test. Correlation between two parametric variables was calculated using Pearson Coefficient of Correlation 'r' value. p value was used for testing statistical hypothesis. p-value of less than 0.05 was considered as significant and less than 0.001 as highly significant.

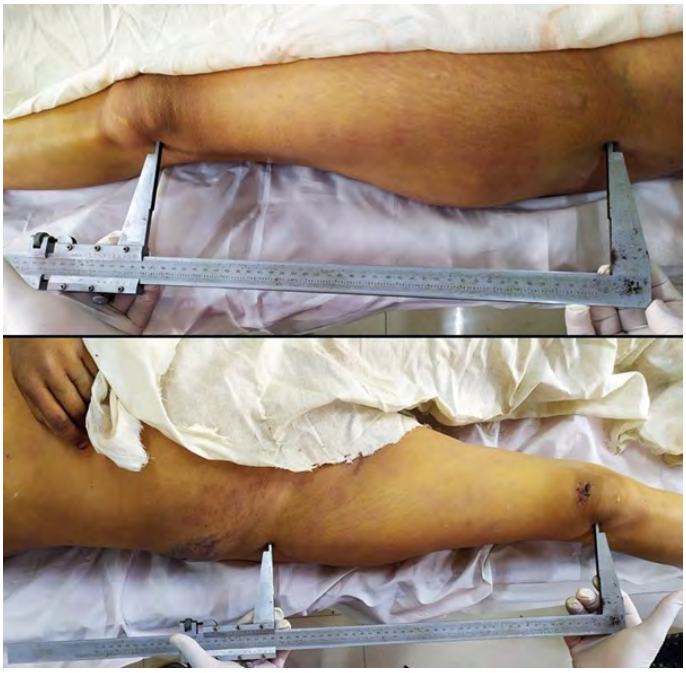

Figure 1: Measurement of the percutaneous femoral length

Results

The present study was carried out on a sample of 250 deceased females in mortuary of Department of Forensic Medicine, Mahatma Gandhi Memorial Medical College and M.Y. hospital, Indore (M.P.). Table 1 shows the age-wise distribution of the study subjects. The mean age of the study subjects was found to be 40.85 ± 11.40 years. Maximum number of cases were in age group of 26-30 years (n = 37, 14.8%), while minimum number of cases were in age group 20-25 years (n = 24, 9.6%). Mean stature of the subjects was 158.27 ± 5.68 cm. The stature of subjects ranged from 143.80 to 172.0 cm. Table 2 shows the statistical analysis for percutaneous femoral length in study subjects. The mean right percutaneous femoral length (38.57 ± 1.70 cm) was found same as that of mean left percutaneous femoral length (38.57 ± 1.70 cm). The maximum percutaneous femoral length was 42.50 cm, while the minimum was 30.0 cm of both right & left side and the range was from 30.0 - 42.50 cm. The average percutaneous femoral length was found to be 38.57 ± 1.70 cm. Maximum average percutaneous femoral length (AvPFL) was 42.50 cm while minimum percutaneous

femoral length was 30.0 cm.

In the present study a statistically significant correlation was observed between right and left percutaneous femoral length (r=0.999). The average percutaneous femoral length and stature correlation coefficient (r=0.766). On the basis of this percutaneous femoral length and stature was found to be positively correlated and the association was highly significant in both sexes. Table 3 shows the regression equation of percutaneous femoral length with stature. The equation obtained was 59.69 + 2.55 x RPFL, 59.67 + 2.55 x LPFL and 59.67 + 2.55 x AvPFL. The stature can be calculated by putting the value of right percutaneous femoral length (RPFL), left percutaneous femoral length (LPFL) and AvPFL in the equation. The multiplication factor for study subjects was 4.10 for the RPFL, LPFL and the AvPFL.

Table 1: Age-wise Distribution of Study Subjects

Age groups (years)	N	Percentage
20 - 25	24	9.6%
26 - 30	37	14.8%
31 - 35	36	14.4%
36 - 40	30	12.0%
41 - 45	33	13.2%
46 - 50	35	14.0%
51 - 55	28	11.2%
56 - 60	27	10.8%

Table 2: Statistical analysis for percutaneous femoral length in study population

	Range (cm)	Mean ± SD (cm)
RPFL	30.00 – 42.50	38.57 ± 1.704
LPFL	30.00 – 42.50	38.57 ± 1.705
AvPFL	30.00 – 42.50	38.57 ± 1.704

RPFL - Right percutaneous femoral length; LPFL - Left percutaneous femoral length; AvPFL – Average percutaneous femoral length

Table 3: Regression models for stature estimation from percutaneous femoral length

Regression Equation
Stature = 59.69 + 2.55 x RPFL
Stature = 59.67 + 2.55 x LPFL
Stature = 59.67 + 2.55 x AvPFL

RPFL - Right percutaneous femoral length; LPFL - Left percutaneous femoral length; AvPFL – Average percutaneous femoral length

Discussion

The present study was carried out on a sample of 250 deceased females in mortuary of department of Forensic Medicine, Mahatma Gandhi Memorial Medical College and M.Y. Hospital, Indore (M.P.). An attempt was made to correlate percutaneous femoral length with stature and derive regression equations to calculate stature from percutaneous femoral length. The percutaneous femoral length and stature correlation coefficient (r) was 0.766. On the basis of this percutaneous femoral length and stature was found to be positively correlated and the association was highly significant.

In the present study the mean stature of female subjects was found to be 158.27 ± 5.68, which was slightly lower than the findings of the study done by Jain et al.[7] in Jain females of Delhi (158.28 ± 5.12), Chhikara et al.[8] in North Indian students of PGIMS Rohtak (158.57 ± 5.85) and Kumar et al.[9] in females of Patna, Bihar (160.30 ± 5.04) while it was higher than the study done by Anand and Nath[10] in Brahmin & Rajput females of Garhwal (149.12 ± 5.87) & (156.14 ± 6.77) respectively, Sethi and Nath[11] in Punjabi females of Delhi (148.60 ± 5.61), Bhavna & Nath[12] in Shia Muslim females of Delhi (154.40 ± 4.91), Mohanty et al.[13] (156.54 ± 7.32) and Sanjay et al[14] (156.00 ± 5.61), as compared to present study.

In the present study mean average percutaneous femoral length (AvPFL) 38.57 ± 1.70 was found nearly similar to results of Bhavna & Nath[12] in Shia Muslim females of Delhi (38.93 ± 1.62) and Ansah et al.[15] in Kumasi females of Ghana (38.28 ± 2.61) while the findings of Chhikara et al.[8] in North Indian students of PGIMS Rohtak (42.40 ± 1.92) found to be on higher side while the findings of other study done by Jain et al.[7] in Jain females of Delhi (33.48 ± 2.08), Kumar et al.[9] in females of Patna, Bihar (36.44 ± 2.10) and Anand and Nath[10] in Brahmin & Rajput females of Garhwal 32.42 ± 1.68 & 31.08 ± 1.48 respectively were found to be on lower side as compared to present study.

The measurements of the stature obtained using regression equation were compared with the actual measurements and significant association was found between the measurements. So, stature can be predicted with high accuracy using regression equations. In the present study regression equation for estimation of stature for right and left percutaneous femoral was 59.69 + 2.55(RPFL) & 59.67 + 2.55(LPFL) respectively. The regression equations derived in the present study showed a different pattern than other study conducted by Jain et al.[7] in Jain females of Delhi 94.86+1.50 (FEML), Anand and Nath[10] in Brahmin & Rajput females of Garhwal 77.60+1.64 (FEML) and 162.66+1.10 (FEML) respectively, Sethi and Nath[11] in Punjabi females of Delhi 97.95+1.28 (FEML), Bhavna and Nath et al.[12] in Shia Muslim females of Delhi 66.82+2.25 (FEML) which shows variations in the regression equations in different ethnic

groups in India. So, regression equations of the present study cannot be applied to other population groups.

The multiplication factor is a handy tool and proves vital in situation where the forensic investigator is not well versed with complex mathematical equations or where the investigator is dealing with number of cases like mass disaster or people affected in terrorist attacks etc. The multiplication factor derived in present study for percutaneous femoral length (4.10) was found to be lower as compared to females in the study by Bhavna et al.[16] on Jat females (4.36) & Brahmin females (4.40) of Sampla, Haryana. Lower multiplication factors were observed in other studies too- 3.92 in Jain et al.,[7] 3.74 in Chhikara et al.,[8] 3.74 in Kumar et al.[9] 3.33 and 3.37 respectively in Brahmin and Rajput females of Garhwal in the study by Anand et al.,[10] 3.76 in Sethi and Nath,[11] and 3.97 in the study by Bhavna and Nath.[12]

Conclusion

Anthropometric measurements (stature and built) differ in different sex and ethnic groups due to demographic factors which are strongly influenced by genetic and environmental factors, suggesting the need for different nomograms for each endogamous group. Furthermore, the need for the alternative formulae for males and females has been substantiated as the rate of skeletal maturity in both sexes vary during the course of development. Limited literature is available on the estimation of stature using percutaneous length of femur in Central India. Further research on the subject across different demographic locations is suggested.

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ORIGINAL ARTICLE

Dermatoglyphics and saliva blood grouping can be used for sex identification

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Abstract

Fingerprints and blood-groups constitute identifying characteristics of individuals. Correlation between dermatoglyphics and blood-groups can be of use in victim identification. The aim of the present study was to determine accuracy of blood-group determination from saliva and to establish the association between distribution of fingerprint pattern and blood-groups in gender identification. 100 dental undergraduate students aged 18-22 years participated in the study. Fingerprint pattern was determined using Ink Method. ABO blood- grouping was done from saliva using the absorption-elution method. Present study showed that, most common fingerprint pattern was Loops (60%), followed by Whorls (26%) and Arches (14%). Most common blood-group was B, followed by A and O. Higher percentage of secretors in saliva was observed with females (86%) as compared to males (80%). In males, most common blood-group was AB while A was more common in females. In males, arches were most common finger print pattern (60%) whereas in females loops (55%) and whorls (52%) were more common. The study reports association between blood-group and dermatoglyphics which may help in gender identification in Forensic Medicine. It also suggests that saliva can used for ABO blood-group determination when blood stains are not available at crime-site.

Keywords

Dermatoglyphics; Blood grouping; Finger printing; Saliva; Forensic odontology; Victim identification.

Introduction

Identification of humans is a prerequisite for personal, social and legal reasons. There are various traditional methods of personal identification which include anthropometry, dermatoglyphics, DNA fingerprinting, sex estimation, estimation of age, measurement of stature, post-mortem reports and differentiation by blood groups. Among these, dermatoglyphics, that is, the study of fingerprints is considered as the best tool for the purpose of individualisation and identification.[1] It has its origin from the Greek word 'derma' meaning skin and 'glyphics' meaning curved.[2] Dermatoglyphics deals with study of the epidermal ridges and their configuration on the volar aspect of fingers, palms and soles. The ridge pattern depends upon cornified layer of epidermis as well as dermal papillae. The characteristic patterns of epidermal ridges are formed during third and fourth month of fetal life.[2] It is genotypically determined and remains unchanged from birth to death.[3] The finger prints are classified depending upon their primary pattern as loops, whorls and arches.

Among many biological evidences in medico-legal cases, blood is an important parameter as once established blood group remains unchanged throughout life, constituting thus an identifying class characteristic.[4] Blood groups are classified on the basis of presence or absence of antigens on the surface of the RBCs. The two most important blood groups are ABO (Landsteiner) and the 'Rhesus' antigen which determines the blood type.[5] Though blood can serve as a primary source of evidence, in some cases, where, blood stain may not be found at the crime site, saliva found in some form or the other which could be relied on. It is of utmost importance in determining the blood group of a victim or suspected culprit. Saliva may be obtained from bite marks, cigarette ends, envelope flaps, dental appliances or other articles contaminated with saliva.

Fingerprints constitute a highly individualistic form of evidence. Given the persistence and unchanged characteristic of these two evidences, a correlation between dermatoglyphics and blood group can be of use in victim identification.

Materials and Methods

The present study was conducted at Yerala Medical Trusts' Dental College and Hospital, Kharghar, Navi Mumbai with voluntary participation of 100 under graduate dental students aged 18-22 years. The present study was initiated after approval from the Institutional Ethics Committee. Participants were subjected to finger print identification and blood grouping using saliva and blood after obtaining a written informed consent from the participants. Participant's details like name, age, sex were noted. Subjects with normal thumb were included in the study. Students with permanent scars on their fingers and/or thumbs, or with any hand deformities due to injury, birth defect or disease, those having worn fingerprints, extra webbed or bandaged fingers, hypersensitivity to endorsing ink were

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excluded from the study.

The subjects were asked to give imprints of their left thumb by using the Ink Method as described by Cummins and Midlo.[6] Sweat, oil and dust from the skin surface was removed, by cleaning the hands with soap and water and wiping with ethyl alcohol, so as to enhance the quality of dermatoglyphic prints. Primary patterns such as loops, whorls and arches were observed with the help of a powerful hand lens.

ABO blood grouping was done using saliva and correlated with ABO blood grouping system. [7] ABO blood group of the patient was assessed by slide agglutination method. The results were recorded accurately and the detected blood group from blood was considered as standard against which the salivary blood group was compared. For blood group identification using saliva, all the samples were subjected to absorption-elution method because of its high sensitivity.[8] The subjects were asked to rinse their mouth thoroughly to remove debris and asked to spit in clean and dry test tubes. 1.5 ml of saliva was added to distilled water and the test tubes were placed in a hot water bath for 10 minutes. After discarding the sediment, supernatant was taken in two test tubes and labelled as A and B to which anti-sera A and B were added respectively. The test tubes were then thoroughly shaken and then placed into an incubator for 5 hours for adequate antigen-antibody reaction to occur. The test tubes were then heated in a hot water bath maintained at 56°C to break the bond between the antigen and the antibodies. A single drop of freshly prepared pooled red blood cells of known group was added to the respective test tubes and shaken well following which, incubation was done for 15 min at 37°celcius. Both the test tubes were then centrifuged for 1 min at 2000 rpm. The agglutination was observed microscopically and the presence of agglutination was considered as a positive result.

Results

In the present study, among 100 participants, 76 were females and 24 were males. On analyzing the distribution of finger print patterns, we found that loops (60%) is the most common pattern followed by whorls (26%) (Table 1). The least common pattern was found to be arches (14 %). In males the most common finger print pattern was arches (60%) while in females the most common was loops (55%) and whorls (52%). When we correlated the ABO blood group determination using blood and saliva, we found that higher percentage of secretors in saliva was observed in females (86%) than males (80%). Most common blood group on saliva was found to be B (62%) followed by A (21%) and O (10%) which correlated with the findings on blood. In males the most common blood group was AB while in females the most common blood group was found to be A (Table 2). Table 3 shows distribution of primary finger print patterns among A, B, O and AB blood groups on saliva. In blood group B, the most common pattern observed was loops (40%) followed by whorls (31%).

Table 1: Distribution of fingerprint patterns among study participants

Fingerprint patterns	N
Loops	60
Whorls	26
Arches	14

Table 2: ABO blood group distribution in Males and Females

Blood Group	Males (26)	Females (74)
A	(20%)	(80%)
B	(24%)	(76%)
AB	(55%)	(45%)
O	(25%)	(75%)

Table 3: Fingerprint pattern distribution among ABO blood groups

Blood groups	Loops	Whorls	Arches
A	34%	27%	39%
B	40%	31%	29%
O	39%	31%	30%
AB	29%	40%	31%

Discussion

Fingerprints are a unique characteristic which can be used in identification. Blood group is one of the important factors for identification of an individual for ruling out the identity of suspected unknown individual. At present the most common method for ABO blood typing is from a drop of blood obtained by pricking the finger. Besides blood, these antigens are secreted in various body fluids including saliva. In medicolegal cases, where blood stains are not available, saliva can be of paramount importance in blood group identification. In this study, we tried to find the accuracy of blood group determination using saliva. As finger print pattern and blood group remains unchanged once they are established, we tried to find an association between distribution of finger print patterns and blood groups, where blood group was determined from saliva.

In this study, among finger print patterns, loops showed highest frequency (70%), whorls showed moderate incidence (20%)

and arches (10%) were least common. These findings are similar to the studies by Gowda et al. 1996 [9], Bharadwaja [10] and Hamid et al. [11] In males the most common finger print pattern observed was arches while in females loops and whorls were common.

Indirect blood grouping by saliva, yielded that the most common blood group was B (62%) followed by A (21%) and O (10%) which is similar to the results by Verma et al. (2015) using blood. [12] In males the most common blood group was AB and in females A was most common blood group. In our study higher percentage of secretors in saliva were observed in females (86%) than males (80%). Similar results were obtained for a study conducted by Motghare et al.. [13] More number of Indians are secretors of blood group antigens in saliva as compared to other races.[13] Results of our study suggest that saliva can used for ABO blood group determination where blood stains are not available at the crime site.

For all blood groups, the most common fingerprint pattern was loops, which is in accordance with the study by Desai et al. 2103.[1] When we tried to correlate gender with blood group and finger print pattern we observed that, in females the most common blood group was A and the most common fingerprint pattern was loops. This was followed by blood group B and whorl pattern. Blood group O was third most common and arches were least common in this blood group. In males the most common blood group was AB and most common fingerprint pattern was arches. Blood group O and whorl pattern was second most common finding which was followed by blood group B and arches.

There are some studies where the association between blood group and dermatoglyphics have been studied, however in these studies, blood groups were determined from blood directly. This is the first study to report an association between finger print pattern and blood group where blood group was determined using saliva. Result of the study suggests that an association exists between finger print pattern, blood groups and gender. This association may help in gender identification in forensic medicine. However, whether this association changes with different regions and populations requires further evaluation.

Conclusion

Present study reports an association between blood group and dermatoglyphics and this association may help in gender identification in forensic medicine. Result of our study also suggests that saliva can used for ABO blood group determination where blood stains are not available at the crime site.

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ORIGINAL ARTICLE

Histopathological changes in pancreas in cases of death due to burn injuries-A pilot study on postmortem histopathology

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Abstract

Burn injury causes significant fatality every year with its immediate effect or complications. This is 6th most frequent cause of unnatural death & 3rd most frequent cause of suicidal death. Organ specific pathology has been studied a lot, but pancreatic pathology has been missed and overlooked over the years. This prospective, observational, cross-sectional study was aimed to find out gross & microscopic histopathology changes of pancreas in burn cases & to correlate the pathological findings with the duration of survival after receiving burn injury and total body surface area burnt (TBSA). It was done on medico-legal autopsy cases with burn injury over 4 months. All cases irrespective of gender and age were included except decomposed bodies. The survival period was noted from available documents and TBSA calculated using 'Rule of nine'. Pancreatic specimen retrieved and preserved in 10% formalin solution, processed & examined macro & microscopically. Total 13 cases (9 female, 4 male) aged between 19 to 38 years examined while survival period varied from 7 hours to 429.5 hours & TBSA varied from 44.5% to 93.5%. Patchy area of blackish discoloration found in 3 cases macroscopically. Microscopically- pancreatic oedema, congestion was most consistent finding, hemorrhage being inconsistent & necrosis rarest along with various other significant findings suggestive of severe pancreatic inflammation. Extensive study with larger sample size and extensive recruitment of samples can yield significant evidence in future.

Keywords

Burn injury; Histopathology; Postmortem changes; Pancreas; Post burn pancreatitis

Introduction

Human civilization has changed since the use of fire has enhanced life to its greatest. But hazards due to heat and fire have also been a globally prevalent serious public health concern in the form of burn injury.[1] It has been marked as fourth commonest trauma after traffic accident, interpersonal violence and falls.[2,3] National Health Portal of India reports almost 7 million Indians to be injured and 1.4 Lacs to be dying due to burn yearly.[4] Burn Injury is a thermal injury which causes tissue destruction and affect vital systems of the body namely, nervous system, gastro-intestinal system, male and female reproductive system, renal and endocrine system.[5,6] There is no exact single reason for death in burn patients but many early and late causes have been identified till date. It is established that morbidity and mortality in burn is directly proportional to age and total body surface area burnt.[7] Different pathophysiological response following burn injury affects various organs leading to many frank and occult complications like septicemia, pneumonia, acute kidney injury and multiorgan failure.[8,9,10,11] Forensic pathologists thus studied target organ specific histopathology to find out the not-so-infrequent unidentified aetiology behind the death of burn patient. Organs like lungs, kidney, liver have been experimented for any change in burn injuries but pancreas has been studied very less. But it has significant contribution in complication of burn patients. It has been 45 years when Goodwin, in a conference paper, showed burn patients affected with pancreatitis. Advancements in burn care led to an uprise in the survival rate of people by managing previously hidden and unrecognized complications which are now better handled and managed.[12] Even after extensive study, pancreatic complications remain undiagnosed or neglected in the broad umbrella of multiorgan dysfunction syndrome (MODS) or frequently missed.[13] This study is an attempt to delve deep into the pancreatic pathology in burn patients complicating to death with the objective of finding out gross & microscopic histopathological changes of pancreas in burn cases & to correlate those findings with duration of survival after receiving burn injury and total body surface area burnt (TBSA).

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Materials and Methods

After receiving proper approval from the institutional ethics committee, this prospective, observational and cross-sectional study was done in a tertiary care referral centre and

Government medical college over a period of 4 months on burn injury cases coming for medico-legal autopsy. All the cases during the study period including both sex and open age range were considered except bodies with decomposition, postmortem burns, electrocution and chemical burns. Bodies were dissected with proper care and skill, maintaining conventional autopsy protocol. After opening the abdominal cavity, whole pancreas was dissected out carefully as sample. It was duly collected and preserved in a medium sized plastic container by submerging in 10% formalin. Dissected specimens of pancreas were examined for gross pathological findings, if any, before preservation. Then these samples were further examined in Department of pathology for further gross pathological examination after fixation for 24 hours. The pancreas sample was properly cut into randomized sections of small size. Transverse or longitudinal or random sections were done from head, body and tail of pancreas as required. Tissue processing was done with automated tissue processor Lieca TP 1020 followed by staining with haematoxylin and eosin (H&E) stains. Thereafter, slides were examined under microscope for histopathological findings and the data were tabulated, plotted and analyzed in MS Excel spreadsheet.

Results

Thirteen burn injury cases (n=13) coming for medicolegal autopsy were selected according to inclusion and exclusion criteria. Among 13 cases, 9 were female and 4 cases were male, all aged between 19 to 38 years and having survival time ranged from 7 hours to almost 18 days. Survival time showed an average of 131.7±99.8 hours. Total Body Surface Area burnt (TBSA) ranged from 44.5% to 93.5% with an average of 60.5±14.2%. On random section in macroscopic examination, red patchy areas of hemorrhage [Figure 1] and blackish areas of necrotic tissues [Figure 2] were spotted within pancreatic parenchyma in different cases. We found pancreatic congestion and edema to be most consistent finding (in 12 cases) followed by hemorrhage (in 9 cases), inflammation (in 8 cases), acinar homogenization and destruction (in 5 cases) and fat necrosis (in 4 cases) [Table: 1]

On arranging the cases in the increasing order of the survival time, we came to a conclusion that hemorrhage was evident after 2 days of survival whereas necrosis was prominent around 4^{th} day and after 6^{th} day. Similar attempt was made with Total Body Surface area burnt (TBSA) and it was evident that hemorrhage had no specific trend in relation to TBSA and necrosis was found in more than 45% TBSA, though it was not a very consistent finding. Other findings, though inconsistent in relation to survival period or TBSA, were dilated pancreatic ducts with mucinous discharge within it, acinar homogenization and fibrin thrombi visible in vessels with infiltration of inflammatory cells.

Table 1: Demographic and pathological desciption of cases (n=13)

Case no	Sex	Age in years	Survival in hours	TBSA%	Congestion	Oedema	Haemorrhage	Inflammation	Acinar destruction	Fat necrosis
1	Female	19	154	46.5	Yes	Yes	Yes	Yes	Yes	Yes
2	Female	19	162	65.5	No	Yes	No	Yes	Yes	Yes
3	Female	31	139	93.5	Yes	Yes	Yes	No	No	No
4	Female	22	429.5	46	Yes	Yes	No	Yes	Yes	No
5	Female	30	119	89.5	Yes	Yes	Yes	Yes	Yes	Yes
6	Male	36	10	64.5	Yes	Yes	Yes	Yes	No	No
7	Male	38	53.5	61	Yes	Yes	Yes	Yes	No	No
8	Male	24	122.3	58	Yes	No	No	Yes	No	No
9	Female	22	7	53.5	Yes	Yes	N	Yes	No	No
10	Female	36	91	60	Yes	Yes	Yes	No	No	No
11	Female	19	112	50	Yes	Yes	Yes	No	No	No
12	Male	26	91	44.5	Yes	Yes	Yes	No	Yes	Yes
13	Female	21	163	82	Yes	Yes	Yes	No	No	No

*TBSA= Total Body Surface Area burnt

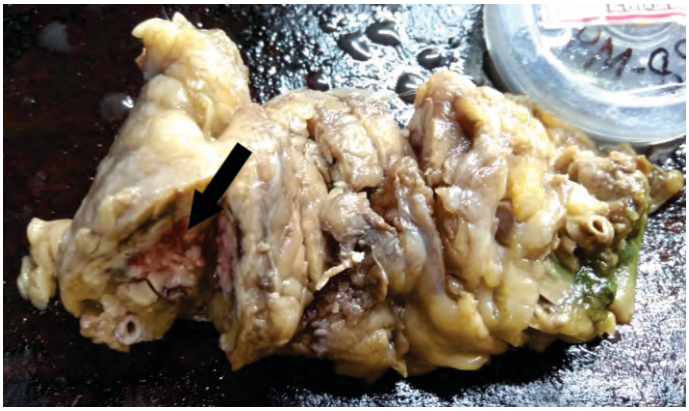

Figure 1: Red patchy areas of pancreatic hemorrhage as shown by the black arrow

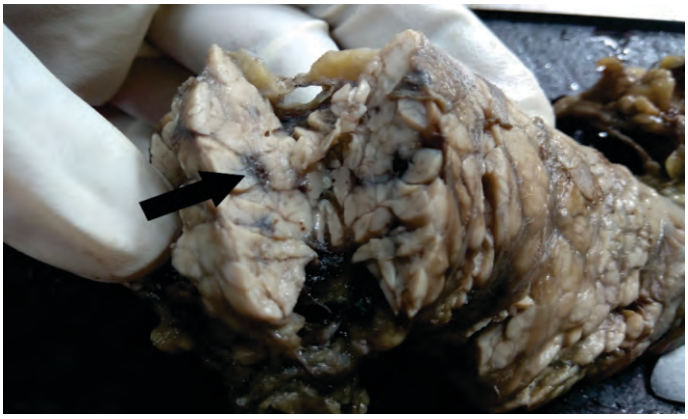

Figure 2: Blackish areas of pancreatic necrosis in gross pathology as shown by the black arrow

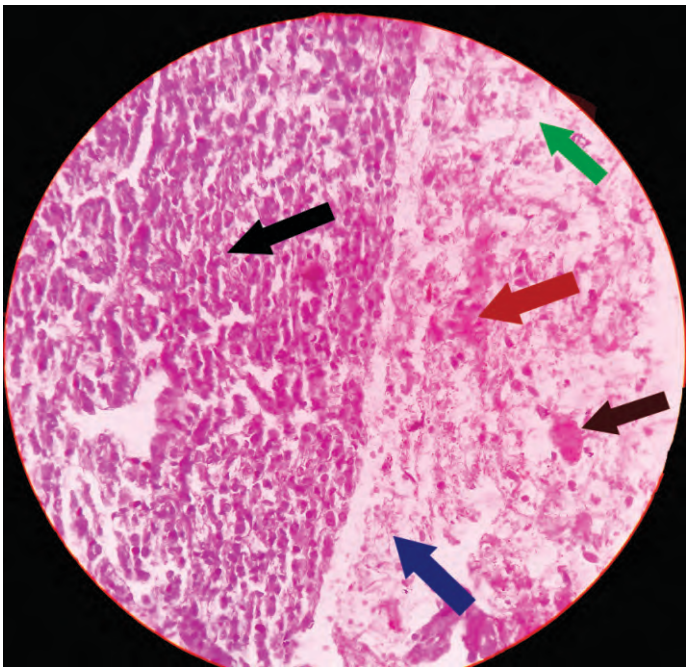

Figure 3: Pancreatic edema, hemorrhage, congestion with acinar cell homogenization and inflammatory cell infiltration

*Green arrow=Edema; Red arrow=Hemorrhage; Brown arrow=Congestion; Black arrow=Acinar cell homogenization; Blue arrow=Inflammatory cell infiltration.

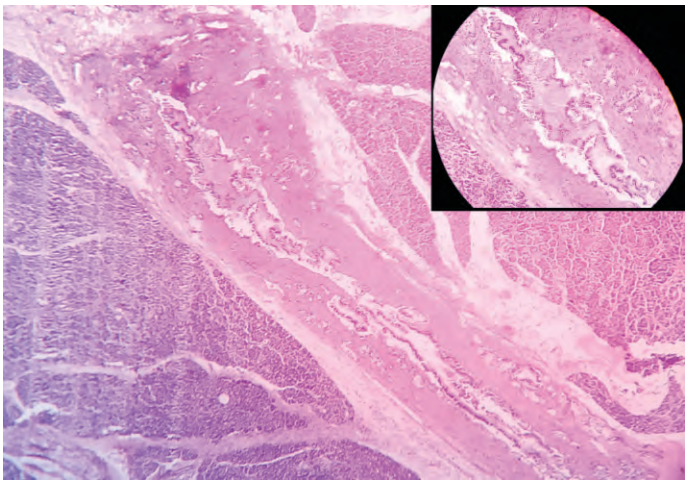

Figure 4: Dilated pancreatic duct with denuded endothelium and mucinous discharge within (Inset: Magnified view)

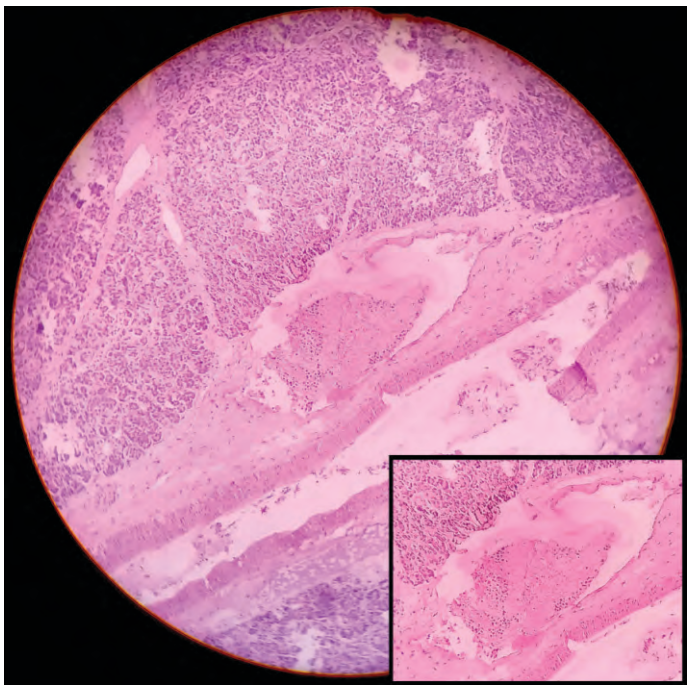

Figure 5: Fibrin thrombus within pancreatic vessel with surrounding inflammatory cell infiltration (Inset: Magnified view)

Discussion

Burn injury initiates a high metabolic response within body and exacerbates the inflammatory response through free radicals in the body leading to organ dysfunction involving predominantly liver, heart, lung, kidney, gastrointestinal tract and pancreas.[11,14] Though upgradation of knowledge in pathophysiology of shock in burn injury and fluid replacement therapy reduced early death and increased survival in severely burnt patients, still organ dysfunction pathology has always been a point of interest to the researchers and studied over years.[15] But pancreas has

always been studied very less and very few studies mention about pancreatic pathology in burn patients namely pancreatitis etc.[8] In our study, all cases were adult with TBSA more than 44% which is consistent with what WHO says that >15% TBSA in adult is serious.[7] Though earlier studies on burn pathology recruited 50% to 57% of total study population having >40% TBSA.[16,17] So this study deals with severely affected population having more chance of organ specific pathology and thus conclusions drawn are more trustworthy.

In acute pancreatitis, proenzymes get activated to cause autodigestive tissue necrosis which is classified into mild or edematous and severe or necrotic variety through Atlanta classification. Grossly, it ranges from swollen and firm to hemorrhagic and necrotic in appearance. Post burn pancreatitis is caused mainly due to hypovolemia and pancreatic ischemia where extent of is a major determinant. The histopathological findings depend on severity and duration of the disease process. Edema is more prominently marked in fibrous and adipose tissue. Marked parenchymal hemorrhage, acinar destruction and fat necrosis, dilated ducts with discharge within and thrombi within capillaries and vessels indicate severe inflammation.[18] In our study, all of these findings were evident in different cases establishing the presence of pancreatic inflammation of severe degree. Ryan et al in their retrospective review of 121 adult burn patients found elevation of amylase and lipase levels in 40% cases and symptoms of pancreatitis in 82% cases of burn injury having >20% TBSA. It was claimed that high enzyme elevation and ≥50% TBSA are risk factors.[19] A record-based study in Canada on 2699 pediatric burn patients revealed evidence of pancreatic inflammation including fat and parenchymal necrosis on autopsy to establish acute pancreatitis in 13 (0.05%) cases.[20] But in our autopsy-based study, pancreatitis has been found more frequently. Acute pancreatitis (AP) after extensive burn injury is under-recognized and easily missed complication which is associated with significant increase in mortality. Low-density area detected in the pancreas on CT scan early after receipt of burn injury may predict the development of pancreatitis.[21] Increase in extent of inflammation and necrosis of pancreatic tissue within 48 hours of burn injury indicates pancreatitis.[18] Some researchers claim no acute change in function of liver, heart and pancreas in early phase of post burn period and also no correlation between serum enzymes, except amylase, and TBSA%.[11] The assessment of magnitude and severity of the pathology is necessary for systematic planning of prevention.[22] The limitation of our study was small sample size, exclusion of electric and chemical burns, non-estimation of serum enzymes (amylase, lipase etc.) to correlate with the pathology. The duration of untreated hours before admission of the patients was also not available.

Conclusion

From this pilot study, we conclude that pancreatic pathology causes serious complications including fatality in early to late phase of burn injury. Thus, a better prevention strategy is solicited which can save life in low to middle income country like India. Developments in burn care and enhanced technologies have decreased the chances and a risk of death as compared to past and it has increased the longevity of life in many affected persons. More advancements and more detailed research with various organs can pave a way to discovery of more accurate causes of death in cases of burn injury. A multi centric study with a larger sample size and more extensive recruitment criteria of samples can be further enlightening. Pancreatic studies have a positive impact as very few have been done till now. So in a distant future, we can aim at the most beneficial treatment and management of burn injuries which will be the least invasive and will target the minimum suffering of the patients.

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ORIGINAL ARTICLE

Road traffic injuries - A comprehensive retrospective analysis

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Abstract
Road traffic injury has emerged as a major public health problem in recent years. The present study conducted over a period of two and a half years besides focusing on the demographic and medical aspects of road traffic injuries is unique in sketching a psychological and economical effects of the same in detail. Males 88.21% (187) predominate females 11.79% (25) as victims. Most victims coming to hospital had grievous injuries (47.17%) followed by dangerous (26.89 %) and simple (25.94%) injuries. Firsthand accounts of reason leading to road traffic injuries reveal high speed 35 cases (16.52%) and rash driving from other vehicle 25 cases (11.79%). Most of cases of high-speed road traffic injuries involved young adults males in second or third decade of life travelling on two wheelers (mostly motorcycles) driven by a necessity for example, to reach work in time 15 cases (42.86%); thrill seeking behavior in 11 cases (31.43%); or influenced by speed centric films in 8 cases (42.86%). Maximum cases (49.53%) needed 1-2 weeks of hospitalization. The cost of such injuries is huge; a major operative procedure consumes 75 days of manpower besides a baseline cost of 4000 rupees. This excludes the cost of infrastructure; specialized treatment; or medical accessories needed for such a treatment. This baseline cost gets multiplied by a factor of 3 to 4 times at private run hospitals.

Keywords
Road traffic Injury; Demographics; Grievous injury; Thrill

Introduction

Road traffic continues to be a major developmental issue, a public health concern and is a leading cause of death and injury across the world killing more than 1.35 million globally in 2016 as reported in the Global Status report on Road Safety 2018 with 90% of these casualties taking place in the developing countries. As per the World Health Organization, accident related deaths, are known to be the eighth leading cause of death and the first largest cause of death among children aged 5-14 and adults in the age 15-29.[1] Globally, 54% of accident related deaths are pedestrians, cyclists and motor cyclists. This results in considerable economic losses not only to individuals, their families, but also to the nations as a whole.[1] Road accidents in India kill almost 1.5 lakh people annually. Accordingly, India accounts for almost 11% of the accident related deaths in the world. In India a total of 4,67,044 road accidents were reported by States and Union Territories (UTs) killing 1,51,417 people and causing injury to 4,69, 418 persons in 2018. This translates into an average of 1,280 accidents and 415 deaths every day and nearly 53 accidents and 17 deaths every hour in 2018.[2] Total deaths reported under Sec 304 IPC in state of Jammu & Kashmir for year 2016 were 880 in 674 incidents with a crime rate of 5.4%. Among these deaths due to rash and negligent driving alone accounted for 652 incidents claiming 851 lives with a crime rate of 5.2% i.e. 96.70% of all the death occurring under sec 304 IPC.[3] This figure has reached to 635 incidents with 958 deaths with a rate of 5.0% for the year 2017.[4] This underscores the importance of Road traffic Safety in public health domain.

Similarly, there were 6451 injuries of Grievous nature (sec 320 IPC) in 4859 incidents of rash driving booked under sections 337 & 338 IPC in state of Jammu & Kashmir for year 2016 with a crime rate of 39.0%.[3] The above-mentioned statistics run contrary to the inquest into the world's first road traffic death on 17th August 1896, where the coroner was reported to have said, “This must never happen again”. The victim Miss Bridget Driscoll a 44-year-old mother of two, was a pedestrian who was struck down by a motor vehicle.[5]

Material and Methods

This is a retrospective study involving 212 road traffic injuries cases conducted by direct interview, medicolegal reports, police records, outdoor and in-door records of the patients involved. The study was conducted in Associated Hospitals of Govt. Medical College Srinagar a urban medical institution in northern Indian State of Jammu & Kashmir between January 2017 to June 2019. The Associated Hospitals serve as main centers of tertiary care in and around the major urban center of Srinagar. The study is representative of avoidable disease burden put on a population by a fast-tracked modern life. A total number of 230 cases were analyzed, out of which as per exclusion criteria 18 cases were

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rejected as the injuries could not be directly linked to road traffic incidents because of non-coherence of patient statements, insufficient data and records. A unique feature of the study was to interview the victims in reassuring manner, allying fears of possible negligence on their part. Still in 49 cases (23.11%) no definitive or vague reasoning for causation of accident could be obtained in spite of best possible reassurance given.

Treatment in Govt. Hospital means average baseline cost of treatment for each hospitalization. All treatment modalities are exclusive of technical equipment and infrastructure needed for such procedures. It includes cost in rupees of only baseline items needed for procedure prevalent at that point in time. Baseline items refer to medication or allied resources like gauze; cotton; betadine; sutures; tetanus, diclofenac, ranitidine, penicillin injections; ringer lactate, dextrose, normal saline infusions; surgical gloves, aprons, masks, caps, foot covers; anesthetic drugs and similar items. Table No. 6 is therefore only an indicative of disease burden on community and does not cover the exact cost of each treatment which may be much more that indicated depending on type of surgery or post-surgical rehabilitation. Average manpower; money and other resources spent are highlighted as under:

1. Average for laceration repair like procedure needing 1 specialist; 1 technical staff;1 nursing staff and 1 house-keeping staff. For the same procedure average cost of surgical expendables and anesthetic expendables comes to 900 Rs per procedure.
2. Average for hernia repair like procedure needing 2 specialists; 1 assistant; 2 technical staff for surgical team and 1 specialist; 1 assistant; 1 technician for anesthetic team with 1 member of housekeeping staff on day of surgical procedure. An average 3-day post-operative hospitalization will need additional manpower per day of 2 junior doctors; 2 nursing staff; 1 technical staff and 2 housekeeping staff. For the same procedure average cost of surgical expendables and anesthetic expendables comes to 1650 Rs per procedure and 450 Rs per procedure respectively which does not include use of special equipment or medication needed for certain surgeries.
3. Average for a laparotomy like procedure needing 2 specialists; 2 assistants; 2 technical staff for surgical team and 2 specialists; 1 assistant and 1technical staff for anesthetic team with 2 members of housekeeping staff on day of surgical procedure. An average seven-day post-operative hospitalization will need additional manpower per day of 2 senior doctors; 2 junior doctors; 2 nursing staff; 1 technical staff and 2 housekeeping staff. For the same procedure average cost of surgical expendables and anesthetic expendables comes to 3000 Rs per procedure and 1000 Rs per procedure respectively which does not include use of special equipment or medication needed for certain surgeries.

Results

Males predominate females as far gender distribution of injuries is concerned. Males constitute 88.21% (187) and females 11.79% (25) of all cases. These results are similar to those obtained in numerous national and international studies.[6-11] One of the factors for dominance of injuries amongst males may be the fact that in majority of cases they are the sole earning members of the family and therefore get exposed to traffic and foreign environment outside home. In our study nearly 53.77% of cases belonged to 21-40-year age group which was the maximum percentage of population susceptible to road traffic accidents among any age groups (Table 1). This is similar to studies carried out by Nilamber et al. in JIPMER where maximum injuries were found to occur in the age group of 20-29 years (31.3%) and 71% of the victims were under 40 years of age[12] and also by Ganveer and Tiwari where majority of the victims were in the age group 18-37 years.[13] This is similar to results obtained by Gururaj et al. in NIMHANS where highest number of Traumatic Brain Injuries was in the age group of 21-35 years (43%) with a male to female ratio of 4:1.[14] Another study by Municipal Corporation of Delhi found maximum morbidity in age group of 15 to 35 years with males: female ratio of 4:1.[15] In our study 144 cases (67.92%) belonged to rural population of the state and 68 cases (32.08%) belonged to urban population (Table 1). These findings are concordant with study done by Rastogi in Kota in 1994 where 16.66% and 29.16% road traffic accidents were found to occur in rural centers of population located around national and state highways respectively. [16] Most of injuries suffered by victims had an overlap in the injuries observed, with abrasions presenting in maximum cases (53.50%) (Table 2). As per our study most injuries were confined to the appendicular skeleton especially the upper and lower limbs, which is again in conformity with studies done by Garg, Singh et al and Srivastava et al. (Table 3).[6,10,11] The major organ system involved was observed to be the intestine in 14 cases, followed by the liver (11) and spleen (9) as shown in Table 4. Splenectomy and hepatic repair presented as major disabilities resulting from accidents (Table 5).

Most victims coming to hospital had grievous injuries (47.17%) followed by dangerous (26.89%) and simple (25.94%) injuries. On being asked to give firsthand accounts of reason leading to road traffic injuries (RTI); most of the victims blamed high speed 35 cases (16.52%) and rash driving from other vehicle 25 cases (11.79%). In 49 cases (23.11%) no reason for accident was provided (Table 6). In subset questionnaire it was found that most of cases of high speed RTI involved young adults males (32) and fewer females (3) in second or third decade of life travelling on two wheelers (mostly motorcycles) driven by a necessity for example, to reach work in time 15 cases (42.86%); thrill seeking behaviour in 11 cases (31.43%); or influenced by speed centric movies in 8 cases (42.86%) (Table

9). In our study primary target of RTIs were two-wheeler riders 101 cases (47.64%) followed by four wheelers like cars 62 cases (29.64%) (Table 5). This is similar to study done by Pramod and Tewari in Delhi where two-wheeler users account for 46.3% victims.[15] In another study done at JIPMER two wheelers including motorcycles (31.1%) and bicycles (38.6%) accounted for maximum number of victims.[12]

Maximum cases (49.53%) needed 1-2 weeks of hospitalization were as in only 45 cases (21.23%) patients were discharged in single day only (Table 10) This may be due to our hospital being the primary referral center were specialized treatment is available. These results are in contrast to MCD community-based study were most of injured had simple injuries and needed lesser time of stay at hospital.[15]

Table 1: Age distribution of road traffic injury cases

Age group (years)	N	%
<10	15	7.08
11-20	35	16.51
21-40	114	53.77
41-60	45	21.23
>60	3	1.41
Total	212	100

Table 2: Distribution of study sample according to type of road traffic injury (N= 212)

Type of injury	N	%
Abrasions	113	53.50
Bruises	104	49.06
Laceration	68	32.07
Incised wound	8	3.77
Fracture	100	47.17
Injury Overlap	181	85.38

Table 3: Distribution of injury on the body (N= 212)

Body part	N	%
Head	64	30.19
Neck	6	2.83
Upper limb	93	43.87
Lower limb	79	37.26
Chest	35	16.50
Abdomen	42	19.81
Back	14	6.60
Pelvis	11	5.19
Injury Overlap	132	62.25

Table 4: Distribution according to major organ system involved

Major organ system involved	N	%
Brain	8	14.04
Lungs	8	14.04
Liver	11	19.30
Spleen	9	15.79
Kidney	5	8.77
Intestine	14	24.56
Miscellaneous	2	3.50

Table 5: Major disabilities resulting from accidents

Type of disability	N	%
Aphasia	1	0.47
Permanent facial disfigurement	1	0.47
Hemiplegia	2	0.94
Paraplagia	1	0.47
Hemicolectomy	2	0.94
Nephrectomy	2	0.94
Splenectomy	4	1.89
Major hepatic repair	4	1.89
Penile amputations	1	0.47

Table 6: First-hand account regarding accidents

Cause of accident	N	%
High speed driving	35	16.52
Rash driving of other vehicle	25	11.79
Fall from moving vehicle	11	5.19
Bad roads	22	10.38
Loss of control of vehicle	32	15.09
Pedestrian hits	16	7.55
Mechanical failure	3	1.41
Stray bullet	1	0.47
Animals in middle of road	4	1.89
High light beam from incoming vehicle	6	2.83
Weather conditions	7	3.30
Drunk driving	1	0.47
No reason given	49	23.11
Total	212	100

Table 7: Age distribution of individuals involved in high speed accidents (N=35)

Age group	N	%
11-20	10	28.57
21-40	23	65.71
41-60	2	5.71

Table 8: Types of vehicles involved in high speed accidents (N=35)

Vehicle type	N	%
Motorcycle	15	42.86
Sumo	8	22.86
Car	5	14.28
Truck	5	14.28
Auto rickshaw	3	8.57

Table 9: Reasons given for high speed driving (N=35)

Reason given	N	%
Films	8	22.86
Thrill	11	31.43
Necessity	15	42.86
No reason	1	2.86

Table 10: Hospital stay following road traffic injuries (N= 212)

Days of stay	N	%
1	45	21.23
2-5	58	27.36
6-10	47	22.17
11-15	16	7.54
16-20	12	5.66
>20	34	16.04
Total	212	100

The cost of such injuries is huge and, in our estimates, keeping baseline treatment in mind at a government run hospital an average case of RTI needing major operative procedure consumes 75 days of manpower besides a baseline cost of 4000 rupees. This excludes the cost of infrastructure; specialized treatment; or medical accessories needed for such a treatment. This baseline cost gets multiplied by a factor of 3 to 4 times at private run hospitals. For daycare procedures, the 4 workdays were used alongside a baseline cost of Rs. 700, whereas, for minor operative procedures it amounted to 29 working days and 2000 rupees.

Discussion

The economic cost of road crashes and injuries is estimated to be 1% of Gross National Product (GNP) in low-income countries, 1.5% in middle income countries and 2% in high-income countries. The global cost is estimated to be US$ 518 billion per year. Low-income and middle-income countries account for US$ 65 billion, more than they receive in development assistance. The global burden of disease due to RTI (in terms of DALYs-Disability Adjusted Life Years) is expected to move from ninth position to third position by 2020.[17]

Recognizing the magnitude of the problem the World Health Organization in 2004 had its theme as “Road Safety: is no accident.”[18] This may be interpreted in two ways, i.e. roads are safe only when there are no injuries on the road (including foot paths and sidewalks), which is straightforward. But the most important point is that Road safety cannot be achieved accidentally, unless there is a concerted and sincere effort from all the areas concerned with road safety. Use of accident with road traffic is a tragedy of sorts in itself. A WHO expert committee has defined accident as “A premeditated event resulting in recognizable injury.”[19]

Arbous has defined accident as “In a chain of events, each of which is planned or controlled, there occurs an unplanned event, which being the result of some non-adjustive act on the part of the individual (variously caused) may or may not result in injury. This is accident.”[19] When this is applied to the field of Injury Prevention the term 'accident' would actually suggest that the event leading to an injury cannot be prevented. This is in fact an observation made by researchers earlier in the field of Injury prevention. “There has been a change in the terminology regarding injuries, which were earlier regarded as accidents and one serious handicap in systematic research on the causes of accidents is the lack of precision in terminology.”[20] It is to be understood that injuries are no longer regarded to be result of 'accidents'. Road traffic injuries are no exception to this understanding of injury occurrence. Systematic research into injury causation has shown that most of the injuries are predictable and therefore preventable.[21] It is therefore necessary to define injury rather than an accident if we are to prevent injuries in general and Road Traffic Injuries in particular.

Conclusion

A number of facts become clear from research results which help us to sketch a complete picture of a Road Traffic Injury. Young individuals mostly males in their second or third decade of life in chase of a quick success, influenced by today's media,

fancied by physical thrill, unmindful of regulations of society and law become easy victims of Road Traffic Injuries. Not only are these occurrences common but as author of two research publications[22] the data of which has come from two tertiary care hospitals; the morbidity and economic burden that a state has to bear is extreme. Time has come for us to understand that as responsible members of a civilized society we should regulate our self as per laws of land which involves educating our younger generation in safe driving and traffic laws. Another observation of this study was that only 15 First Information Reports were registered which is grossly inadequate. Registering a FIR in India is generally not considered easy by people as they are reluctant to interact with the police. It is widely known that the tedious administrative process of attending in the court of law is a major rein for people to report RTA to police, therefore, not reporting it or outside settlement between those involved are the preferred choices for the majority.[23] The administrators of state should also understand that laws cannot be followed unless they are strictly enforced. The state in recent past has realized this mistake and new laws regulating Road Traffic which enlist strict punishments with heavy fine for Road traffic offences have been formulated and implemented so that this modern epidemic is nipped in its bud.[24]

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ORIGINAL ARTICLE

Analysis of firearm deaths from Central Delhi region - A 6-year retrospective study

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Abstract
Firearm injuries were well known for their atypical findings and appearances in routine so a retrospective study from 2013 to 2018 was performed to evaluate the morphology of firearm injuries and the damaged caused by it. Data of 65 cases was collected from post mortem notes of the deceased. It was observed that the age group of 21-40 years was most commonly affected with 63 cases (96.9%) and a male : female ratio 31.5:1. Individuals of the Hinduism religion (50 cases, 76.9%) were most commonly affected and most of the victims were brought dead or were dead on the spot (34 cases, 52.3%). Rifled firearm weapon most commonly used (63 cases, 96.9%) while shotgun was used in 02 cases (3.1%). Single entry (43 cases, 66.2%) and exit wounds 37 cases (56.9%) were most commonly observed. In 41 cases (63.1%) no bullet was recovered while single bullet was recovered in 16 cases (24.6%) during post mortem examination. Entry wounds were most commonly found on head, face and neck region of body in 29 cases (44.6%) followed by chest region in 26 cases (40.0%), while right lower limb region with one case (1.5%) was least commonly found. Exit wounds were most commonly found on head, face and neck region (22 cases, 33.8%) followed by back region (15 cases, 23.1%). Lungs (22 cases, 33.8%) and brain (21 cases, 32.3%) were most commonly damaged organs in firearm injuries while kidneys and spleen (2 cases, 3.1%) each were least commonly involved organs. Skull and facial bones (23 cases, 35.4%) were most commonly fractured bones by firearm weapons followed by ribs and clavicle (17 cases, 26.2%). Abrasion collar was the most common entry wound artefact (53 cases, 81.5%) followed by smudging/ blackening/ stippling (20 cases, 30.8%). Homicidal was the most common manner of death with 44 cases (67.7%), followed by Suicidal with 15 cases (23.1%). Shock and Haemorrhage was the most common cause of death with 30 cases (46.2%).

Keywords
Firearm injuries; Entry wound; Exit Wound; Rifled firearm; Shotgun firearm; Cause of death.

Introduction

Deaths due to firearm weapons have increased tremendously around the world, especially in developing countries where illegal firearms and locally made or country made guns are easily available without licensing. This unregulated use of firearms has resulted in an increased rate of death and injuries by these weapons. Though there were previously published studies on firearm injuries of many countries, there were only a few studies on the incidence and pattern of death from firearm injuries in Delhi City. In the present study, our objective was to investigate the pattern of injuries, autopsy findings, survival period, cause of death and the range of firearm in cases of deaths due to firearm injuries. In case of firearm injuries, their severity was determined by following factors: The damage of the tissues caused by the mechanical interaction between the bullet and the tissues, and the effects of the temporary cavity produced by the bullet.[1]

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Material and Methods

The present retrospective study was conducted in the Department of Forensic Medicine of the Maulana Azad Medical College and Lok Nayak hospital, New Delhi which caters to the Central Delhi population. The data of 6 years from 1st January 2013 to 31st December 2018 was collected from post mortem notes of the deceased. During this period, a total of 7127 post mortem cases were conducted, of which 65 cases (0.91%) were deaths due to firearm injuries. The data was collected in a proforma prepared for this study purpose. The collected data was analyzed using Statistical Package for the Social Sciences [SPSS, IBM Corp., Armonk, NY], Version 20.0.

Results

In the present study, male gender 63 cases (96.9%) most commonly affected with male: female ratio was 31.5:1. The age group of 21-40 Years was most commonly affected 41 cases (63.1%). Total 50 cases (76.9%) were found to belong from Hindu religion and only 15 cases (23.1%) were from Muslim religion. Most of the victims 34 cases (52.3%) were died on Spot or brought dead on arrival in accident and emergency department followed by period of survival 1-10 days in 13 cases (20.0%) after hospitalization. The rifled firearm weapon was most commonly used in this study of 63 cases (96.9%) and

shotgun firearm was least used in 2 cases (3.1%). Single firearm entry wound were found in 43 cases (66.2%) followed by two entry wounds of firearm were found in 13 cases (20.0%). While single exit wound of firearm was found in 37 cases (56.9%) followed by no exit wound of firearm were found in 16 cases (24.6%). In 5 cases (7.7%) multiple entry and exit wound of firearm were found from single bullet. In 2 cases (3.0%) penis was injured in firearm injuries with age of victim of 20 years and 30 years.

Table 1: Age Group wise distribution of cases

Age Group (years)	Cases	%
0-20	11	16.9
21-40	41	63.1
41-60	12	18.5
>61	1	1.5
Total	65	100

Table 2: Period of survival after incidence wise distribution of cases

Period of survival after incidence	Cases	%
Spot dead/Brought dead	34	52.3
Death within 12 hrs	3	4.6
Death after 12 hrs to 1 Day	5	7.7
1-10 Days	13	20.0
>11Days	10	15.4
Total	65	100

Table 3: Number of Entry and Exit wounds present on the body

Number of wound	Entry wound N (%)	Exit wound N (%)
0	--	16 (24.6)
1	43 (66.2)	37 (56.9)
2	13 (20.0)	5 (7.7)
3	04 (6.3)	3 (4.7)
4	01 (1.5)	2 (3.1)
5	01 (1.5)	01 (1.5)
6	01 (1.5)	01 (1.5)
7	01 (1.5)	--
9	01 (1.5)	--
Total	65 (100)	65 (100)

During post mortem examination in 41 cases (63.1%) no bullet were recovered from body and in 16 cases (24.6%) single bullet were recovered from body. In one case (1.5%) wad & pellets were recovered during post mortem examination. Firearm entry wounds in 29 cases (44.6%) were most commonly present over the head, face and neck region of body followed by chest region of body in 26 cases (40.0%). While the head, face and neck region of body was most commonly involved region of body in exit wound of firearm in 22 cases (33.8%) followed by back region of body in 15 cases (23.1%). The lungs were the most commonly damaged organ in body in 22 cases (33.8%) followed by brain in 21 cases (32.3%). The skull and facial bones were most commonly fractured in 23 cases (35.4%) followed by fractures of ribs and clavicle in 17 cases (26.2%).

Abrasion collar were most commonly found in entry wounds of 53 cases (81.5%) followed by smudging / blackening / stipplings in 20 cases (30.8%). Alleged manner of death was homicidal in 44 cases (67.7%) followed by suicidal in 15 cases (23.1%). The most common cause of death in this study was shock and haemorrhage in 30 cases (46.2%) followed by cranio-cerebral damages and sepsis following firearm injuries both were in 19 cases (29.2%) each.

Table 4: Number of Bullets recovered from the body

Number of Bullets	Cases	%
0	41	63.1
1	16	24.6
2	6	9.2
3	2	3.1
Total	65	100

Table 5: Region of body involved in Entry and Exit wounds

Region of Body	Entry Wound N (%)	Exit Wound N (%)
Head Face and Neck	29 (44.6)	22 (33.8)
Chest	26 (40)	12 (18.5)
Abdomen including Genital	21 (32.3)	8 (12.3)
Back	8 (12.3)	15 (23.1)
Right Upper Limb	9 (13.8)	6 (9.2)
Left Upper Limb	6 (9.2)	2 (3.1)
Right Lower Limb	1 (1.5)	1 (1.5)
Left Lower Limb	3 (4.6)	3 (4.6)

Table 6: Organ damaged in firearm cases

Organ damaged	Cases	%
Brain	21	32.3
Heart	7	10.8
Lungs	22	33.8
Liver	7	10.8
Spleen	2	3.1
Kidneys	2	3.1
Stomach	7	10.8
Pancreas	4	6.2
Small Intestine	14	21.5
Large Intestine	12	18.5

Table 7: Bones fractured by Bullets

Bones fractured	Cases	%
Skull and Facial bones	23	35.4
Ribs and Clavicle	17	26.2
Spine	16	24.6
Humerus	5	7.7
Radius	4	6.2
Ulna	3	4.6
Femur	1	1.5

Table 8: Entry wound characteristics

Entry wound characteristics	Cases	%
Abrasion collar	53	81.5
Contusion collar	6	9.2
Singing of Hairs	8	12.3
Smudging / Blackening / Stippling	20	30.8
Muzzle imprint	6	9.2
Bullet graze	3	4.6

Discussion

In the present study male gender 63 cases (96.9%) was most commonly affected with male:female ratio was 31.5:1 which were consistent with the findings of studies done by Mariam et al[2], Myint et al[4], Thube et al[3], Khetran et al[7], Kohli et al[9] and Rastogi A.K.[5]. The age group of 21-40 years was the most commonly affected 41 cases (63.1%), this finding was consistent with studies done by Mariam et al[2], Myint et al[4], Thube et al[3], Khetran et al[7], Kohli et al[9], Rastogi A.K.[5] and Kumari et al[8].

The youngest victim was found to be 11 years old male and oldest victim was 68 years old male which was similar to study of Mariam et al[2]. Most of the victims were spot or brought dead 34 cases (52.3%) followed by period of survival 1-10 days in 13 cases (20.0%) after hospitalization, this was similar to the finding of Sachan et al[6]. Rifled firearm 63 cases (96.9%) were the most commonly used weapon which were consistent with finding of Myint et al[4], Thube et al[3] and Khatran et al[7]. However this finding was in contrast to the finding of the study done by Kumari et al[8] in which shotgun weapon 60% (country made guns) used. Single firearm entry wound were found in 43 cases (66.2%) which were consistent with finding of the study done by Myint et al[4], Kohli et al[9], Kumari et al(8] and Sachan et al[6].

Exit wound of firearm was found in 49 cases (75.4%) and in remaining 16 cases (24.6%) no exit wound present. Out of 49 cases single exit wound was found in 37 cases (56.9%) and in remaining 12 cases (18.4%) more than two exit wounds were found which were similar with Kumari et al[8]. In 16 cases (24.6%) single bullet was recovered from body after post mortem examination and in 41 cases (63.1%) no bullet was recovered from body which were consistent with Myint et al[4] and Kohli et al[9]. Head, face and neck region 29 cases (44.6%) followed by chest region of body in 26 cases (40.0%) which were consistent with the studies done by Myint et[4], Thube et al[3], Kohli et al[9] and Sachan et al[6]. However this was not consistent with Khetran et al[7] chest and abdomen region, Mariam et al[2] chest region, Kumari et al[8] abdomen region most commonly involved. Lungs 22 cases (33.8%) and Brain 21 cases (32.3%) were most commonly damaged organs which were consistent with the studies done by Kohli et al[9].

Abrasion collar were most commonly found in entry wound 53 cases (81.5%) followed by smudging/blackening/stippling in 20 cases (30.8%) on the basis of which rang of firearm was determined. In 6 cases (9.2%) were from contact range, 8 cases (12.3%) were from near contact range which were consistent with the Myint et al[4] and in contrast with Thube et al[3], and Sachan et al[6]. Whereas 20 cases (30.7%) were from intermediate range which were consistent with studies conducted by Thube et al[3] & Sachan et al[6] and in contrast with study conducted by Kumari et al[8]. Alleged manner of death was homicidal 44 cases (67.7%) most commonly found, followed by suicidal 15 cases (23.1%) and accidental death 6 cases (9.2%) these findings were consistent with Mariam et al[2], Myint et al[4], Thube et al[3], Khetran et al[7], Kohli et al[9], Rastogi A. K[5], Kumari et al[8] and Sachan et al[6].Whereas most common deaths due to firearm were suicidal in nature in some of the foreign studies done by Sachan et al [6], Kumari et al [8], Norton et al[13], Hagras et al[10], Druid et al[11] and De la Grandmaison et al,[12].

Most common cause of death was shock and haemorrhage in 30 cases (46.2%) followed by cranio-cerebral damages in 19 cases (29.2%) and sepsis following firearm injuries in 19 cases (29.2%) which were consistent with the studies done by Thube et al[3], Kohli et al[9], Rastogi A. K.[5], Kumari et al[8] and Sachan et al[6].

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ORIGINAL ARTICLE

Autopsy findings in sudden cardiac death victims at a tertiary health care centre

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Abstract
In the present era there is a transition of the cause of death from communicable to non-communicable diseases (NCD) due to changing life style as well as environmental factors. Sudden cardiac death (SCD) is one of the most common NCD and an important mode of death all over the world. Hence, the accurate diagnosis of the causes of SCD is now of particular importance. Pathologists are solely responsible for determining the precise cause and mechanism of sudden death through autopsy. In present study we included 260 cases with age ranging from 1 to 80 years. 75 (28.8%) of these 260 cases showed cardiovascular lesions with a male: female ratio of 14:1. Coronary artery disease with or without other associated lesions was the most frequent finding (90.7%). Other causes included atherosclerosis of aorta, myocardial infarction (MI), myocarditis and cardiomyopathy. Rare findings were left atrial myxoma and malignant mesothelioma. Though predominantly affected age group was 41-50 years, there was significant number of affected young patients as well. Thus, this study highlights the importance of screening the population from young age itself for cardiovascular diseases to reduce related morbidity and mortality.

Keywords
Autopsy; Sudden cardiac death; Myocardial infarction; Coronary artery disease; Atherosclerosis

Introduction

Cardiovascular diseases are considered to be responsible for approximately 17 million deaths every year globally. It predominantly includes sudden cardiac death (SCD), myocardial infarction (MI), valve abnormalities and other coronary artery diseases (CAD).[1] India is also experiencing a rapid transition of communicable to non-communicable diseases (NCD) as the cause of morbidity and mortality. These NCDs include diseases like cardiovascular diseases, malignancies and diabetes mellitus (WHO). About 206 million people die of cardiovascular diseases in India, maximally affected age group being 35-64 years. Urban population is affected 3 times more than the rural areas. The most important risk factors are stress, tobacco chewing, smoking, alcohol abuse, obesity, unhealthy diet and physical inactivity.[2]

SCD is one of the most important modes of death worldwide (about 30% to 50% of all deaths).[3] Sudden cardiac death (SCD) is a sudden unexpected event, from a cardiac cause, that occurs in less than 1 hour after the symptom onset in a person without any previous condition that would seem fatal or who was seen without any symptoms 24 hours before being found dead. Acute coronary findings, a fresh thrombus or recent myocardial infarction are often present in patients who die suddenly.[4] As CAD accounts for ≥50% of heart failure (HF) patients in the Western world, it is possible that acute coronary events contribute importantly to the progression of HF and SCD.[5] The incidence of SCD increases dramatically with age, in parallel with the age-related increase of CAD. Cardiomyopathies, myocarditis, premature coronary artery disease, congenital coronary artery anomalies and valve abnormalities play a major causative role.[6] The role of autopsy is to know whether death is attributable to a *cardiac disease* or to other causes of sudden death; the nature of the cardiac disease and whether the mechanism was arrhythmic or mechanical or inherited, requiring family screening and counseling.[7]

Pathologists are responsible for determining the incidence, precise cause and mechanism of sudden death through autopsy, ensuring that in future appropriate preventive strategies are implemented.[7] In many cases sudden death (SD) is often the first clinical manifestation of an underlying disease in previously asymptomatic, apparently "healthy" subjects. In this setting, autopsy represents "the first and the only" opportunity to establish and register an accurate cause of death.

Material and Methods

Present study was a retrospective cross-sectional study with total 260 autopsies being performed from July 2018 to June 2019, in the Department of Pathology which included both Medicolegal and Clinical autopsies. For autopsy the heart specimens were received in either pieces or as a whole. They were fixed in 10% neutral buffered formalin. The cases included deaths predominantly due to sudden cardiac death (SCD), road traffic accidents (RTA), poisoning, drowning.

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Detailed clinical history was retrieved from the records. Weight and gross findings like enlarged size, dilation of chambers, areas of infarction, valve abnormalities, atherosclerotic plaques were noted. Thereafter, multiple sections from representative areas were taken for histopathological study. The slides were stained with Hematoxylin and Eosin. Special stains were performed wherever required. All clinical, gross and histopathological findings were analyzed and correlated by Senior Pathologists and results were tabulated.

Results

Present study included 260 cases, out of which 176 (67.6%) were males while 84 (32.4%) were females. 75 (28.8%) of these 260 cases showed cardiovascular lesions. As shown in table 1, the age ranged from 1 to 80 years. 93.3% of all these cases were males while females were 6.7% with a male: female ratio of 14:1. Predominantly affected age group was 41-50 years and the least affected being 71-80 years.

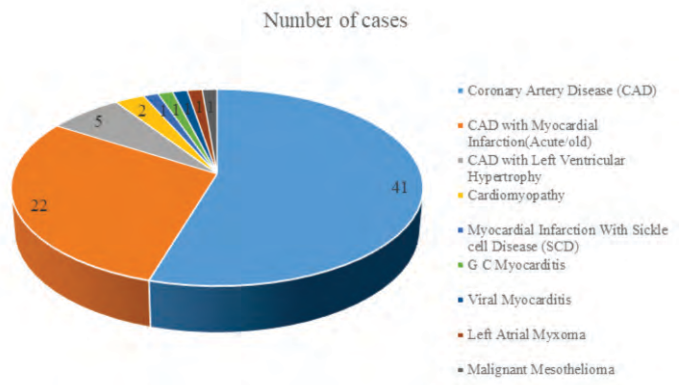

Figure 1: Frequency of Cardiac Lesions (n=75)

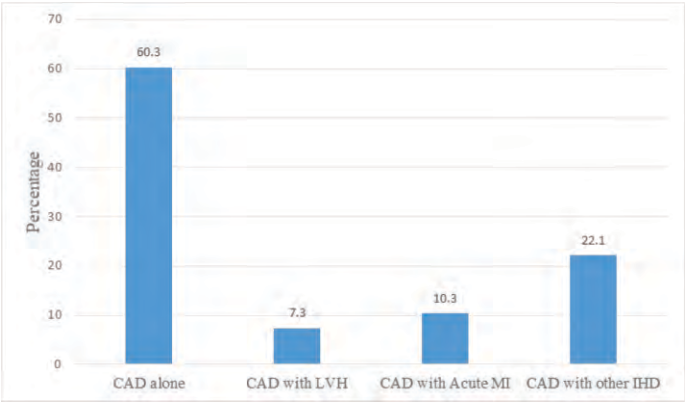

Figure 2: Frequency of Coronary Artery Diseases and other cardiac lesions (n=68)

Coronary artery disease with or without other associated lesions was the most frequent finding (90.7%). Other causes included atherosclerosis of aorta, myocardial infarction (MI), myocarditis and cardiomyopathy. Rare findings were left atrial myxoma and malignant mesothelioma (Figure 1). As shown in Figure 2, CAD alone was seen in 41 cases whereas CAD with left ventricular hypertrophy (LVH), CAD with Acute MI and CAD with other ischemic heart diseases (IHD) were seen in 5, 7 and 15 cases respectively.

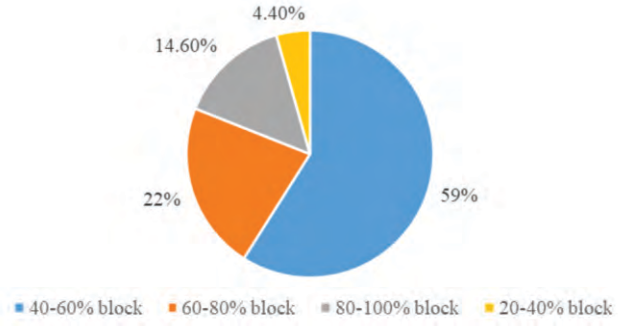

Figure 3: Percentage block in coronary vessels in coronary artery disease (n = 68)

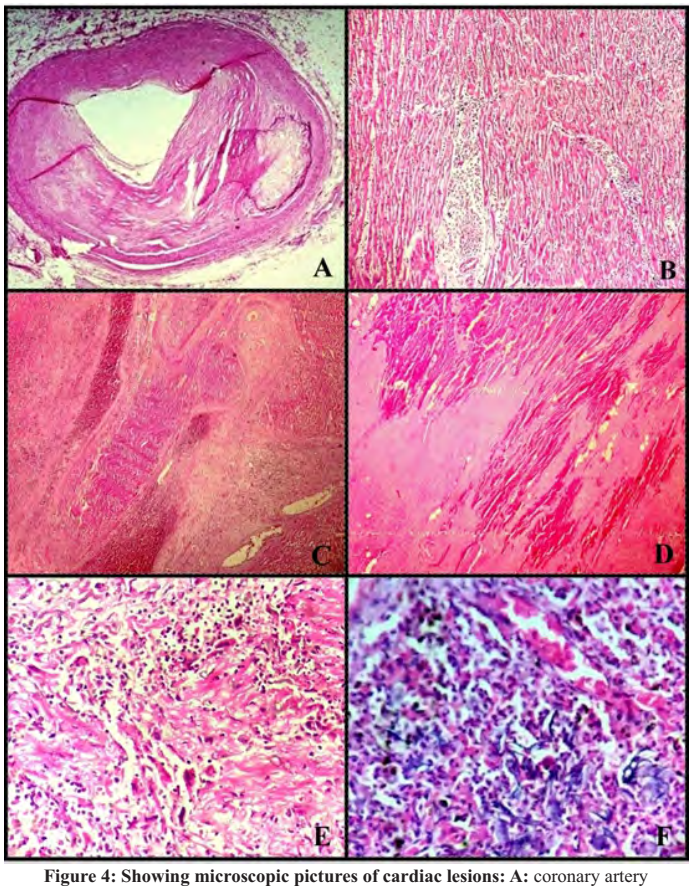

Figure 4: Showing microscopic pictures of cardiac lesions: A: coronary artery atherosclerosis (H & E, 100X); **B:** Myocardial infarction with sickle cell disease (H & E, 100X); **C:** Acute myocardial infarction (H & E, 400X); **D:** Old myocardial infarction (H & E, 400X); **E:** Giant cell myocarditis (H & E, 400X); **F:** Malignant mesothelioma (H & E, 400X)

Table 1: Age and sex distribution of cases included in the study (n=75)

Range (years)	Male	Female	Total	Percentage
1-20	-	-	-	0
21-30	3	-	3	4
31-40	20	-	20	26.7
41-50	23	-	23	30.7
51-60	15	3	18	24
61-70	8	1	9	12
71-80	1	1	2	2.6
Total	70	5	75	100

Table 2: Table Showing Age and Sex Distribution of Cardiac Lesions

Disease	Age (years)						Sex		Total
	21-30	31-40	41-50	51-60	61-70	71-80	Male	Female	
LVH	-	-	-	2	2	1	5	-	5
Acute MI	1	1	4	1	-	-	6	1	7
Old MI	-	-	2	3	10	-	14	1	15
MI with SCD	-	1	-	-	-	-	1	-	1
Giant Cell Myocarditis	1	-	-	-	-	-	-	1	2
Viral Myocarditis	1	-	-	-	-	-	-	1	1
Cardiomyopathy	2		-	-	-	-	2	-	2
LA Myxoma	1	-	-	-	-	-	1	-	1
Malignant Mesothelioma	-	-	-	-	-	1	1	-	1
CAD	4	6	22	5	4	-	39	2	41

LVH: Left ventricular hypertrophy; MI: Myocardial infarction; SCD: Sickle cell disease; LA: Left atrial myxoma; CAD: Coronary artery diease

Out of 68 cases of CAD, single vessel involvement was seen in 23 cases while triple vessel involvement was seen in rest of the cases. 40-60% block was seen in maximum cases (58.8%), whereas 80-100% block was seen in (14.7%) as shown in Figure 3. Acute MI was seen in about 34.8% and old MI was seen in 65.2% cases. Table 2 shows various cardiac lesions seen in different age groups with male and female distribution. Incidence of MI was significantly higher in males in forth decade. Whereas myocarditis both giant cell and viral, were particularly seen in young females.

Discussion

There is an alarming increase in the number of deaths due to coronary artery disease in India and this number is expected to escalate rapidly in the next decade. In the present study it was observed that 93.3% of all these cases were males while females were 6.7% which are more or less similar to most of the studies done in the past. Murthy et al.[8] studied 150 cases out of which 123 (82%) were males and 27(18%) were females. Singh et al.[9] studied 200 cases with 170 (85%) males and 30 (15%) females. Padmavati[10] and Tandon[11] found 66.5% males and 33.5% females. Similarly Bhargava et al.[12] studied 74.8% males and 24.2% females in their study. The reason being that as males are predominantly earners in family which makes the males more vulnerable to accidents, violence and stress. Also, males more commonly get indulged in smoking, alcoholism and addictions.

Atherosclerotic lesions usually develop early in life starting from age 15 years onwards. In our study the incidence of atherosclerosis (Figure 4a) was found to be 68%. It was 40% in study by Yazdi et al.[13] and 28.9% in study by Golshahi et al.[14] The degree of atheroma encountered in different age group and in two sexes. The most commonly affected age group was 41-50 years (30.7%) followed by 31-40 years (26.7%) and thereafter there was a gradual decrease both in the severity and frequency of IHD. Earlier studies in India by Wig[15] found significant atheroma in two-third of cases above the age of 20 years while Tandon[11] found atherosclerosis in second and third decade. Singh et al.[15] found atherosclerosis atthe age of 17 years.

Coronary artery involvement was seen in 68 (90.7%) cases. Incidence of coronary involvement in Left Anterior Descending artery involvement was seen in 88.2% cases, Right Coronary Artery 75% & Left Circumflex Artery 69.1%. This was in concordance with the data given by Sudha et al.[16] who showed Left Anterior Descending as the most common site for plaque (47%) and Yazdi et al.[13] who showed Left Anterior Descending as the most commonly involved artery (60%) , followed by Right Coronary Artery (50%) and Left Circumflex Artery (42.5%). Single vessel involvement was seen in 33.8% while triple vessel involvement was seen in 66.1%. Triple vessels involvement was the most common in our study. It was correlated with the study given by Yazdi et al.[13] whereas Virmani et al.[17] found single vessel disease is greater than others (44%).

MI was seen in 23 cases (30.7%) which included both acute and old MI (Figure 4c and 4d) maximally in the age group of 41-50 years. Death due to MI was seen in a patient with sickle cell disease (Figure 4b). This is exponentially higher as compared to data given by Maru[18] (6.5%). Out of 23, 20 were males while rest 3 were females. Youngest person dying of MI was 26 years

old. Less number of females might be as result of protective effect of estrogen. All MI cases showed significant atherosclerosis in aorta and coronary vessels.

We also reported a case of left atrial myxoma in a 30 years old male who presented with sudden death and left atrium showed 2X 1cm soft gelatinous tumor which showed microscopic features of myxoma. Modi et al. also reported a case of left atrial myxoma with sudden death.[19] We also reported another rare case of 75 years old male who presented with sudden cardiac death and microscopy showed features of malignant pericardial mesothelioma (Figure 4f). Sudden cardiac death due to primary malignant pericardial mesothelioma was reported by Rafael Martínez-Girónet al.[20] in a 46 years old male. Other uncommon cardiac autopsy findings were Giant cell myocarditis (Figure 4e) in 23 years old female and viral myocarditis in 21 years old female. Shanmugam et al.[21] reported a case of SCD due to giant cell myocarditis in a young male.

Hence it is important to screen population from third decade of life irrespective of symptoms for early detection of cardiovascular diseases and prevention of related deaths, thus reducing the prevalence of non- communicable diseases.

Conclusion

The present study showed very high prevalence of sudden death especially because of cardiovascular diseases in this region. The predominant cause being CAD. Though the incidence is more in males as, it is alarming for both males and females. There was a significant number of affected young population. Thus, this study highlights the importance of screening the population from young age itself, irrespective of symptoms for cardiovascular diseases, considering the emerging risk factors and changing lifestyle to reduce related morbidity and mortality.

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ORIGINAL ARTICLE

Pattern of asphyxial deaths: A medicolegal study

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Abstract
Violent asphyxia is a commonly reported mode of death. Based on a three years retrospective study, conducted in the Dept. of Forensic Medicine, Mamata Medical College between Jan 2016 and Dec 2018, details about all violent asphyxial cases collected. During the study period 148 (7.74%) cases were reported resulting from violent asphyxia (148/100000 per year) out of 1912 medicolegal autopsies conducted. The data was collected from relatives, hospital records and autopsy reports. Incidence of asphyxial deaths is 7.74% of total autopsies. Most victims were 21–30-year-old males. The most common method amongst them was hanging 77 (52.02%) followed by drowning 28 (18.91%). In majority of the cases, the incident occurred at the residence of the victim during the day. Most cases were encountered during winter especially in November. All cases of hanging were suicidal. Homicidal hanging was not reported for any case. On the other hand, all the cases of smothering, strangulation and throttling were homicidal. Among the cases of drowning, 89.28% were accidental and 10.71% were suicidal. The prime motive behind violent asphyxial deaths was personal problems. Domestic violence plays a great role in suicidal and homicidal cases. The primary objective of the study was to analyse the epidemiological profile, seasonal variation, motive, manner, cause, circumstance, recent trends and patterns of asphyxial deaths as well as the preventive measures.

Keywords
Asphyxial deaths; Pattern; Hanging; Drowning; Strangulation; Smothering; Recent trends; Manner; Motive.

Introduction

Adelson defined asphyxia as the physiological and chemical state in a living organism in which there is an acute lack of oxygen for cell metabolism and is associated with inability to eliminate excess carbon dioxide. There may be many forms of violent asphyxia such as Hanging, Drowning, Strangulation, Suffocation, and Traumatic asphyxia.

Mechanical asphyxia is a broad term in which either sufficient external pressure is applied to the neck, chest or other areas of the body or the body is positioned in such a way that respiration is rendered difficult or impossible. Asphyxial death usually implies mechanical blockage of the air passages. Drowning is a form of asphyxia due to aspiration of fluid into air-passages caused by submersion in water or other fluids. Submersion of the nose and mouth alone for a sufficient period can result in death from drowning.[1] Hanging results from the constriction of the neck as a result of the suspension of the body by ligature. Here, the constricting force is the weight of the body or a part of the body. Hanging is generally attributed to suicide.

Due to population explosion, poverty and increasing stress in daily life, the number of suicides and homicides have increased. Both males and females endure such stress but males tend to have greater exposure to the external environment and therefore, more cases of suicides are generally reported in males.[2]

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Material and Methods

Data pertaining to a three-year retrospective study, from Jan 2016 Dec 2018, of 326 cases of violent asphyxia autopsied in the Department of the Forensic Medicine & Toxicology, Mamata Medical College, Khammam, Telangana, was collected and analysed to determine the epidemiological profile, seasonal variation, motive, manner, cause, circumstance, recent trends and patterns of asphyxial deaths, as well as, the preventive measures.

Results

During a study period of 3 years from Jan 2016 to Dec 2018, a total of 1912 post-mortem examinations were conducted in the morgue of Mamata General Hospital attached with Medical College, Khammam, of which 148 were asphyxial deaths. Each case was studied following proforma. The incidence of asphyxial death cases was 7.74% out of total number of cases autopsied.

The most commonly affected age group was 21-30 years (N= 62; 49.81%) followed by 31-40 years (N=46;31.08%) and 41-50 years (N=37;25.00%). Males (N=86;58.10%) predominated females (N=62;41.89%) with a male: female ratio of 1.38:1 The study also revealed that 103 victims were married

(N=103;69.59%) and 45 victims were unmarried (30.40%).

In this study most of the individuals followed Hindu religion (N=88; 59.45%) followed by Islam (N=29; 19.59%%) and Christianity (N=21;14.18%). 35 deaths (N=86;58.10) were from urban areas which was greater than those reported in rural (N=62;41.89%) areas. Majority of victims 66 (44.59%) had secondary education and 42(28.37%) had not studied primary education. Most of the victims 66 (44.59%) belonged to a low socioeconomic status followed by middle socioeconomic status 48 (32.42%) as depicted in Table 1. Most of the victims were labourers 62 (41.89%) and 29 were farmers (19.59%) as depicted in Table 2.

Regarding seasonal variation, 46 asphyxial deaths (31.08%) were reported in winter, 36 in summer (36.32%) and 29 (19.59%) in monsoon. Majority of asphyxial deaths 90[60.81%] occurred in the house of victim followed by pond / river/well/drain (N= 28;18.91%) and those occurred in outfield were 20 (13.15%) cases as depicted in Table 3.

In the study, 98 deaths (66.91%) were reported during the day while 50(33.78%) occurred during night as depicted in Table 1. Monthly data indicated that 15 cases (23.43%) were in January, 10 cases (15.62%) were in November. June and October had lowest incidence of just 2 cases each.

Regarding monthly variations, 16.18% cases were reported in May followed by 14.86% cases December. Regarding the day of incidence, asphyxial deaths were more prevalent on weekends as depicted in Table 1.

In our study, the distribution of different forms of violent asphyxial deaths is shown in Table 1. Maximum number of violent asphyxial deaths was due to hanging (77cases; 52.02%) followed by drowning (28 cases; 18.21%), suffocation (26 cases; 17.56%), strangulation (17cases; 11.48%). Cases of mugging, garrotting and sexual asphyxia were not reported.

In this study, the motives behind asphyxia included family disputes (66 cases; 44.59%), depression in 38 (25.67%), harassment in 20 (13.51%), ill health in 10 (6.75%) and financial problems in 8 (5.40%). In 6 cases motive was not mentioned.

The intention behind asphyxiation in majority was suicide. All cases of hanging were suicidal. Homicidal hanging was not recorded. All cases of smothering, strangulation and throttling were homicidal. Among cases of drowning, 89.28% were accidental and 10.71% were suicidal. In deaths due to hanging, male (52; 43.91%) outnumbered female (25 cases). Ratio of gender in hanging was 2.08:1 and is slightly higher than all other forms of asphyxia deaths.

In hanging, eyes remained open in 67 (45.27%), protrusion of tongue was seen in 56 (37.83%), dribbling of saliva at angle of mouth (33; 22.29%), discharge of semen from glans in 76 (51.35%) and inward displacement fracture of hyoid in 4.65% cases.

Table 1: Incidence of Asphyxial death

Year	Total cases	Asphyxial deaths	%
2016	620	44	7.09
2017	634	46	7.20
2018	658	58	8.81
Total	1912	148	7.70

Table 2: Socio-demographic profile

Trait		N (%)
Education	Illiterate	42 (28.37)
	Primary	23 (15.54)
	Secondary	66 (44.59)
	Intermediate	10 (6.75)
	Degree	5 (3.37)
	Post Graduate	2 (1.35)
Socioeconomic Status	Low	66 (44.59)
	Middle	48 (32.42)
	High	18 (12.16)
Occupation	Labourers	62 (41.89)
	Farmers	29 (19.59)
	House wife	15 (10.13)
	Student	18 (12.16)
	Employed	8 (5.40)
	Unemployed	10 (6.75)
	Business	6 (4.05)
Habitat wise	Rural	86 (58.10)
	Urban	62 (49.81)
Marital Status	Married	103 (69.59)
	Unmarried	45 (30.40)

Table 3: Seasonal Variation of incidents

Type of Asphyxia	Summer	Rainy	Winter	Cases	%
Hanging	20	32	25	77	52.02
Drowning	6	14	8	28	18.91
Smothering	2	4	3	9	6.01
Throttling	2	3	4	9	6.01
Ligature Strangulation	1	2	1	8	5.40
Suffocation	2	3	2	7	4.72
Choking	1	1	1	3	2.02
Traumatic asphyxia	2	2	1	5	3.37
Gagging	0	1	1	2	1.35
Total	36	29	46	148	

Table 4: Distribution by place of occurrence of incident

Type of Asphyxia	House	Out Field	On a tree	Work place	Pond	River	Well	Drain	n
Hanging	60	10	6	1	-	-	-	-	77
Drowning	-	-	-	0	19	2	5	2	28
Smothering	7	2	-	-	-	-	-	-	9
Throttling	8	1	-	-	-	-	-	-	9
Ligature Strangulation	6	2	-	-	-	-	-	-	8
Suffocation	5	2	-	-	-	-	-	-	7
Choking	2	1	-	-	-	-	-	-	3
Traumatic asphyxia	1	1	-	3	-	-	-	-	5
Gagging	1	1	-	-	-	-	-	-	2
Total	90	20	6	4	19	2	5	2	148

Table 5: Pattern of asphyxial deaths distributed by sex

Type of Asphyxial Death	Male	Female	Total	%
Hanging	52	25	77	52.02
Drowning	12	16	28	18.91
Smothering	4	5	9	6.01
Ligature Strangulation	3	6	9	6.01
Throttling	5	3	8	5.40
Suffocation	3	4	7	4.72
Choking	2	1	3	2.02
Traumatic asphyxia	4	1	5	3.37
Gagging	1	1	2	1.35
Total	86	62	148	

Table 6: Cause of asphyxial death distributed by manner

Cause of Death	Suicidal	Accidental	Homicidal	Male	Female	Total	%
Hanging	77	0	0	52	25	77	52.02
Drowning	3	25	0	12	16	28	18.91
Smothering	0	0	9	4	5	9	6.01
Strangulation	0	0	9	3	6	9	6.01
Throttling	0	0	8	5	3	8	5.40
Suffocation	0	0	7	3	4	7	4.72
Choking	0	3	00	2	1	3	2.02
Traumatic Asphyxia	0	5	00	4	1	5	3.37
Gagging	0	0	2	1	1	2	1.35
Total	80 (55.04%)	33 (22.29%)	35 (23.64%)	86	62	148	

Discussion

The present study shows similarities & dissimilarities with the results of other studies. In the present study, a total of 148 cases of deaths due to asphyxia were analysed at Department of Forensic Medicine, Mamata Medical college, attached with MGH, Khammam, Telangana between period January 2016 to Dec 2018 showed that the incidence of asphyxial deaths was 7.70%. Similar observation made by similar to studies [2, 3]

In study, most victims were young, age group of 21-30 years 62 [49.81%] and 3140 years 46 [31.08%] with male predominance. This could be explained by the fact that the age group of 21-40 years is the most active phase in life. These were consistent with others studies [3, 4] as depicted in Table 2. In the present study, a significant difference in the incidence of male 86 (58.10%) and female 62 (41.89%) victims could be observed, thus, giving male to female ratio of 4.81:1. Males are often sole bread winners of the family and responsibility of family is on males. When they are unable to fulfil responsibilities of family, suicidal tendency develops in males and hence any small reason can create a suicidal impulse in males. This could reflect a changing scenario in the sex ration of asphyxial deaths. [2, 3, 5, 6, 7]

Religion wise, majority of the victims followed Hindu belief (88; 59.45%), while followers of Islam were 29 (19.59%) and Christians were 21 cases (14.18%). This variation is due to the religious demography of India. This is supported by other studies.[8]

In the present study, urban population had 86 cases (58.10%) and rural had 62 cases (41.89). The probable reasons for higher incidence among urban people are due to migration, unemployment, urbanization, education of children etc. Similar observation was noted by others [7,8] as depicted in Table 2.

In the study we observed that the married victims (103; 69.50%) outnumbered unmarried victims (45; 30.40%). In married personal, male victims were 68 (45.94%) and female victims were 35 (23.64%). Of the 45 unmarried victims, 18 were male and 27 were female. This could be due to married people being the more vulnerable group when compared to unmarried people. Similar results were obtained by others [5, 7, 8, 9] as depicted in Table 2.

In our study, most of the asphyxial deaths occurred in lower socioeconomic class (66; 44.49%) followed by middle class (48; 32.42%) and upper class (34; 22.97%). Struggle for survival is the cause for this disparity. This is similar to other studies.[5, 9, 10]

The study revealed that maximum number of were victims (66; 44.59%) had studied till high school, 42 (28.37%) were illiterates and 10 (6.75%) had completed intermediate level education. This concurs with studies conducted by other Indians.[9, 11, 13]

We observed occupation wise, highest number of victims were daily labourers (62; 41.89%), followed by farmers (29; 19.59%) and 18 were students. Among others, 15 were house wife, 10 were unemployed, 8 were employees and 6 had business. This is similar with the other studies.[7, 9-12]

Regarding diurnal variation, maximum deaths occurred during day (98; 66.21%) as compared to night (50; 33.78%). The reason for more incidents reported during day was due to greater work stress, family, social stress. Similar findings were reported in studies conducted by others.[5, 13, 14, 18] (Table 2)

In our study, maximum number of asphyxial deaths took place at victim's residence (90; 60.81%) followed by outside (20; 13.51%). Total deaths due to drowning (28; 18.91%) were reported in different drowning sources like ponds (19), river (2), well (5) and drain (2). This could reflect that majority of victims chose their residence. These are consistent with other studies [5, 12, 13, 18] as depicted in Table 4.

Regarding seasonal variation, in our study highest number of asphyxial deaths (46; 31.08%) were reported in winter, in summer (36; 36.32%) and 29 (19.59%) were in monsoon. This is because people tend to spend more times indoors during winters. Similar observations were made by other studies [11, 12, 13] as depicted in Table 3. In this study we observed that monthly, maximum number of deaths were reported in January (16; 23.43%) and 13 were reported in December and 10 were in February, 7 cases (15.62%) were in November. June and October had the lowest incidence with just 2 cases each. These are consistent with other studies. [12, 13]

In the present study most common mode of death due to asphyxia was hanging **(**77; 52.02%) followed by drowning in 28 cases (18.91%). Other mode of deaths due to asphyxia were suffocation (26), smothering (9), suffocation (7), traumatic asphyxia (3), choking (2). Ligature strangulation was observed in 9 (7.81%) cases, and manual throttling in 8 cases (3.12%). Similar findings were reported by other studies.[9-14] Asphyxial deaths were categorized based on inquest reports and pattern of ligature marks. If ligature mark was oblique, non-continuous and high up in the neck, it was reported as hanging. When ligature mark was transverse, circular, continuous and below the thyroid cartilage, it was strangulation. When there was lack of oxygen from obstruction of the air passages at the level of the nose and mouth, it was suffocation (Table 5).

All cases of hanging were suicidal. Possibility of homicide was ruled out. Most victims were 21-30 years old (62; 41.89%). The male: female ratio was 2:08 with which other studies also concur.[11-17] Asphyxia death using plastic bag, showed that majority of victims searched for homicidal techniques on internet. This scenario was reported in India also as depicted in Table 6.

Among the 28 cases of drowning, 25 cases (89.28%) were accidental and 3 (10.71%) were suicidal in nature. Most victims were 21 to 30 years old and females predominated males. The male to female ratio was 0:75. Similar observations were made by others.[11-17]

In our study, 9 cases of smothering were found. Five were female (21, 22 years,28,29 and 50 years respectively) and four were male as seen in another studies. [13-19] This might be because females being the weaker sex may offer lesser resistance comparatively. In the present study, 7 cases of suffocation were observed. Four were females whereas three were male. We are noted that the 5 cases were of traumatic asphyxia cases, 3 of choking and 2 cases of gagging were found. Sexual asphyxia case was not found in our study. All the cases of throttling (9; 6.08%), smothering (9; 6.08%), strangulation (8; 5.40%), suffocation (7; 4.72%), choking (3; 2.02%) and gagging (2; 1.35%) were homicidal. In fact, strangulation should be assumed to be homicidal unless proven otherwise. All the cases of traumatic asphyxia (5) were found accidental. Other researchers made similar observations.[15-19]

Personal reasons were the cause in 41 cases (27.70%) of hanging followed by family problems in 26 (15.86%) and marital conflicts in 10 (06.75%). The main reasons for suicide among males were unemployment, crop failure, marital conflicts, family disputes, love failure and extramarital affairs. Deaths due to asphyxia were less common in females. Mental stress and depression are less common in females as they are more expressive emotionally. Main factors for suicide in females were marital conflicts, dowry, love failure and extramarital affairs. Other researchers made similar observations.[15-21]

In 4 cases of strangulation, the reason remained unknown. 9 victims were smothered for revenge. No victim drowned accidentally. In 8 cases of throttling, the reason for homicide was marital conflicts. It was elicited from the history that personal reasons like failure in the examinations, psychiatric problems, long time illness etc. were the most common reasons for hanging. Other researchers made similar observations.[15-21] The most common external signs are cyanosis of the skin, lips, and nails in 60 cases, facial congestion in 56 and contusions in 16 cases. The most commonly seen is lung congestion with or without froth (28 cases) followed by tracheal congestion in 59 cases and blood vessels congestion in 42 cases. The mark on the neck was principal sign of hanging and ligature strangulation. Cyanosis (evident as bluish discoloration), petechial haemorrhages, visceral congestion, and dark fluid blood were noticed in all cases. In study, there was no fracture of hyoid bone in hanging. Similar findings were observed by other studies [15-21]

Conclusion

This study of 148 cases of death due to asphyxia at the Department of Forensic Medicine, Mamata Medical college, attached with MGH, Khammam, Telangana during period January 2016 to Dec 2018 showed that hanging followed by drowning are the common modes of death by asphyxia. Death due to asphyxia was most common in age group of 21-40 years with male predominance. Death due to asphyxia was common for urban labourers belonging to low socioeconomic and low literacy class. Maximum deaths due to asphyxia were reported at victim's residence and during winter. Manner of death due to asphyxia was suicidal followed by accidental. The study further noted that accidental drowning can be prevented by using protective covering on well, protective fences around lake and using danger signs for deep water in rivers. Homicidal deaths were due to strangulation and throttling. The cause for homicide was marital conflicts which can be prevented by proper marital counselling.

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ORIGINAL ARTICLE

Brought dead cases at a tertiary care hospital in Ahmedabad with reference to dispensing with the need of medico legal post-mortem examination: Provisions, Protocol & Procedure

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Abstract
Brought dead cases are of concern not only clinically with regards to medical certification of cause of death, but also medico legally. Generally, brought dead cases are considered as medico legal, which in fact need not be always. Need has arisen to study the provisions and practice of handling brought dead cases with respect to whether medico legal post-mortem is required for all such cases or not. A retrospective, cross-sectional, observational study was carried out by examining case files, police papers and post-mortem reports of brought declared dead cases (n=62) received at a tertiary care hospital in Ahmedabad with the objective being to observe the epidemiology of brought dead cases and to review the provisions and practice of handling brought dead cases, as well as, medico legal post-mortem examination (Under S. 174 Cr.P.C.) for such cases. Majority cases belonged to more than 50 years of age with a history of previous/current major illness. Hence, ascertaining the cause of death became quite obvious after excluding common unnatural causes. Only 23.72% cases were subjected to autopsy. In some cases police denied permission for performing the autopsy. A protocol to handle brought dead cases is suggested which might require some reforms in relevant law(s) and state resolutions. The centers with high load of autopsies of brought dead cases from natural manner should carry out such a study to decide whether really medico legal autopsy is required in such cases or not and to request the state authorities to amend the provisions accordingly.

Keywords
Brought dead; Medical certificate of cause of death; Medico legal post-mortem

Introduction

Brought dead case is that in which on arrival of the patient to the hospital, no signs of life are detectable on examination by the attending medical practitioner. Brought dead cases are of due concern, not only clinically with regards to medical certification of cause of death (MCCD), but also for medico legal purposes. The prime issues to be addressed in such cases include deciding the cause and manner of death. It is generally observed that brought dead cases are considered as medico legal case (MLC) and police is informed for sending the body for autopsy to ascertain cause and manner of death. The facts concerning the history of past or recent medical illness, its severity, treatment being taken for the same, whether treatment was being provided by the same doctor declaring the patient dead or another are of utmost importance; but unfortunately, are not focused upon while deciding the cause and manner of death. Assessing the role of above mentioned factors is crucial in dealing with such cases and further, suggesting guidelines to the law making bodies for smooth operation in such cases. The centers with high load of medico legal autopsies of brought dead cases resulting from a natural manner can reduce their burden after thoroughly assessing such cases and helping in formulating the guidelines by the government and law making agencies. Hence, the authors undertook the present study with the aims and objectives to observe the epidemiological distribution of brought dead cases received at a tertiary care hospital in Ahmedabad, to review the procedure of handling brought dead cases, to review the provision(s) and practice of medico legal post-mortem examination (under S.174 of CrPC.) in brought dead cases & to formulate suggestions regarding handling brought dead cases.

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Materials and Methods

A retrospective, cross-sectional, observational, document based study was carried out in the department of Forensic Medicine and Toxicology at a tertiary care hospital in Ahmedabad, Gujarat after obtaining approval from the Institutional Ethics Committee. The case files, police papers and autopsy reports of total 62 brought dead cases were studied. All the data was entered in Microsoft Office Excel 2007 software and analysis was carried out.

Results

Table 1 shows that majority of the brought dead cases 29 (46.77%) belonged to 51-70 years age group.

Table 1: Age & Sex wise distribution of cases

Age group (years)	Male	Female	Total
0-1	3	0	3
1-10	3	2	5
11-20	2	0	2
21-30	2	3	5
31-40	2	2	4
41-50	5	1	6
51-60	**12**	**4**	**16**
61-70	**5**	**8**	**13**
71-80	3	3	6
81-90	0	2	2
Total	**37**	**25**	**62**

Table 2: Procedure followed for handling Brought dead cases (No. of cases – percentage)

Total Brought Dead cases **62 (100%)**			
MLC issued **59 (95.16%)**		MLCnot issued **3 (4.88%)**	
MCCD issued	MCCD not issued	MCCD issued	MCCD Not issued
1 (1.69%)	**58 (98.31%)**	**3 (100%)**	**0**
↓ MCCD not issued **(58)**			
Police informed	Police not informed		
56 (96.55%)	**2 (3.45%)**		
↓ Police Informed **(56)**			
Autopsy conducted	Autopsy not conducted		
14 (25%)	**42 (75%)**		
↓ Autopsy not conducted **(42)**			
Refusal by relatives & known illness - Requisition from police for not conducting autopsy	Refusal by relatives (No past history of any known illness) – Requisition from police for not conducting autopsy		
36 (85.71%)	**6 (14.29%)**		

Table 3: Distribution of cases according to past medical record

Cases with history of major past illness		
Present	Absent	Total cases
42 (67.74%)	**20 (32.26%)**	**62 (100%)**

Table 4: Description of cases with history of Major Past illness (42) – All Natural deaths

Cases with history of Major Past illness (**42**) – All Natural deaths			
History of treatment taken in past	**(42)**	Absent	**4 (9.52%)**
		Present	**38 (90.48%)**
Past illness Documents availability	**(42)**	No	**31 (73.81%)**
		Yes	**11 (26.19)**
Past treatment taken at	**(38)**	At present hospital	**9 (23.68%)**
		Other than present hospital	**29 (76.32%)**
Last visit to the doctor	**(38)**	Within 1 day	**9 (23.68%)**
		Within last 1 week	**4 (10.53%)**
		Before more than 1 week	**25 (65.79%)**
MCCD issued or not	**(42)**	Issued	**2 (4.76%)**
		Not issued	**40 (95.24%)**
MLC issued or not	**(42)**	Issued	**41 (97.62%)**
		Not issued	**1 (2.38%)**
Autopsy	**(41)**	Conducted	**6 (14.63%)**
		Not conducted	**35 (85.37%)**
		Reason for not conducting autopsy	Police gave requisition for not conducting autopsy due to refusal by relatives & known illness
Discrepancy between History in inquest and Cause of death	**(6)**	No	**5 (83.33%)**
		Yes	**1 (16.67%)**

Table 2 shows that total 62 brought dead cases were studied during the study period out of which 59 (95.16%) cases were issued as Medico legal cases, while in 3 (4.88%) medico legal case was not issued & medical certificate of cause of death (MCCD) was issued. Out of 59 cases which were issued as medico legal cases MCCD was issued in only 1 (1.69%) case, while in rest 58 (98.31%) cases MCCD was not issued by the attending doctor at emergency. Out of 58 cases in which MCCD was not issued police was informed in 56 (96.55%) cases, while police was not informed in 2 (3.45%) cases due to the reasons best known to the emergency medical officer. Out of 56 cases in which police was informed regarding brought dead status of the patient medico legal autopsy was conducted in 14 (25%) cases only, while in 42 (74%) cases medico legal autopsy was not conducted because police requested for handing over the body to the relatives without conducting autopsy in 36 (85.71%) cases out of 42 due to known illness of the patient and refusal by the relatives and in 6 (14.29%) cases out of 42 due to refusal by the relatives even in absence of any significant past

medical history or any known illness.

According to Table 3 out of total 62 brought dead cases history of significant past history of major illness was present in 42 (67.74%) cases, while such history was absent in rest 20 (32.26%) cases.

Table 5: Description of cases with absence of any history of past medical illness (20)

Manner		No. of cases
Natural		**12 (60%)**
MCCD issued (Based on symptoms & exclusion of other un-natural events)		**2 (16.67%)**
MCCD not issued		**10 (83.33%)**
MCCD not issued **(10)** -Police was informed for Medico legal autopsy	Autopsy done	**2**
	Autopsy not done	**8**
	Reason for not conducting autopsy	Police gave requisition for not conducting autopsy due to refusal by relatives
Discrepancy between history in (**2**) inquest and cause of death after autopsy	No	**2 (100%)**
	Yes	**0 (0%)**
Un natural		**8 (40%)**
Road Traffic Accident (RTA)		**1 (12.5%)**
Corrosive ingestion		**1 (12.5%)**
Hanging		**1 (12.5%)**
Drowning		**3 (37.5%)**
Fall from height		**1 (12.5%)**
Abdominal injury		**1(12.5%)**
All un-natural cases **(8)**	Autopsy done	**6 (75%)**
	Autopsy not done	**2 (25%) (Drowning cases)**

Table 4 shows details of the brought dead cases with significant past history of major illness (42) which were all concluded to be natural deaths. Out of these 42 cases, 38 (90.48%) patients had history of treatment taken in past for major illness, while 4 (9.52%) patient did not have any kind of treatment in past. Out of these 42 cases only 11 (26.19%) patients' relatives could bring documents/records of past illness and treatment, while 31 (73.81%) patients did not have any kind of documents. Out of 38 patients who had history of treatment taken in past only 9 (23.68%) patients took treatment in the present hospital, while 29 (76.32%) patients took treatment at any hospital other than present hospital. Out of these 38 cases 9 (23.68%) patients visited the doctor within one day, 4 (10.53%) within last one week & 25 (65.79%) before more than one week of their death, Out of 42 cases with history of major past illness MCCD was issued in only 2 (4.76%) cases and medico legal case was issued in 41 (97.62%) cases. Out of the 41 cases in which medico legal case was issued in only 6 (14.63%) cases medico legal autopsy was conducted, while in 35 (85.37%) cases police gave requisition to the doctor for not conducting autopsy due to refusal by the relatives of patients and known past illness. Out of the 6 cases in which autopsy was carried out, in only 1 (16.67%) case the discrepancy was found between the history in inquest and cause of death after autopsy conducted at present hospital. In rest of the 5 (83.33%) cases the cause of death after autopsy was in consonance with the history mentioned in the inquest report.

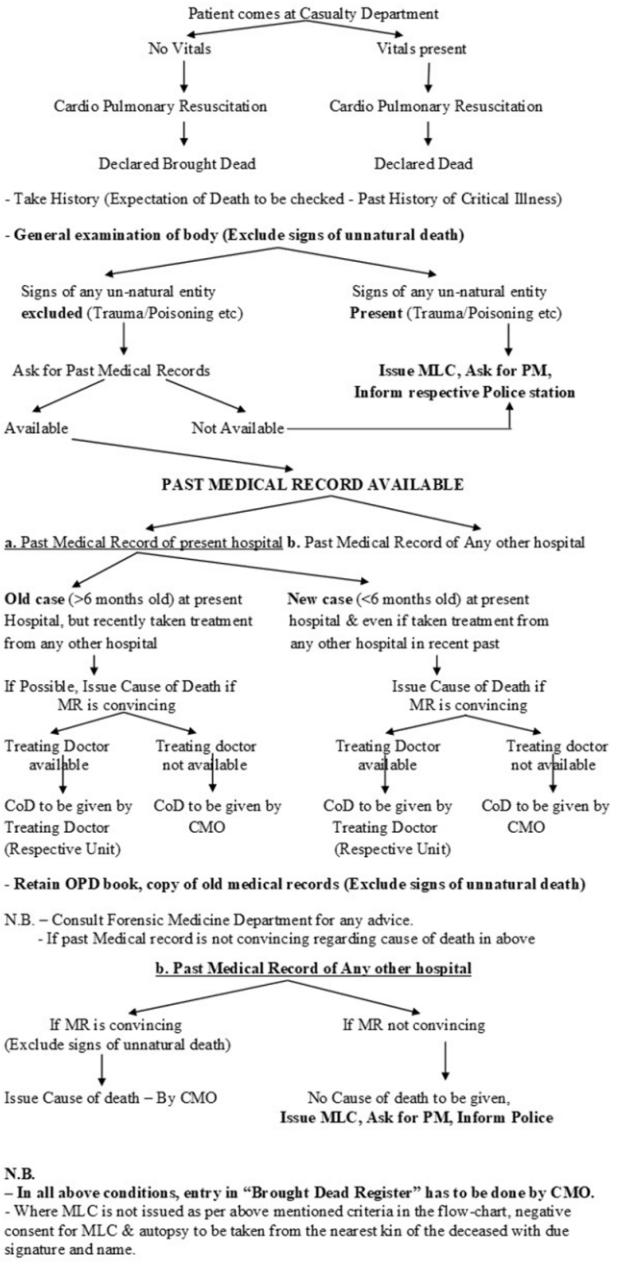

Figure 1: Protocol to be followed in case of Brought dead Patient

Table 5 describes the brought dead cases with absence of any significant past history of major illness (20) out of which 12 (60%) cases were of natural death, while 8 (40%) cases were due to un-natural events. Out of these 12 cases of natural death MCCD was issued on the basis of symptoms & exclusion of un-natural causes only in 2 (16.67%) cases, while MCCD was not issued in 10 (83.33%) cases. Out of the 10 cases where MCCD was not issued medico legal autopsy was done in only 2 (20%) cases, while police gave requisition for not conducting autopsy due to refusal by the relatives in 8 (80%) cases. No discrepancy was found between history mentioned in inquest and the cause of death derived after medico legal autopsy in any of the case in which autopsy was performed. The 8 cases which were of un-natural deaths consisted of 3 (37.5%) of drowning and 1 (12.5%) case each of road traffic accident, corrosive ingestion, hanging, fall from height and abdominal injury. Out of these 8 cases of un-natural deaths autopsy was requested by police in 6 (75%) cases, while in 2 (25%) cases of drowning police gave requisition for not conducting autopsy due to refusal by relatives of the deceased. Out of the 6 autopsies carried out, 5 autopsies were conducted at present institute amongst which there was discrepancy between history mentioned in inquest and the cause of death derived after autopsy in only 1 (20%) case. 1 autopsy was carried out at the some other institute on request of police so, information about cause of death in that case is unavailable to the authors.

Discussion

Brought dead cases form a good chunk of total autopsies conducted at any centre. It is generally observed that brought dead cases have a history of some or the other past major illness. It is crucial to assess the expectedness of death in such cases. Almost all brought dead cases are generally considered as medico legal but they may not be. An autopsy based study by Gupta et al[1] shows 10.7% cases of total autopsy conducted was under the category of "Brought dead" and the difference between the cause of death given in police papers and after autopsy was found only in 8 out of 457 cases (1.75 %) v/s 2 out of 14 cases (14.28%) in present study. The reason deduced was the type of study – the earlier study being an exclusively autopsy based study. Gupta et al.[1] raise the question about necessity of conducting post-mortem examination in such cases. In present study, out of total 62 brought dead cases, 59 were issued MLCs, amongst which medico-legal autopsy was carried out in only 14 (23.72%) cases. In rest of the 45 (76.28%) cases, when police personnel in the beginning gave written requisition to hand over the body without medico legal postmortem; we were cautious concerning any such existing provisions. Earlier we believed that the police was exercising its powers under S. 174 of Cr.P.C. "*impliedly*" provided in the referred section. But in addition Gujarat Police Manual[2]; S. 144 contains an "*expressed"* provision. It goes as: "*S. 144 Post-mortem examination when necessary, - 1) In any case under investigation, in which a person has met with his death, the Police Station officer or a Police officer not lower than a Sub-Inspector is empowered by S. 174(3), Criminal Procedure Code, to send the body to nearest Civil Surgeon or other qualified medical man for post-mortem examination: - i) if, there is doubt as to the cause of death or ii) in cases where bodies are found in well, tank, lake, river etc. to decide whether the death was homicidal, suicidal or accidental, iii) if, there is no such doubt the Police officer thinks it expedient, to do so e.g. in order to procure expert medical evidence as to:- a) the period of time that might have elapsed since death; b) the personal identity of the deceased; c) whether the deceased is a case of infanticide was born dead or alive, or d) whether the death was due to accident, when a prosecution is intended in case of motor accident. Note: No examination will ordinarily be necessary in cases of motor car or other accidents where no prosecution is intended and there is clear evidence of the cause of death."*A more or less similar circular exists for Union Territory of Chandigarh[3], where the District Magistrate, Chandigarh issued a memo to the Senior Superintendent of Police (SSP) of Chandigarh and instructed the Station House Officers (SHOs)/Investigating officers to act according to rule 25.36(2) of the Punjab Police Rules, 1934, which categorically states that "*the investigating officers are fully competent to dispense with the post-mortem of a body and have it delivered to the heirs of the deceased without post-mortem.*" A notification from Home department, state of Rajasthan[4] with reference to deaths in rail and road accidents mentions that police has power to dispense the medico legal post-mortem examination, if investigating officer does not have any doubt regarding cause of death. Moreover, Khandekar in his report[5] submitted to the Prime Minister of India, Chief Minister – Maharashtra state, Home & Law Minister – Maharashtra state and Union Home Minister in December, 2015 stated that the government should direct the police department that they should not order a post-mortem examination of dead body and collection of organs forcefully without the consent of next of kin till the law is amended in this regard. He also suggested removing the flaws in law, and that the government should take immediate steps to lay down special laws for forensic medical death investigation or to amend the existing laws so that the scientific forensic death investigation system functions effectively. Chaphalkar et al.[6] in their study concluded that using structured format for inquiry/investigation into the cause of death i.e. inquest which includes the indication for forwarding the case for post-mortem examination as per section 174 CrPC[7] and by reviewing its first three sub-clauses in cases where there is no justifiable reason for post-mortem

examination, it can be possible to reduce the number of unnecessary post-mortem examinations carried out.

In the light of increasing demand for not conducting post-mortems in cases of natural deaths, the authors have designed an institutional protocol to deal with such brought dead cases whilst safeguarding legal duty as a registered medical practitioner, which might require the relevant existing laws and state resolutions to be amended accordingly by law making agencies and central / state governments. Suggested protocol is described in Figure 1.

Conclusion

It is concluded that majority of the brought dead cases (59.68%) were more than 50 years of age, amongst which history of major past illness was predominant (67.74%). In majority of such cases expectedness of death was not low. Out of 32.26% cases, where history of major past illness was absent, 60% cases were of natural deaths in which autopsy was not conducted due to written requisition given by the police for dispensing the need of autopsy on refusal by the relatives and known past illnesses. Even in un-natural deaths, 25% cases were not subjected to autopsy due to request given by the police for not conducting autopsy following refusal by the relatives. Till the desired reforms with expressed provisions for handling the brought dead cases are made by the state; an institutional protocol as suggested by the authors in this study can be followed post a critical reviewed and customization without contravening state directives, which can help in decreasing the load resulting from un-necessary autopsies. This protocol requires some reforms to be made by law making agencies and government for laws like S. 174 CrPC, Birth & Death Registration Act and other relevant central and state government orders/directives/resolutions. The centers with high workload of autopsy are suggested to carry out such a study in compliance with concerned state directives and illuminate further with respect to this debatable issue.

Ethical clearance: A prior approval was obtained from the Institutional Ethics Committee

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ORIGINAL ARTICLE

Paradoxes of suicide and psychological crisis - An Uttarakhand phenomenon during COVID-19 lockdown

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Abstract

Indian government had mandated nationwide lockdown with stringent guidelines from March 24th to May 4th 2020. Lockdown created huge impact on everything. It has exacerbated pre-existing mental illness in many, thereby leading to "Quarantine Blues." This retrospective study had been conducted in Department of Forensic Medicine and Toxicology at a tertiary health care centre, Haldwani in Nainital district; Uttarakhand to focus on how the lockdown effect correlated to suicide from March 24th to May 4th 2020 with the same time period of preceding years (2016-2019). There was a decline in the trend of suicides during lockdown (n=1) when compared with concurrent time interval over the previous years. Domestic violence spikes are supposed to bloom the number of suicides, but Uttarakhand phenomenon is a paradox which needs to be further evaluated.

Keywords

Suicide; Lockdown; Covid-19; Pandemic; Deliberate self-harm

Introduction

Suicide has been a leading cause of preventable death. According to the NCRB data of 2018, the number of death due to suicide was 1,34,516 and there was an increase of 3.6% compared to 2017. The national suicide rate in 2018 was 10.2 where the highest was in Andaman and Nicobar Islands with a rate of 41 while in Uttarakhand it was 3.8.[1] The major causes for suicide are family problems followed by illnesses, marriage related issues, drug abuse/addiction, love affairs, bankruptcy, exam failures, unemployment, career issues and property disputes. The most prominent methods of suicide were hanging, poisoning, drowning and fire/self immolation. The total number of suicides in Uttarakhand was 421 which was an increase of 27.2 % compared to that of 2017.[1]

Lock down period has given families an opportunity to spend time together. But at the same time WHO predicts that the effect of lockdown may increase domestic violence and its subsequent consequences like suicide. These are two sides of the same coin. In this article, we are attempting to study about the comparison of suicides during the lock down with the corresponding time period of preceding years.

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Materials and Methods

Uttarakhand is a newly formed state in India. Haldwani is a small city in the Nainital district of the state. The study was conducted in a tertiary care centre in Haldwani catering the entire population of Kumaon region. This is a retrospective data analysis comparing the suicide fatality during the lockdown period starting from March 24 to May 4, 2020 with the same time period of the previous years (2016-2019) that was reported in this teaching hospital. Being the sole hospital in the district with a forensic surgeon, most of the cases of the fatal deliberate self harm are brought to this hospital for autopsy and are reported.

The data was obtained from the records regarding the number of suicides, age, gender and cause of death. The data was entered in MS Excel. The data was presented as numbers, means and proportions. All the cases reported were included in the study and confidentiality of the information collected was strictly maintained.

Results

Following the lockdown, there was a dramatic decline in the number of suicide fatality. There were only eleven deaths due to suicide when compared with nineteen, seventeen, twenty one and nineteen during the same time period of the preceding years. This showed that the effect of lockdown has brought down the number of deaths due to suicide. Males were more affected than females in 2020, 2019, 2018 and 2016, though the difference is very minimal. The mean age of the affected remained almost the same with 34.45 years in 2020. Poisoning was the commonest cause of death followed by hanging in the

studied population as observed during the study period. More than 70% of the affected choose poisoning for the deliberate self harm.

Discussion

Lockdown was announced in India to curb the spread of COVID-19. The first and second phase of the lockdown was from March 24 to May 4, 2020 accompanied with strict rules and regulations. All the non essential shops remained closed and people were not allowed to step outsides their homes because of strict enforcement and fear of contracting the disease. Mental health issues were roiling with the number of corona cases, henceforth government commenced a helpline within few days of lockdown. According to Indian Psychiatry Society there was a hike of 20% in total number of cases related to mental health illness.[2] The launch of helpline in NIMHANS, Bangalore, has subsequently recorded 16,000 calls within a month.[3] It clearly indicates how the lockdown has fortified anxiety, fear and depression in the population. This study was mainly to observe the mortality rate of this specific time period compared with that of earlier years.

Lockdown was a time where life came to a standstill, it was like a pause button in the life of a person. Social distancing had proved to be one of the most effective ways to reduce the spread of Covid-19. Over this period, one was always with the family, desperately thinking of what to have and desires were not over and above. The stress of the outbreak in Haldwani was not as intense compared to urban cities. According to the NCRB data of 2018, the maximum number of suicides in Uttarakhand was due to family problems of about 150 out of 421. The other major causes were marriage related issues (52), love affairs (29), drug abuse/addiction (22), illness (8) and unemployment (7)[1]. In our study among fatal suicide cases during this lockdown period, there was a significant decrease in the total number of cases compared to earlier years (Figures 1 and 2). The mean age of the fatal cases as depicted in Figure 1 remain almost same as that of 2019. There was no difference in the sex distribution or mean age or type of self harm when compared with the previous years. The age standardization was not done in the present study as there was no significant difference in the mean age of the subjects in the study.

Preponderance of family problem related cases contributed to more than half of the total cases. This was in ordinance with the importance of the family in Indian culture. Indian parents always want their children rooted to Indian cultural heritage, thereby providing them with ample social and moral support simultaneously enforcing numerous rules and regulations. Parental expectations create undesirable pressure on children which compels them to take their own life in the long run. Similar scenarios are seen in husband wife relationship along with various other confounding factors that constitute family issues. Most of the studies reports the majority of suicide deaths are among married people.[4, 5, 6, 7]

In a report by National Legal Services Authority the maximum number of domestic violence cases during lockdown period was reported from Uttarakhand.[8] In our study out of 11 cases, 7 cases were directly linked with family problems which consisted of fight between couples regarding their child's school admission, to newly married couple having fight over substance abuse by husband. Accessibility of any lethal methods have become difficult due to presence of all the family members at home subsequently reducing the number of suicidal cases over this particular time interval.

Probable factors could be the stoppage of alcohol sale and non-availability of other abusive substances. According to a recent study, in places with no alcohol outlets ban during pandemic time exhibited a jump in consumption with fueling rise in the calls in suicide hotlines and preventive services[9]. Implementation of the liquor ban during the first phase of the lockdown where Kerala witnessed around 7 suicidal cases due to withdrawal symptoms,[10] our study has reported no such cases. The method of suicide was found to be hanging and poisoning by the usage of pesticide meant for agricultural purposes which were easily accessible at home.[11] Although the trend in the method of suicide remains almost the same as depicted in Figure 1, the total number of cases has tremendously reduced in both groups. This might be subjected to difficulty in procuring poison due to closure of shops. Concurrently, hanging also became difficult as family members are staying indoors.

In accordance to history; two cases revealed direct relationship with lockdown. The first case was on antidepressant drugs. He was experiencing severe anxiety and stress on unavailability of drugs which led him to suicide. The second case was a migrant laborer from Nepal who after being unemployed and was stranded in the area due to lockdown; committed suicide out of stress. Another case indirectly connected to lockdown was the one struggling with debt.

The decrease in suicide number is supported from another study conducted in the western world where the cases got decreased by 50% compared to that of the previous 7 years.[9] Historically cases have shown a steep decline during the early stages also known as the honeymoon time period but the amalgamation of multifactorial risk factors could precipitate an influx of cases in the near future.[12] The repercussions of job loss, unemployment, global recession, low demand in consumer market, unexpected loss of near ones in pandemic, stress during the quarantine time period, increased usage of substance abuse after lockdown period, social isolation, decreased access to religious and spiritual support, difficulty in availing health treatment could

trigger an increase of suicide rates in the coming days. In addition, the reforming labour laws in favour of companies and labour exploitation may add up to the scenario.

Mental distress and economic hardship are the well known factors of suicide. As discussed in many articles there may be a storm of cases. But the relationship between suicide and disasters are complex. In some studies, there is an increase in the number of suicides,[13, 14, 15] some with a decrease in number[16] and other that show no significant changes[17] after the disaster. This research is not sufficient to study the effect of lockdown and has to be investigated in the coming months to reach a conclusion.

Conclusion

The long term effect on mental health over the pattern of Deliberate Self Harm by the pandemic and the lock down effects needs to be further investigated and take necessary steps to reduce the ongoing threat. In this study, the number of completed suicide cases has reduced significantly in this short term but the major causes for suicide like domestic violence and mental health illness have increased significantly as seen by several statistics. While the whole planet is affected by this pandemic, it becomes difficult to take steps regarding how to cope with the mental health of an individual without appropriate planning.

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ORIGINAL ARTICLE

Screening for violence risk assessment of juveniles in a reformatory school in a capital city of Central India

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Abstract

Juveniles of today will become the adults of tomorrow, the face of the world. Hence, it is of utmost importance to make sure that the youth of nation are given a wholesome protected environment to thrive and grow in. It has been recommended that the juvenile delinquents should be given special care and their psychological and risk assessments should be done to prevent recidivism in future. The main purpose of this study is to carry out violence assessment of juvenile delinquents. We also wish to address the juvenile related factors associated with violence risk. All willing inmates who gave their consent for participation were included in our study. Both male and female inmates of the reformatory schools were studied for violence risk assessment screening. We used the violence risk screening questionnaire (V-RISK-10). The assessment of juveniles in the remand home revealed that 100 boys were at low risk for violence, 20 (15.9%) were at moderate risk and 6(4.8%) were at high risk. The individuals with moderate risk for violence will be subjected to more detailed violence risk assessment. Violence can be prevented in many cases by building strategies addressing the underlying cause of violence. Thus, by proper counselling of aggressive individuals we can combat violence.

Keywords

Juveniles; Delinquents; Counselling

Introduction

Juveniles of today will become the adults of tomorrow, the face of the world. Hence, it is of utmost importance to make sure that the youth of nation are given a wholesome protected environment to thrive and grow in. As we are all aware children come under one of the most vulnerable groups of societies which makes them more prone towards risk of many social evils. Hence it should be considered a priority to provide them with a protected environment with adequate love and care for their appropriate growth and development. [1] According to many studies on adult law offenders, it has been found that they had a history of being a juvenile offender in their teenage years. [2,3] It has been recommended that the juvenile delinquents should be given special care and their psychological and risk assessment should be done to prevent recidivism in future. [4,5]

Violence means the actions or words intended to hurt people. Physical violence is a serious crime and has multifaceted forms including domestic violence, sexual violence, gang fights, homicide and terrorism. [6] Numerous factors like poverty, income and gender inequality, the harmful use of alcohol, and the absence of safe, stable, and nurturing relationships between children and parents plays a role in determining the frequency and severity of violence. [7,8]

Screening for Violence risk assessment is considered a necessary tool in violence management and prevention in future. [9] Violence risk assessment is considered a challenging task especially in juvenile settings. [10]

Violence can be prevented in many cases by developing strategies addressing the underlying cause of violence. Thus, by proper counselling of aggressive individuals we can combat violence. [11,12] The main motive of this research is to identify the juveniles who are more likely to indulge in violence and commit crimes in the future. By identifying such persons in advance, we can counsel them effectively in time and prevent crimes. This can in turn reduce the crime rates in our nation. By giving proper counselling we can propel the delinquent youth in the right direction making them good citizens of tomorrow.

The main purpose of this study is to carry out violence assessment of juvenile delinquents. We also wish to address the juvenile related factors associated with violence risk. These results could be utilized by health professionals to initiate appropriate treatment either via psychotherapy or counselling for averting violence episodes and crime prevention in future. Our study is focused on the violence and aggression assessment of juveniles in reformatory school. The main objectives our study were:

- The causative factors behind the unlawful acts of juveniles
- The vulnerable age of juveniles which make them prone towards going against the law

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- To assess the current psychological state of the juveniles.
- To study the risk of violence in these juveniles.
- To find out the Factors contributing to violence risk
- To highlight the probable consequences of violence
- To chart the juvenile -related variables used in the risk assessments

Materials and Methods

The study was conducted on the juveniles of government Reformatory schools in the capital city of Lucknow (Rajkiya Bal Sudhar Grah boys and Rajkiya Bal Sudhar Grah, Girls, Barabanki). All the willing inmates who gave their consent for participation were included in our study. Both male and female inmates of the reformatory schools were studied for violence risk assessment screening. We made use of the violence risk screening questionnaire (V-RISK-10). [13] Permission was taken from the institutional ethical committee before the commencement of the research work.

Data collection was done in a phased manner. Permission was taken from the concerned authority, i.e. the Juvenile Justice Board Magistrate to meet and interview the juvenile inmates. The juvenile inmates were screened by the violence risk assessment screening tool which comprised of 10 questions. The detailed opinion of officials in charge of remand homes were also taken. The Juvenile inmates were interviewed for the following -

- Any previous or current episode of violence.
- Previous and /or current threats (verbal/physical)
- Previous and/or current substance abuse
- Previous or current major mental illness
- Personality disorder
- Shows lack of insight into illness and/or behaviour
- Expression of suspicion
- Shows lack of empathy
- Unrealistic planning
- Future stress situations

All the collected data was analysed in the form of tables and charts. The inmates were divided into two groups i.e. below 16 years of age and above 16 years of age. The children of juvenile homes were also studied for various factors like family history and background. Simultaneously they were also assessed for the level of education they had received. The type of offence committed i.e. non-heinous crime or a heinous crime was recorded. The number of inmates who were involved in sexual crimes was also noted separately. Presence or absence of drug abuse was also noted. The type of addiction and age of onset was enquired.

Results

A total of 126 boys and 42 girls were included in the study. The percentage of boys aged <16 years and >16 years was 36.5% and 63.8% respectively, and the percentage of girls aged <16 years and >16 years was 83.3% and 16.7% respectively. The percentage of boys aged <16 years (36.5%) in remand home was significantly higher ($p<0.05$) than girls aged <16 years (16.7%).

Assessment of the education level of the adolescents shows association of gender with the education level. It is seen that a significantly higher number of males with lower educational status were likely to be booked under the juvenile act than females ($p=0.030$).

The assessment of juveniles in the remand home revealed that 100 boys were at low risk for violence, 20 (15.9%) were at moderate risk and 6(4.8%) were at high risk. 2((4.8%) girls were found to be at high risk for violence and 5(11.9%) at moderate risk. The individuals with moderate risk for violence will be subjected to more detailed violence risk assessment

Table 1: Division into two groups (126 boys, girls 42)

Age of Juvenile	Boys	Girls
Age <16	46 (36.5%)	7 (16.7%)
Age >16	80 (63.5%)	35 (83.3%)
Total	126	42

Table 2: Educational Qualification of Juveniles

Education level	Boys	Girls	p-value
Illiterate*	16 (12.7%)	0	0.030*
Up to Primary*	42 (33.3%)	10 (23.8%)	
Up to High School	57 (45.2%)	25 (59.5%)	
More than High school	11 (8.7%)	7 (16.7%)	
Total	126	42	

*Merged for statistical calculations

Table 3: Violence risk in Juveniles (as reported by wardens)

Education level	Boys	Girls	p-value
Low	100 (79.5%)	35 (83.3%)	0.821
Moderate	20 (15.9%)	5 (11.9%)	
High	6 (4.8%)	2 (4.8%)	
Total	126	42	

Discussion

Our study revealed that the major part of the population of juvenile offenders in remand homes belong to the age group of older than sixteen (63.49%). This finding is significant as it may point towards the increasing tendency of older adolescents to commit crimes. The reasons may vary. Increased testosterone levels in this age group may contribute greatly to the tendency to commit violent and sexual crimes. Batrinos in his study linking testosterone and violent behaviour indicates similar trends. [14]

73.57% of the female inmates are older than 16. Some of the girls were even eighteen years old and one of them was twenty-one. These findings indicate the same trend of increasing rates of crimes in older adolescents. The younger population in general committed relatively minor crimes like theft and fraud.

Surveillance of the family background reveals that most of the inmates belong to lower, upper lower and lower middle socioeconomic background. It may seem to point towards the greater tendency of juveniles from poorer backgrounds to commit crimes. Various researches disprove this notion and find no correlation between income and crimes like theft, assault, burglary and robbery when poverty is adjusted. [15] The scarce number of inmates from the upper middle class and upper socioeconomic strata might reflect loopholes in the Indian judiciary system. The conviction rate is much lower in the affluent strata of society. This may be due to access to superior lawyers, better knowledge of laws and rights and corruption amongst the police and judiciary set up of India.

One of the inmates of the remand home belonged to the upper middle-class socioeconomic strata. His family was substantially well off and he had been receiving good education in a very prominent school of the area. He had a love affair with one of his classmates. The parents of the girl spurned by this affair accused the boy of rape and got him arrested. The juveniles belonging to more affluent sections have mostly been arrested under the charges of rape. Many of them were in consensual relationships. This is a very typical scenario in the present age where advantage of existing archaic laws is misused for personal revenge. Despite engaging in sexual activities with full consent, the boy was found guilty of rape as the legal age for consent is 18. Perhaps it is indeed time to review and change the legal age of consent. The age of consent varies amongst nations ranging from puberty to after marriage**.** The ages of attaining puberty in general have been declining indicating earlier onset of puberty. [16] In addition, trends of increasing age of marriage and westernization and liberalization of attitudes towards sexual relationships lead to greater number of teenage relationships. The dynamic, changing attitudes of the society must be contemplated and laws be amended.

The majority of inmates had lower educational qualifications. Out of the 126 boys, 12.67% were found to be illiterate. 23.81% of the individuals have studied only till 5th grade, 45.24% from 6th to 10th grade and the remaining 8.73% have completed 11th or 12th grade. And 1 boy was of madrasa level. The presence of illiteracy in these adolescents despite several educational programs in our country is alarming. Overall a connection between low academic achievement and crime rates was observed. Some studies have found the tendency of less violent behaviour in adolescents with higher educational aspirations. [17] Hormonal levels may also be contributory, as, studies have linked violent sexual crimes and repeated sexual offences to high levels of testosterone. [18]

The violence displayed in movies, television, videos and videogames may also lead to aggression and violence in the youth. Various studies provide solid evidence suggesting an increase in violence and aggression amongst youngsters due to violence depicted in media. This may be due to the tendency of youngsters to emulate observed behaviour. The research by Anderson et al. emphasizes the link between media and violence. [19] It suggests that violent behaviour is learnt by various learning processes such as imitation, admiration for the aggressive characters, and desensitization or reduction in the normal negative response to violence. There must be parental supervision of multimedia consumption by children, and awareness about detrimental impact of violent media. Brockmyer in his study found evidence of violent videogames leading to desensitization and probable acts of aggression and violence. [20]

An extremely disturbing trend observed was the massive number of female juveniles convicted for murder. 45.25% of the girls had committed murder. The reasons for this finding are not properly understood. This must be delved into and analysed by further research.

Some inmates showed recidivism i.e. they were arrested many times for various offences. These individuals must be given special attention and the underlying causes should be assessed.

One of the juveniles was a drug peddler and had been arrested for possession and selling of illegal drugs. Although there was allegedly no substance abuse and drug use in the reformatory homes, the authorities must remain vigilant and prevent the penetration of drug nexus into remand homes and prisons.

An important aspect to be looked into is the mental health of the juveniles. The contribution of family in the mental health of juveniles cannot be overlooked. Ceballo et al. found a positive impact of parental monitoring on the psychological wellbeing of affected youths. [21,22] The remand homes must strive to provide a nurturing and fear free environment for growth and wholesome development of the juveniles.

The assessment of juveniles in the remand home revealed that 100 boys were at low risk for violence, 20 (15.9%) were at moderate risk and 6(4.8%) were at high risk. The individuals with moderate risk for violence will be subjected to more

detailed violence risk assessment. The 6 juveniles marked as high risk have greatest possibility of committing violent crimes in future. These juveniles will be given utmost attention. 2(4.8%) girls were found to be at high risk for violence and 5 (11.9%) at moderate risk. The high-risk juveniles have exhibited acts of violence including physical attacks like kicks, punches, blows etc. By providing special care, proper guidance and counselling to these juveniles, we might effectively prevent such crimes in future.

Conclusion

Many juvenile participants in the study had committed violent and sexual crimes. Hence, we suggest appropriate measures should be taken to prevent youth victimization and violence, which includes comprehensive violence prevention plans in all spheres of life, i.e. homes, schools, communities. This will definitively reduce as well as prevent juvenile delinquency as well as recidivism We recommend Juvenile Drug treatment centres should be set up to address these needs and initiate strategic planning. They could help in implementing treatment, tracking as well as family engagement and support. Juvenile mentoring programs should be initiated in the reformatory schools where the mentors should guide the juveniles and provide technical assistance and training in their field of interest. There should be a facility for web based free learning and training. Thus, we can expect that through proper care and counselling, these juveniles including those showing predisposition towards violence could be molded to grow in the right direction and become good and responsible citizens of our nation.

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ORIGINAL ARTICLE

Smartphone dependence: A socio-physiological nightmare

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Abstract
Smartphone has become a common platform for communication, education, entertainment, infotainment. Not only has such diverse usage made it an indispensable item of daily usage but its infiltration into our personal lives in form of social media platforms like Facebook, WhatsApp etc have put a lot of strain on our social interactions. A combination of multipurpose usage and socialization has made smartphone and its dependence producing habit a subject of intense studies in recent past. Present study is exceptional and productive because it utilizes the environment of sudden depravation of smartphone usage and applies the withdrawal produced by it in understanding the basic human socio-physiological response. This study is also unique by the fact that predominant population used in the study, had a professional medical background and were more accurate in providing data especially related to physiological aspect of study.

Keywords
Smartphone; Social media; Multipurpose usage; Dependence; Socialization; Physiological.

Introduction

A prospective study involving use of smartphones by general population was carried out between October 2019 to December2019 in Govt. Medical College Srinagar. The Govt. Medical College Srinagar and its Associated Hospitals serve as main centers of tertiary care, in and around, the major urban center of Srinagar. The study is a representative of avoidable disease burden put on an individual due to reckless abuse of modern technology.

Smartphone term was introduced in the market, referring a new class of mobile phones that provides integrated services from communication, computing and mobile sectors. [1] Later on Smartphone evolved to include capabilities to display photos, play games, play videos, navigation, built-in camera, audio/video playback and recording, send/receive e-mail, television, built in apps for social web sites and surf the Web, wireless Internet and much more. This ability of Smartphone to provide such diverse range of products on a single platform is the main reason for its dependence inducing behavior in sharp contrast to helping the business community for whom it was actually introduced. [2]

People are likely spend more of their quality time on social media, doing online business, academic search, playing games , watching films, random searching for answers on the net etc. This "necessity" for smartphone use is exemplified by fact that in developed country like America almost 95 percent of population own cell phones and 77 percent own smartphones. Around the world, smartphones were used by 1.85 billion people in 2014 which is expected to be 2.32 billion in 2017 and 2.87 billion in 2020. [3]

A unique aspect of this study is to highlight socio-physiological effects of smartphone dependence which was made scientifically more reliable and accurate by a sudden blanket internet ban on the newly formed union territory. Outcomes during this stage were systematically recorded and results obtained were outstanding.

Material and Methods

This is a prospective study involving 448 individuals with access to smartphones conducted by direct interview by means of a questionnaire. The study was conducted in an urban medical institution in northern Indian union territory of Jammu & Kashmir between October 2019 and January 2020. A total number of 448 cases were analyzed, out of which as per exclusion criteria 16 cases were rejected as the information provided was incomplete; and could not be reasonably justified. A unique feature of the study was to interview the individuals in reassuring manner where they were given a chance to share any additional information not given in questionnaire which could be of use to study. Another important aspect of study was to educate the individuals about some of the medical terms used in the study before questioning them. The physiological results from the study were made more reliable by the fact that most of the individuals in the study had a professional medical background.

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Results

Demographic data collected in the study shows that majority of study sample comprises of young adults with almost equal male to female ratio and having slightly more rural component (Table 1).

Table 1: Socio-demographic characteristics of study sample (N= 432)

Age group	N	%
15-20	228	52.78
21-25	171	39.58
26-30	9	2.08
31-40	8	1.86
41-50	4	0.92
51-60	8	1.86
61-70	3	0.69
71-80	1	0.23

Table 2: Smartphone and its primary usage in study group (N= 432)

Smartphone usage	N	%
Communication	399	92.36
Social Media	294	68.06
Education	363	84.03
Entertainment	346	80.09

Primary usage of smartphones in study population is Communication 399 cases [92.36%]; Education 363 cases [84.03%] ; Entertainment 346 cases [80.09%] and Social media 294 cases [68.06%] with overlap of 69.19% that is multiple usage of smartphones in two or more of above faculties (Table 2).As far as timed usage of smartphone was concerned 94 cases [21.76%] used smartphones for 3 - 4hours; 72 cases 4-5 hours [16.67%] whereas in 29 cases 6.71%] smartphone usage was in range of 10 hours or above. In rest usage ranged from less than 30 minutes to 10 hours (Table 3). Analysis in to time spent with relatives revealed that 1hour-2hours in 129 cases [29.86%]; less than 30 minutes in 88 cases [20.38%]; 2hours - 3hours in in 83 cases [19.21%]. In rest time spent ranged from 3 hours to above 10 hours (Table 3). When asked about non digital media usage in most cases fell in less than 30 min range 102 cases [23.61%]; 1hr-2hr 83 cases [19.21%]; 2hrs -3hrs 83 cases [19.21%] . In rest of the cases usage was between 4hrs to more than 10 hrs (Table 3). At the time of internet ban when asked about any non social interaction 304 cases [70.37%] read books or newspapers; 267 cases [61.81%] played (Table 3). Digital games or physical games like cricket etc; 177 cases [40.97%] devoted more time to television/cable; 170 cases [39.35%] preferred to spend more time in gym. There was overlap of 486 cases [47.06%] were more than one means of recreation was preferred (Table 4). During the same time when asked social interactions 348 cases [80.56%] spent more time with their mother, father or siblings; 299 cases [69.21%] increased frequency of visits to their close relatives; 162 cases [37.50%] found more time for picnics or outings with family and friends and 120 cases [27.78%] were interested in other activities like gardening etc. (Table 5). Sudden and blanket withdrawal of internet from entire population did produce withdrawal symptoms like decreased sleep 51 cases [11.81%]; decreased

Table 3: Smartphone and its timed usage (N= 432)

Hours spent on smartphone			Hours spent with relatives			Hours spent on non-digital media		
Range	N	%	Range	N	%	Range	N	%
<30 min	7	1.62	<30 min	88	20.38	<30 min	102	23.61
30min- < 1hour	6	1.39	30min- < 1hour	54	12.50	30min- < 1hour	22	5.09
1hour - < 2hours	25	5.79	1hour - < 2hours	129	29.86	1hour - < 2hours	83	19.21
2hours - < 3hours	57	13.19	2hours - < 3hours	83	19.21	2hours - < 3hours	83	19.21
3hours - <4hours	94	21.76	3hours - <4hours	40	9.26	3hours - <4hours	51	11.81
4hours - < 5hours	72	16.67	4hours - < 5hours	14	3.25	4hours - < 5hours	45	10.42
5hours - < 6hours	59	13.66	5hours - < 6hours	8	1.85	5hours - < 6hours	17	3.94
6hours - < 7hours	45	10.42	6hours - < 7hours	3	0.69	6hours - < 7hours	24	5.56
7hours - < 8hours	16	3.70	7hours - < 8hours	2	0.46	7hours - < 8hours	1	0.23
8hours - < 9hours	18	4.17	8hours - < 9hours	2	0.46	8hours - < 9hours	1	0.23
9hours - < 10hours	4	0.92	9hours - < 10hours	2	0.46	9hours - < 10hours	1	0.23
10hours & more	29	6.71	10hours & more	7	1.62	10hours & more	2	0.46

appetite 54 cases [12.50%]; restlessness 120 cases [27.78%]; increased anxiety 136 cases [31.48%] (Table 6). These results are to be considered more reliable in comparison to similar other studies as the study population had major component of individuals having sound medical background and could therefore understand the medical meaning of questions that they were answering. When enquired about their personal experience vis a vis "smartphone withdrawal" 146 cases [33.80%] had worst experience viz communication, education, entertainment component; 252 cases [58.33%] had better experience viz increased social interaction and increased use of non-digital media; 23 cases [5.32%] had both worse and better experiences and 11 cases [2.55%] found no effect of "smartphone withdrawal" on their lives (Table 7).

Table 4: Alternatives to smartphone usage - Non social interactions (N= 432)

Alternatives to smartphone usage	N	%
Books/ Newspapers	304	70.37
Games-Video/ Physical	267	61.81
Television/ Cable	177	40.97
Gym/ Exercise	170	39.35

Table 5: Alternatives to Smartphone usage - Social Interactions (N= 432)

Alternatives to smartphone usage	N	%
Time spent with mother/father/siblings	348	80.56
Time spent with close friends/ relatives	299	69.21
Picnics/ Outings	162	37.50
Miscellaneous	120	27.78

Table 6: Withdrawal symptoms arising due to sudden stoppage of smartphone use (N= 432)

Withdrawal symptoms	N	%
Decreased sleep	51	11.81
Decreased appetite	54	12.50
Restlessness	120	27.78
Increased anxiety	136	31.48

Table 7: Withdrawal effetcts due to sudden stoppage of smartphone use- personal experience (N= 432)

Effects	N	%
Drastic withdrawal	146	33.80
Improved quality of life	252	58.33
Both good and bad effects	23	5.32
No effect	11	2.55

Discussion

Mobile phone use has both advantages as well as disadvantages. while they make our lives comfortable but they also tie us down psychologically. Mobile dependence not only has physical effects but also psychological and social effect at the same time. Sleep deficit, anxiety, stress, and depression which are all associated with internet abuse, have been related to mobile phone usage too. De-Sola Gutiérrez et al., 2016 found association between physiological effects like anxiety, stress; depression and smartphone usag.[4] Alavi et al., 2012 were of view that all entities which can stimulate a person can be an addiction and whenever a habit is converted into an obligation, it becomes an addiction. [5] Thomée et al., 2011 and Rosen et al., 2013 are of view that excessive use of smartphone paired with negative attitude and feeling of anxiety and dependency on gadgets may increase the risk of anxiety and depression. [6,7] Jones (2014) conducted a survey about Elon Students' behavior along with an online survey and found that students seemed to be addicted to their mobile phones. [8] Reinecke et al. (2017) investigated psychological health effects and stimulator of digital stress. He surveyed 1,557 German internet users aged 14 to 85 and reported that communication load was positively related to perceived stress and had an indirect impact on depression and anxiety. [9] Boumosleh & Jaalouk (2017) investigated whether anxiety and depression independently contributed to smartphone addiction. Their sample was 668 random Lebanese undergraduate students. Their cross-sectional study proposed that depression and anxiety were also a positive predictor of smartphone addiction. [10] Negi and Godiyal (2016) observed HNBUG-SRT college students while walking around the campus, along with a questionnaire and found 64 % of students used mobile phones in the campus. A randomized sample of 100 students was collected. The survey showed that there were negative psychological effects of smartphone usage on the young generation. They felt depressed and anxious while using cell phones. [11] An online study conducted by Parasuraman et al., in 2017 on Malaysian 409 respondents stated that heavy mobile phone usage may lead to physiological and psychological complications when a study was conducted on. [12] Cha and Seo (2018) aimed to examine the predictive factors of smartphone addiction in middle school students in South Korea. [13] Another study by Augner and Hacker (2012) examined an association between over usage or dysfunctional usage of cell phones and psychological health. They indicated that low emotional stability, chronic stress, and depression have a correlation with phone usage. [14]

Addiction to Smartphone is major impact on social life. Surveys show that Smartphone addiction is interfering with our night's sleep. According to the survey, 33% of mobile workers admitted that they check their phones for email and message throughout the night. Nearly 50% of those surveyed said, they

wouldn't even think of going to bed without have their Smartphone's tucked under their pillows. This addiction to Smartphone is impacting the social and family life and creating frictions in our lives. [15] According to another research the organizations expect their employees to respond to the emails immediately even after working hours, due to that employee feel compelled to respond to official emails. Many Smartphone users engage in continuous monitoring of their work related emails, which creates compulsive routines of chronic checking and in the long run it is responsible for increased stress. There are evidences that Smartphone usage is responsible to blur the distinctions between the work and family life. [16]

Cyber bullying is another major issue of smartphone abuse finds targets among emotionally vulnerable population that cannot share their ordeal with others and as such face significant unshared stress that can ruin their lives.

Conclusion

Smartphone usage among young adults is clearly showing a pattern where this extremely beneficial technology might lead to certain amount of psychological and physiological dependence. This combined with "technological socialization" has weakened our family bonds and have made us forget our social obligations. The olden days book readings skills; family picinics ; and other means of personality development traits have all come to occupy back stage of present day life. Fast tracked life; quick profits; increased desire to succeed in shortest possible time have all contributed to loss of quality family life. An interesting outcome of this study was to find people searching for old world entertainment; infotainment; socialization skills and not only reconciling with them but often enjoying freedom from modern technology. A worrying outcome of this study was that all features of smartphone dependence were found in certain groupings and it is this form of dependence that finally leads to technology addiction which is akin to other addictions and often has long standing negative socio-physiological outcomes. What better answer could I have got from this study than that from one of the volunteers that she "*learnt to re-establish her bond with her parents that had long been lost because she never had time to talk to them and in spite of living in the same house most of their communications happened to be on facebook or whatsapp posts*".

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REVIEW ARTICLE

Waive off or conduct medicolegal autopsy in suspected, probable or confirmed COVID-19 patients - A dilemma for Forensic Pathologists in an Indian scenario

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Abstract

COVID -19, declared by WHO as a pandemic disease,1 is derived from SARS -corona virus-2 which originated from Wuhan, China in the late 2019, is still peaking across the world and in India. It has been predicted that the disease is here to stay till 2021 or beyond. The Mode of transmission, as it is understood is person to person transmission through droplets, skin contacts.2The clinical presentation includes fever, fatigue, dry cough, myalgia, dyspnea, sore throat, rhinorrhea, gastrointestinal symptoms etc.3,4 Containment and prevention remains the best option. Globally, about 3.4% of reported COVID-19 cases have died.5 Cause of Death is mostly due to respiratory failure, septic shock, and multi organ failure etc.6 Autopsy guidelines have been released by various committees, however to practice those in Indian scenario may not be as easy. The article thus, may be considered as a summary and interpretation of the standard guidelines taking into consideration of Indian scenario. Clinical history, and Histopathological correlation aspects will be discussed.

Keywords

COVID -19;Pandemic; Autopsy; Transportation;Embalming; Disposal

Introduction

Coronavirus disease (COVID-19) is an infectious disease caused by a newly discovered coronavirus.[7] The virus responsible for the disease is severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) classified and nomenclature by International Committee on Taxonomy of Viruses (ICTV) on 11 February 2020. WHO announced "COVID-19" as the name of this new disease on 11 February 2020, following guidelines previously developed with the World Organisation for Animal Health (OIE) and the Food and Agriculture Organization of the United Nations (FAO).WHO has begun referring to the virus as "the virus responsible for COVID-19" or "the COVID-19 virus" when communicating with the public. Neither of these designations are intended as replacements for the official name of the virus as agreed by the ICTV.[8] The name coronavirus refers to the fringe of surface projections, surrounding the virus, resembling the solar corona. Corona viruses (CoVs) have single - stranded RNA genome covered by an enveloped structure .[9] The group originally contained veterinary pathogens such as avian infectious bronchitis virus, and transmissible gastro enteritis-virus of swine.

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Human coronaviruses were first isolated from cases of common cold by inoculating organ culture of human embryonic trachea with nasopharyngeal washings.[9]

Seven different types of strains of human CoVs have been identified, which includes:[10]HCoV-229 E,HCoV-NL63,HCoV-OC43, HCoV-HKU1, Middle East Respiratory syndrome (MERS)-CoV,Severe acute respiratory syndrome (SARS)-CoV, Severe acute respiratory syndrome (SARS)-CoV 2 (COVID 19 virus).

21st century witnessed 3 major epidemics from the 3 strains of coronavirus. In 2003, severe acute respiratory syndrome coronavirus (SARS-CoV) originated at Guangdong, China.[11] In 2012, Middle East respiratory syndrome coronavirus (MERS-CoV) caused epidemic in Saudi Arabia.[12]The most recent pandemic started in the late 2019 i.e. novel coronavirus (COVID 19), which originated from Wuhan province of China and has now spread worldwide.[13]

The primary mode of transmission as understood from the recent studies is droplet transmission via cough, sneezes or by touching a surface or object that has the virus on it and then touching their own mouth, nose, or possibly their eyes. Virus have been also found on faeces, though faeco oral route of transmission has not been established.[14]

COVID 19 has a high infectivity and the incubation period is approximately 14 days and has been observed to last up to 24 days or more in few cases.[15] [16] Clinical presentation includes Fever, Fatigue, Dry cough, Myalgias, Dyspnea, Headache, Sore throat, Rhinorrhea and Gastrointestinal symptoms etc.

Pneumonia appears to be the most common and severe manifestation of infection.[17]

On the day of writing this review article the disease burden is 3595662 cases worldwide and took 247652 lives in 215 counties[18] and in India total infected cases are 49390 among them 33514 active cases with 1694 deaths.[19]There is no specific antiviral treatment recommended for COVID-19, and no vaccine is currently available at time of writing this article. The therapeutic strategies which are in practice at the moment are only supportive and prevention aimed at reducing transmission by containment and prevention in the community remains the best option.[20]

Medicolegal autopsy, if warranted shall be based on the national regulations, guidelines and should be backed up by scientific approach. In Indian setting where the mortuary lacks basic facilities, it is a herculean task in dealing with suspected, probable or confirmed COVID 19 patients. The guidelines have been issued by The Royal College of Pathologists, World health Organization, and from India through Ministry of Health & Family Welfare, Directorate general of Health services which provide recommendations for biosafety and infection control practices during specimen collection and handling, as well as autopsy procedures.

Thus, this article aims to summaries these guidelines based on our current understanding of COVID-19 in early March 2020 and may change as more information becomes available.

It is expected from a forensic pathologist/ institution to be timely updated with knowledge of COVID-19 and the recommended practices and principles should be followed to avoid infection.

Approach to management of dead body in Medicolegal Autopsy in COVID 19 pandemic

Approach of a Forensic Pathologist can be classified under:

A. Case and contact definition
B. Identification and characterization of pathogens
C. Requirements/Resources
D. Role of Forensic Pathologist

A. Case and contact definitions[21]

a) Suspect case

A patient with acute respiratory illness (fever and at least one sign/symptom of respiratory disease, e.g., cough, shortness of breath), AND a history of travel to or residence in a location reporting community transmission of COVID-19 disease during the 14 days prior to symptom onset.

OR

A patient with any acute respiratory illness AND having been in contact with a confirmed or probable COVID-19 case in the last 14 days prior to symptom onset;

OR

A patient with severe acute respiratory illness (fever and at least one sign/symptom of respiratory disease, e.g., cough, shortness of breath; AND requiring hospitalization) AND in the absence of an alternative diagnosis that fully explains the clinical presentation.

b) Probable case

A suspect case for whom testing for the COVID-19 virus is inconclusive.

OR

A suspect case for whom testing could not be performed for any reason.

c) Confirmed case

A person with laboratory confirmation of COVID-19 infection, irrespective of clinical signs and symptoms.

d) **Contact**

A contact is a person who experienced any one of the following exposures during the 2 days before and the 14 days after the onset of symptoms of a probable or confirmed case:

a) Face-to-face contact with a probable or confirmed case within 1 meter and for more than 15 minutes;
b) Direct physical contact with a probable or confirmed case;
c) Direct care for a patient with probable or confirmed COVID-19 disease without using proper personal protective equipment; OR
d) Other situations as indicated by local risk assessments

Identification and characterization of pathogens

Advisory Committee on Dangerous Pathogens (ACDP) of UK have categorized the pathogen according to the risk to the human. SARS-CoV2 has been categorized as Hazard group 3 pathogen (HG-3) i.e., these may lead to severe human disease and can be a significant risk to employees. It can spread to other humans. Prophylaxis and/or treatment are generally accessible. [22]The objective of such categorization is to sensitize forensic pathologist, technician and other mortuary staff against potential risk while handling such infectious cases.

Requirements/Resources

a. Design and layout of autopsy room for the deceased with COVID 19.[23]

A study was conducted during the outbreak of SARS CoV2 infection where the serious nature of infection compelled the pathologist in China to consider about the Biosafety level 3

Autopsy room for dissection and tissue processing. Study suggested that BSL-3 autopsy laboratory to be efficient in dealing with contaminated cadavers and also was safer to both the clinicians and environment.Autopsy, if has to be performed should be done in separate and well illuminated autopsy room and it should be adequately ventilated room, i.e., at least natural ventilation with at least 160L/s/patient air flow or negative pressure rooms with at least 12 air changes per hour (ACH) and controlled direction of air flow when using mechanical ventilation.[24]. The wall and the floor of autopsy room should have washable wall and floor. A single autopsy table should be installed in the autopsy room with the facility of both hot and cold water. The drainage inside the autopsy room should be covered and rodents free. Extra items like table, cupboard etc. should not be present in autopsy room. The door of autopsy room should remain closed except during the entry and exit.

In absence of the above-mentioned facility, cadavers can be examined in a disposable safety bag specially designed for postmortem examination of infectious diseases. Poor infrastructure with lack of basic facilities in Mortuaries in India, it becomes difficult in handling of such infected cadavers. More over autopsy being carried out by specialist not specialized in Forensic Medicine also adds to problem.

Body storage system for COVID 19 cases

The body storage system (dead body cooling/freezing chamber) should be available in the mortuary. It should have at least six dead body preservation in capacity and dedicated only for COVID 19 cases. The mortuary should have 24-hour power backup. Dead bodies should be stored in cold chambers maintained at approximately 4°C.

b.Personal protective equipment (PPE) Recommendations for Autopsies of dead body with COVID-19[25]

The following PPE should be worn during autopsy procedures:

1. Double layered latex surgical gloves interposed with a layer of cut-proof synthetic mesh gloves
2. Fluid-resistant or impermeable gown
3. Waterproof Protective suit
4. Goggles or face shield
5. Protective shoe covers
6. NIOSH-certified disposable N-95 respirator or higher (e.g. Powered, air-purifying respirators (PAPRs) with HEPA filters).

The aforementioned PPE should be worn by all who are engaged in mortuary, i.e., Autopsy surgeon, technician, sweepers etc.

c.Instruments required for autopsy for the body with COVID-19.

Almost same autopsy instruments required for the autopsy of the dead body with COVID-19 except a few. In case of dead body with COVID-19 oscillating bone cutting saw with vacuum aspirator should be used. Round ended scissors, PM40 or any other heavy-duty blades with blunted points should be used to reduce prick injuries. High duty gloves should be use along with surgical gloves.

d.Registration of cases of suspect, probable or confirmed in the Mortuary records

All the cases which come to the mortuary should be entered in a COVID-19 dedicated register. The data which enter in the mortuary records should include the preliminary data (name, age, sex, religion, detailed address with Mobile no if available), type of cases (suspect/ probable/ confirmed/ others), Nasopharyngeal sample collection (Yes/ No), result of Nasopharyngeal sample for COVID 19 virus (Positive/ Negative), result of Nasopharyngeal sample for other respiratory pathogens (name of organism).

e.Timing of Postmortem examination

The present scenario showing the low availability of PPE kit. For the better utilization of the present resources the time of autopsy should be restrict after 13:00 till the sunset (different in different places)

Role of forensic pathologist[26-29]

The forensic pathologist has to ensure that heath facilities and safety measures are in place prior to conduction of autopsy. Preparing a checklist would serve the purpose. All the documents pertaining to autopsy like inquest, hospital case sheet, lab reports etc. should be checked. Clinical history can be obtained from the family members, relative or police.

Objectives of management of dead body in COVID 19 pandemic

1. Protect Medical professional and health care worker from infection of SARS CoV2 virus (COVID-19 virus) during handling of dead body.
2. Protection of family members of the deceased from the infection of SARS CoV2 virus.
3. Safe and proper autopsy of medico-legal case.
4. Protection of society from infection of SARS CoV2 by proper disposal of dead body of COVID 19 patients.
5. Judicious use of PPE kit during the period of pandemic.

The dead body sent for medicolegal autopsy during COVID 19 pandemic can be categorized into following categories:

1. COVID-19 confirmed case
2. COVID-19 Suspected case

3. Brought dead cases
4. Dead body with Unknown identity.

Procedure of medicolegal autopsy in dead body with COVID-19[25-29]

Autopsy should be avoided until the case is a medicolegal. At the time of autopsy limited number of autopsy surgeon with helpers should be present inside the autopsy room. All member of autopsy team should use complete set of PPEs (coveralls, head cover, shoe cover, N 95 mask, goggles / face shield) during the procedure. The dead body with COVID-19 should be washed with 1% hypochlorite solution. The en-block technique should be used for opening of body cavity. The organ removed from the cavity should be held firm on the table and sliced with care.

In dead body with COVID-19 always take precautions to avoid aerosol generation. So, Oscillator saw with vacuum aspirator should be used for opening the cranial cavity. In case of unavailability of the above, hand saw with chain-mail gloves can be used. Handling of the lungs is important because of its spongy in nature it could generate aerosols, so precautions must be taken.

Preservation of Postmortem specimen in cases of death with COVID-19[25-29]

Collection of specimen depends upon the cases whether the case with COVID-19 is confirmed or suspected and whether autopsy will be done or waved off. In case, where autopsy is not performed in suspected COVID 19 case, two swabs should be collected from the nasopharynx, one sent for RT-PCR for SARS CoV2 virus and other for testing of other respiratory pathogens. In case of autopsy of suspected case two swab should be taken from both upper (Nasopharyngeal swab) and lower respiratory tract (Lung swab from each lung). One should be sent for RT PCR for detection of SARS CoV2 virus and next swab for detection of other respiratory pathogens. For histopathological examination both the lungs, upper airways and major organs should be preserved in formalin. If autopsy is being performed in dead body with COVID-19 then swab should be taken from the lungs for detection of other respiratory pathogen along with preservation of viscera in formalin according to their clinical history. The swab collected for the detection of SARS CoV2 virus should be stored at 2-8°C for up to 72 hours after collection. If a delay in testing or shipping is expected, store specimens at -70°C or below.

Death certificate in case with COVID-19 positive[30]

If the death is influenced by COVID-19, like it aggravated the underlying causes and also led to pneumonia and/ or ARDS then COVID-19 should be written in lowest line of Part 2 of the death certificate.[30]

Procedure after completion of the autopsy of the dead body with COVID 19.[25-29]

After reconstruction of the autopsied body, it should be disinfected with 1% Sodium Hypochlorite and placed in a body bag, the exterior of which will again be decontaminated with 1% Sodium Hypochlorite solution. The body thereafter can be handed over to the police. Autopsy table to be disinfected as per standard protocol.

Embalming in case of dead body with COVID 19:[25-29]

Embalming of dead body should not be allowed.

Transportation of dead body with COVID-19[25-29]

The autopsied body secured in dead body bag (made up of plastic) should be decontaminated with 1% hypochlorite solution and then handed to the police/ transporting staff, as it does not carry additional risk. The personnel handling the dead body must follow standard precautions for infection control. The vehicle used for transportation of dead body with COVID-19 should decontaminated with 1% hypochlorite solution.

Disposal of remains from the dead body with COVID-19[25-29]

The blood, body fluid and body tissues that exude out after the postmortem examination should be treated before drain into the main drain. The belongings of the dead body with COVID-19 should be incinerated.

At the crematorium/ Burial Ground[25-29]

As per the government of India guideline during creation and burial gathering of more than 20 people are not allowed and they must follow the social distancing. The people working at crematorium and burial ground should be educated that dead body with COVID-19 doesn't carry any other risk than dead body without COVID-19. The staff of crematorium and burial ground should be educated about the standard precautions of hand hygiene, use of masks and gloves. If relatives want to see the dead body for last time, staff of crematorium and burial unzip the face end of body bag to see the face of dead body. Hugging, kissing, touching, bathing reading religious scripts in the ear should not be allowed. After cremation and burial all the staff and friends and family members should perform hand hygiene. The ash after cremation of the dead body with COVID-19 does not carry any risk so can be collected for last rites.

Conclusion

The condition of mortuaries in the periphery of India is not good. Due to presence of less resources, we need to upgrade the existing mortuary to the safety level 3 or government should develop separate mortuary with safety level 3 in every state

according to their size. Due to less availability to PPE Kit in the hospital only single PPE can be utilized to conduct the all postmortem of the day. The timing of the autopsy examination should be restricted between 1 PM till the sunset so that we can utilize PPE Kit to its maximum. All the cases with COVID-19 should be registered as COVID-19 case so that the contact tracing can be done and also the data is also used for the future planning. The death certificate issue in these cases should include COVID-19 in the lowest line in part II. The similar practice update should also be release from time to time in the field of Forensic Medicine & Toxicology so that we can get aware about the present scenario.

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REVIEW

Work pattern in Forensic Medicine: Challenges to Changes during COVID19 pandemic

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Abstract
COVID-19 pandemic has drastically changed the prevailing practices in almost all the disciplines of Medical Sciences and the Forensic medicine could also not bear to be remained isolated to such changes. The old age practice in Forensic Medicine in form of conducting the autopsy has been changed and it is being avoided in COVID positive as well as brought dead cases as much as possible. Now it is being largely limited only to the cases where it can't be avoided and that too in minimally invasive form, following all govt protocols while under the umbrella of full biosafety measures. Due to lockdown measures as people are staying at their home, the workload in form of autopsy on accidental, suicidal and homicidal deaths has been drastically reduced but it has been increased on other side where a larger number of COVID positive deaths are coming up which covers aspect ranging from it's risk reducing management to safe disposal. With the high risk involved in dealing with those bodies and emerging challenges of prevention from contracting disease, now this discipline is also learning to work with riskier procedures under psychological fear of infection and adapting to work under new conditions.

Keywords
COVID-19; Work pattern; Challenges; Changes; Risks; Biosafety measures; Dead body management; Facility expansion

Introduction

COVID-19 is an acute respiratory illness caused by the SARS-CoV-2 virus which is an enveloped, positive-sense single-stranded RNA virus, affecting primarily the respiratory system and particularly the lungs. It has been detected in respiratory, faecal and blood specimens[1] and has caused a large number of cases and deaths worldwide in form of a global pandemic and that too on a continuous rise. However, the source and disease progression are not yet entirely clear and no-one is in position to talk about the exact and full-blown course of the disease and associated deaths. To contain this infection and reduce its impact, various measures like lockdown and social distancing are in place.

Given the lockdown, the crime rate has been dropped and it has reduced the number of medicolegal cases drastically whether it is in terms of accidental, suicidal or homicidal deaths that had been making a significant proportion of total deaths previously. This shift in the proportion of deaths with medicolegal issues out of total number of deaths along with risk and fear of contracting the infection in the autopsy related work, have led to a significant drift in form of changes in the continuing practice of Forensic Medicine in India. This article aims at highlighting those changes in the working pattern of the discipline which has been brought out by the ongoing pandemic of COVID-19.

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COVID-19 death and added challenges

Deaths during COVID-19 pandemic due to corona virus infection and events related directly or indirectly to either spread of the infection or attempts to control the infection, may be clubbed together as 'COVID and COVID related deaths'. The COVID related deaths would include natural, unnatural and incidental deaths, not directly due to a person being infected with Corona virus. Unnatural deaths include accidental, suicidal and homicidal deaths. With this global pandemic, the added challenges to the discipline include the following:

1. The requirements from a medicolegal autopsy end if cause of death is COVID19 but barring few institutes in India, it is not mandatory to screen the dead bodies for Corona virus infection before sending it for autopsy. This implies that the autopsy surgeon is not aware of COVID status of the deceased in most of the cases and the fact is that COVID status of the deceased is rarely available and they remain as 'COVID status unknown'.
2. The test conducted for detection of COVID is not available to everyone on demand. If the criteria comprising of history of travel in last 14 days, fever, cough, etc. devised by Indian Council of Medical Research (ICMR) is not met, the test is not conducted. If a person dies either due to COVID 19 or any other cause and is brought dead to the hospital, the test cannot be applied as the testing strategy till date does not include a dead person. It further reaffirms the prevalent thought that

the dead carries less value and deserves lesser attention.

3. The nasal or oropharyngeal swab when taken, may or may not show positive result in COVID positive person. If a COVID negative person, a few days ago, changed to COVID positive status, it may be missed if not done mandatorily before autopsy. Also the triage of separating COVID and non COVID deaths is the most difficult task and involves the risk of infections.
4. Mortuary in most places of India is not constructed with negative pressure autopsy room. Oscillating electric saw with suction facility is available only in scarce few institutes in the country.
5. The Personal Protective Equipment (PPE) that should be worn by the team while conducting autopsy, is not available at most places also the current manpower is not used to while working with it. Also, the awareness that if a clinician and his unit handling a patient needs PPE, a COVID status unknown dead body where the body cavities will be opened and complete autopsy has to be conducted, will be a threat to the same extent if not more to the autopsy surgeon and the thing is not clear to most of the decision makers.
6. The process and protocol for autopsy regarding samples to be preserved for histopathological or other examination have not been clarified.
7. Also well-designed body bags suitable for transportation of these bodies are not available at most places.
8. Overcoming the psychological fear and prevention from risks of contracting infection during autopsy have also been coming as challenges.
9. As the number of cases and deaths are rising, the dead body management with the limited handling capacity is getting more trickier in the light of more and more of guidelines and protocols are coming up from different sources and which one is to be followed is really a bag challenge.
10. Continuing academics with interest through new means is also posing challenge as both givers and takers are not used to that.

Differences of changes in the work pattern

1. No autopsy is being conducted in confirmed COVID 19 cases as per the protocol of Government of India unless some medicolegal issue is involved. However, the autopsy is being conducted in COVID negative persons and in those with unknown COVID status with some medicolegal issues. However, during the lockdown period, the number of medicolegal autopsies has been drastically reduced at most of the places.
2. The existing manpower has been now subdivided in to small groups as teams and taking care of work on different days and timings.
3. The academic activities and training programmes in few institutes including classes, seminars, demonstration and training programmes for undergraduates and postgraduate medical students are being conducted through online portals.
4. Now getting and conducting autopsies with PPE, conducting minimally invasive autopsies, ensuring proper preservation of the samples, post procedure disinfection of table, tools and environment, designing of suitable leak proof body bags, transportation and cryopreservation of dead bodies irrespective of COVID status, post transfer sanitisation, placing identification tags, providing counselling services to the family about best practices for disposal, coordinating with clinical departments, local administration and police for ensuring disposal of bodies as per protocol are gaining foremost attention than of primary work of conducting autopsy.
5. The discipline is learning stringent infection control procedures. More and more of such SOPs and protocols are coming up from different sources and even individual institutions are making their own SOPs and protocols.

Discussion

In the ongoing pandemic, people are dying from the complications of the disease as well as from things completely unrelated to this. The COVID deaths are taken as natural deaths and autopsies are being avoided in such cases as per the protocol and as it is not recommended in a full-blown case of COVID-19.[2] However it is legal mandate to investigate and finding out the cause and manner of death in a medicolegal case where an appropriate autopsy is needed.[3] It is a known fact the autopsy generates aerosols and there is risk of contracting infection from dead at least in some viral diseases.[4] Recently, the death of a forensic personnel from Thailand sparked a debate on whether COVID-19 may be transmitted from dead to a living persons[5] otherwise until now there are no such evidences of transmission.[4]

The CDC recommends for considering medicolegal jurisdiction, facility environmental control, availability of recommended PPEs and family and cultural wishes for determining the need for autopsy, minimum number of people in an airborne infection isolation rooms with negative pressure.[6] The Royal College of Pathologists advocate against the presence of multiple hands within the cadaver.[7] In India**,** also, at most of the places, teams have been formed with different days

and timings of autopsy related work. Further, many studies have recommended for considering the clinicopathological correlation which is still lacking here.

Unlike previously, now taking relevant medical history from relatives and police as pre-autopsy screening has gained importance but identifying the asymptomatic and latent cases is very challenging task before the forensic pathologists.[8,9] Therefore, as a precautionary measure, during pandemic, any dead body is regarded as potential source of infection and must be COVID tested and same biosafety measures applied.[2,10] Many institutes in India have started doing it before proceeding for autopsy but this is not the case at other places. The minimal autopsy or virtopsy is preferred in such scenario but in India, at most of the places, no facility for virtopsy exists. Further, the avoidance generation of effluent and waste and its discharge post complete inactivation[11] has yet not gained much attention.

After the autopsy, the body is placed in a zipped body bag immediately and identification tag marked 'Covid-19' is placed according to protocol. If a body is found to be Covid-19 positive, then it is neither being directly handed over to the family nor being allowed to be taken home and counselling of family members is done. After the procedure, the exterior of body bag and autopsy table are now being decontaminated with 1% Sodium Hypochlorite solution.[12] Even the Forensic labs in India are now demanding COVID test status before processing of the tissue samples but for dealing with such cases, the autopsy laboratories with certain biological safety levels are needed in the future.[13]

This pandemic has also changed the mode of delivery of academics and training programme from offline to online mode and to overcome the health care worker shortage, medical students are being engaged as part of the workforce on voluntary basis and more flexible approach of medical schools is being recommended in this regard.[14] The preparation of SOPs for the containment of infectious risk, pre-autoptic risk assessment, sampling by core biopsies and promotion of PPEs in daily practice is getting wider attention.[15,16] As the cryopreservation may prolong the persistence of the virus in the body[17] so the segregation of preservation in different cold chambers and its necessary disinfection post transfer can't be ignored.

Conclusion

In the current pandemic, the physical risk and psychological fear of contracting infection have definitely brought the challenges and made changes in the working pattern for the discipline of Forensic Medicine. Though the workload in terms of number of medicolegal autopsies has been significantly reduced but as more and more of COVID deaths are arriving to the mortuary stations, the work has certainly been getting riskier and challenging in terms of its management. However, if number of dead rises to a full-blown pandemic then it would be further challenging to manage that number with the limited capacity of handling at most places in a timely manner. Therefore, various post-mortem procedures and release of the body to safe disposal as properly and smoothly as possible with adequate biosafety measures are getting much attention. At most of the places, the discipline is busy in making SOPs and planning in terms of dead body management but the expansion of facility in terms of future estimate of deaths also needs a considerate thought.

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REVIEW ARTICLE

Smegma: Myths and Facts

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Abstract
In relation to sexual intercourse, in cases of rape various textbooks cite presence or absence of smegma under the foreskin of glans penis and then accordingly interpret the findings. It seems that contemporary literature (which includes various textbooks available for Undergraduate and Postgraduate students as well as lawyers and judges) unscientifically sees and interprets the presence or absence of smegma. This paper tries to put myths and facts in their correct perspective. To achieve this, the paper tries to go through the scientific literature about identification and diagnosis of smegma and limitations prevailing there off in our country and in scientific circle. Objective of the study is that prevailing unscientific notion can be corrected and miscarriage of justice due to wrong interpretation of such finding can be avoided. Authors of various textbooks present and future are advised to look into the matter and do necessary correction in their textbooks.

Keywords
Smegma; Female smegma; Sexual intercourse; Rape; Evidentiary value

Introduction

Sexual offenses, particularly penetrative ones are on the increase. Accordingly, even the sec 375 of I.P.C. is grossly amended.[1] At present we as teachers and practitioners of Forensic Medicine and Toxicology we are following it. It is important for the survivor as well as for the society that they are taken to their logical end. To achieve this goal evidentiary value of examination of accused cannot be over emphasized. Presence or absence of smegma at corona sulcus of penis of an accused considered important findings by various textbooks. It seems that available literature about smegma, (its presence or absence and its interpretation) is loosely written in most of the available and popular textbooks and it requires scientific scrutiny and correction.

What is written in the literature?

"If accused is not circumcised, foreskin may be retracted and the presence or absence of smegma (cheesy secretion of sebaceous glands, consisting mainly of desquamated epithelial cells) on corona glandis should be noted. The absence of smegma may indicate that intercourse might have been performed but presence of smegma rules out possibility of complete penetration because smegma gets rubbed off during intercourse."[2]

Nandy says presence of smegma goes against full penetration and intercourse within the last 24 hours. Also, absence of smegma to an extent, goes in support of sexual intercourse within the last 24 hours (except in a person with habit of cleaning this part daily.[3]

Smegma if present under prepuce and corona glandis is inconsistent with recent intercourse. The smegma is rubbed off during intercourse which takes place about 24 hours for redeposition.[4] Bardale mentions presence of Mycobacterium smegmatis in smegma. He mentions- It takes about 24 hours to collect the smegma on corona glandis. Therefore, presence of smegma indicates non- participation of a male in recent sexual intercourse act.[5] If accused is not circumcised, the existence of smegma around the glans penis may be considered proof against sexual intercourse (since it is rubbed off during the sexual act) The smegma accumulates if no bath is taken for 24 hours.[6]

Normally the glans penis when covered with prepuce will allow deposition of smegma in it. During sexual intercourse smegma gets washed off in vaginal secretions. Hence testing the washings of glans for absence of smegma corroborates rape (smegma can be washed off at bath). If smegma is present it rules out sexual act, within 24 hours. Rao publishes a photograph showing smegma on glans penis. Rao mentions testing of washings of glans for absence of smegma, he does not mention any physical, microscopic or microbiological test for that matter for testing the smegma.[7]

Absence of smegma in the uncircumcised male provided the accused is examined immediately may act as corroborative evidence (taking a bath or washing the genitals can remove the smegma. It takes 24 hours for smegma to accumulate).[8] However, absence of smegma is not conclusive evidence of sexual intercourse. On the other hand, the actual presence of smegma can be taken as evidence that the person did not participate in sexual intercourse.[9]

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In the uncircumcised penis the presence of smegma under prepuce and on the corona glandis rules out complete penetration because smegma usually requires 24 hours to redeposit. Presence of smegma indicates that no sexual intercourse with full penetration is taken place within 24 hours but absence of smegma will not indicate intercourse. Smegma contains the Mycobacterium smegamticus and can be demonstrated by Ziehl Neelsen's stain.[10]

There is nothing to suggest that the subject performed a recent sexual act, consensual or non-consensual if there are no injuries on body and genitals and smegma is present under the glans and there are no vaginal cells on the penile shaft.[11] However, Modi does not agree with it. Modi writes-the existence of smegma around corona glandis is considered by some to be proof against sexual intercourse, since it is rubbed off during sexual act. Nevertheless, the presence of smegma as proof against the sexual intercourse is not of any medico legal value, as legally, if the penis touches the vulva, it is enough to constitute rape. So in a case of rape of this character, it is unlikely that smegma will be rubbed off.[12] Vij, along with Modi, discard the evidentiary value on the basis of technicality of definition of rape.[13] They don't comment on its scientific value or otherwise in relation to penetration as other authors have talked.

Subrahmanyam talks about smegma in relation to examination of accused. But he does not mention anything else, that how to interpret its presence or absence.[14] From legal circle Vyas and Kejriwal say –Smegma? Presence of it is a useful clue, It can refute the charge of false rape.[15] From medical textbooks the reference to smegma and its evidentiary value, wrongly or rightly, has also reached to various judgments delivered by the High Courts.[16,17] Courts have accepted the findings as the text is written in reputed textbooks on the subject.

Observation versus interpretation

First, we analyze what is 'Presence of smegma'. What the examiner observes while examining the accused of rape in question is presence of white cheesy material as described above. So the interpretation is based on merely visual examination. Shinge and Shrigiriwar did mentions in one of their studies that in two of the accused out of eight who were examined within 24 hours of the said incident found, presence of smegma.[18] They did not elaborate further whether their interpretation of smegma was based on visual examination or they performed any objective test for its confirmation.

Authors, except one, do not mention any confirmatory test to objectively say that what one finds on glans penis is smegma. One author does mention that Mycobectirium smegaticus can be stained be Z and N stain.[10] I, in my practice and teaching of forensic medicine of many years, have not come across any literature that such procedure (confirming the presence of smegma by any objective test) is in practice anywhere in India. I have not come across any such foreign study as well.

However, none of the authors including Ignatius says that before we say that smegma is present we must confirm it by such (any) method. In the absence of any unequivocal test to test smegma, merely on the basis of visual observation saying that smegma is present seems dangerous and unscientific. As there are many white cheesy creamy materials available on our dressing table, in our toiletries and in our medicine box. Possibility of accused being tutored by his family members and lawyers before he is medically examined cannot be ruled out.

Microbiology of smegma has been studied by many authors and according to one of them[19] there are 31 bacteria which could be isolated from smegma, 15 gram-positive and 16 gram negative. The most common gram- negative bacteria was Escherichia coli and most common gram- positive pathogen was Enterococcus faecalis. This paper does not mention anything about Mycobecterium smegmatis. However, it quotes one study- “Mycobeterium smegmatis was originally isolated in smegma. The organism is found in dirt and its original isolation from smegma was most probably coincidental”. In view of this light, even the suggestion of Ignatius that substance supposed to be smegma should be and can be tested for Myobecterium smegmatis becomes doubtful.

Satyprakash et al. studied human subpreputial collection bacteriologically, biochemically and histopathologically.[20] But their observations also do not take us anywhere. There is no test yet which unequivocally test smegma.

Facts about smegma

The description of smegma given in above referred textbooks is more are less in consistency with other sources.[21,22] But both these references do mention about smegma present in female genitals. The Wikipedia gives a photograph of female external genitals showing smegma. Structure wise this female smegma is similar to smegma found in males. Only difference is that of source. Smegma on female genitals comes from female cells and glands, that's all. However, above cited references (2-15,18) are very much silent about this female smegma.

Most of the Indian textbooks who have talked about smegma in relation to accused of rape, do not talk about the same in relation to anal intercourse. While we must agree that 'the process of rubbing' in intercourse would be same.

There is one more aspect which is missing. The definition of rape is changed.[1] Now it includes- I.P.C. 375(a) peno-vaginal;peno -urethral; peno -anal and peno- oral penetration. Even if we consider peno vaginal and peno –urethral penetration more or less same (peno urethral would not be possible in most of the cases, and there is a proximity of both

orifices also) still most of the references published after the new law came into being do not mention any thing about status of smegma in relation to peno –anal and peno –oral penetration.[2,3,5,8,9,11,12]

As they do not talk about female smegma they are silent on I.P.C. 375(d) where there is a reference of application of mouth to vagina. If principle of Locard is followed, the application of mouth to vagina (that includes labia majora), there should be exchange of material from one person to other. That is, there exists a clear possibility of female smegma, from genitals of woman attaching to male's (assailant) mouth or face. Above referred references all absolutely silent on this issue.[2,3,5,8,9,11,12]

Does it mean that whatever is written about smegma in relation to accused in reference to peno- vaginal penetration part is exaggerated and overvalued? Yes, It seems so. Two important researchers in the field of clinical forensic medicine Stark[23]and Mclay[24] do not mention a word about smegma in their entire chapters on sexual offenses. This may be the reason that author did not find any study in relation to smegma and sexual offenses and its confirmation thereof. Similarly, the guidelines published by W.H.O. for examination of survivor of sexual assault[25] and guidelines published by the Govt. of India do not mention anything about smegma in their booklet.[26]

Conclusion

Mention of smegma in literature under scrutiny is loosely done. That too, only in relation to one of the aspects of rape, while other areas where its presence or absence could equally be important is ignored. None of the literature referred to mentions about smegma present on female external genitals. There is hardly, any test which can establish that available material (so called smegma) is smegma. There is a strong possibility that when accused is caught and presented for medical examination, he may be tutored and whatever the examiner found under the foreskin on the penis of accused may not be smegma but some artifact. Till the matter is scrutinized and passes the test of science, it should not be given any significance. Serious workers in the field, guidelines of WHO and Govt. of India don't give any significance to smegma. Prevailing textbooks and study materials for our graduate and postgraduate course students should accordingly be updated.

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CASE REPORT

Sudden cardiac death in an adolescent: A case of viral myocarditis

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Abstract

Investigation of sudden deaths to find the cause of death is a challenging task for the pathologist. Cardiovascular conditions remain the leading cause of sudden deaths globally. Underlying pathology in sudden cardiac deaths (SCDs) may be obvious in conditions such as coronary artery diseases, cardiomyopathies etc., while findings may remain inconclusive during the autopsy. Viral myocarditis as a cause of death in SCD is becoming a recognized contributor to unexplained mortality, especially in adolescents. The article reports a rare case of SCD in a 17-year old adolescent male. The autopsy and histopathological findings identified the cause of death as viral myocarditis.

Keywords

Myocarditis; Inflammation; Crime; Underlying Cause of Death

Introduction

Sudden cardiac death (SCD) is defined as "*Death due to cardiac causes, in which the time and mode of death are unexpected, in an individual with or without pre-existing cardiac disease, which occurs within 1 hour of the onset of the symptoms.*"[1] The incidence of SCD ranges from 36 to 128 per 100,000 populations per year in different parts of the world. Cardiovascular conditions remain the leading cause of sudden death globally. South Asians are reported to be at higher risk of SCD at an earlier age.[1]

SCDs are often rapid in onset and caused by a variety of clinical conditions. In a few cases such as cardiomyopathies, coronary atherosclerosis etc. the cause of SCD can be grossly appreciated at autopsy while in others detailed investigation is required to find the cause of SCD.[2] Viral myocarditis is one such condition which is recognized as a cause in sudden death during the first two decades of life.[3] Viral myocarditis is an inflammatory condition of myocardium produced due to a viral infection. Cardio tropic viruses are known to infect more than 90% of the human population, but only 1-5% of them known to develop histologically proven myocarditis.[3]

Every year thousands of sudden deaths involving young individuals (< 35 years of age) remain unexplained even after a complete medico legal investigation including an autopsy. Epidemiological studies have shown that most of the sudden deaths do not show any morphological abnormalities in previously healthy young individuals.[4] We report a rare case of viral myocarditis as a cause of SCD in an adolescent.

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Case report

A 17-year-old male was having his breakfast while sitting on the boundary wall of the rooftop at his single storied home. He all of a sudden fell down from the boundary wall over the ledge approximately 2 feet below. His brother rushed to rescue him and saw him gasping for breath. He was taken to the nearby hospital by his family members where he was declared dead on arrival. On further enquiry, the parent revealed that the deceased had shown flu-like symptoms for a few days ago. Medico legal autopsy was conducted on the same day to find out the exact cause of death.

At autopsy, the dead body of the male weighed 50 kg and measured 166 cm in length. Rigor mortis was present all over the body. Post mortem staining was present over the back and other dependent parts of the body and was fixed in nature. Multiple reddish abrasions were present on the left upper arm with size varying from 9.0 cm X 1.2 cm to 0.3 cm X 0.3 cm. A grazed reddish abrasion of size 11.0 cm X 4.5 cm was present over the right upper arm.

On dissection, all organs were congested and brain was oedematous. The stomach contained about 30 ml yellowish colored fluid, the gastric mucosa was congested. The heart weighed 254g; measuring 12.5 cm X 9.5 cm X 5.5 cm. Subepicardial haemorrhages were present over the heart at places. The inflow and outflow tracts did not show any significant finding. Valves, intra atrial and intraventricular septae, were unremarkable. Atrial wall thickness was 0.4 cm and left ventricular wall thickness was 2.0 cm. Origin and course of the coronary arteries were regular and patent. Aorta didn't show any evidence of atherosclerosis.

Following observations were made on the histopathological

examination of heart, brain, and lungs. The section from the right atrium showed dilated congested blood vessels and edema. Sections of the right ventricle showed edema, separation of muscles fibers and diffuse sparse lymphocytic infiltrate. No necrosis or haemorrhage was identified. Focal degenerative changes were seen in the sections of left ventricle along with diffuse sparse lymphocytic infiltrate. Sections from the coronary vessels were normal. (Figure 1 & 2)

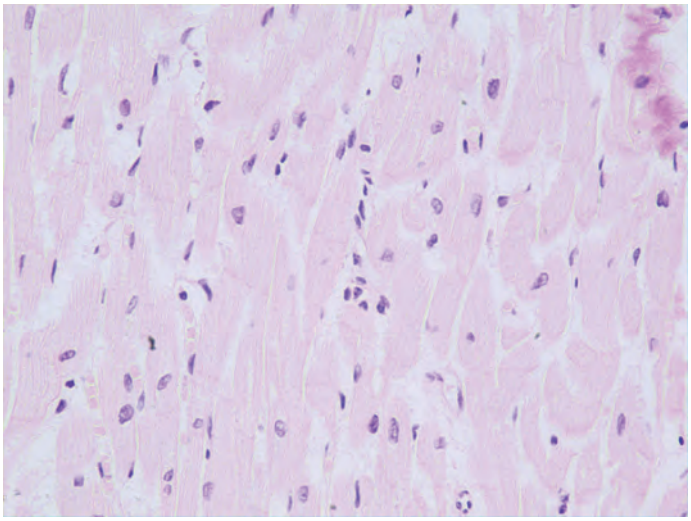

Figure 1: Photomicrograph showing lympho-mononuclear inflammatory infiltrate in the myocardium, H&E 40X

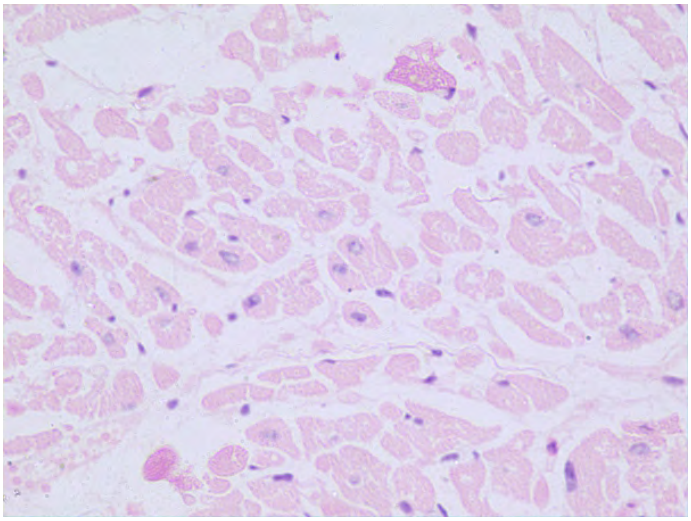

Figure 2: Photomicrograph showing occasional necrosed myocytes (upper right and lower left) in the myocardium, which appear more eosinophilic than the surrounding myocytes and show loss of nuclei, H&E 40X

Multiple sections of the brain were examined. Sections from the cerebral hemisphere showed evidence of cerebral edema in the form of widening of Virchow Robin space which was most prominently seen in the sections from the watershed areas. (Figure 3)

Sections from the right and left lung showed congested blood vessels. Sections from the bronchus were unremarkable and from peribronchial nodes showed anthracosis pigment. (Figure 4). On perusal of autopsy observations and histopathological examination the cause of death was opined as viral myocarditis.

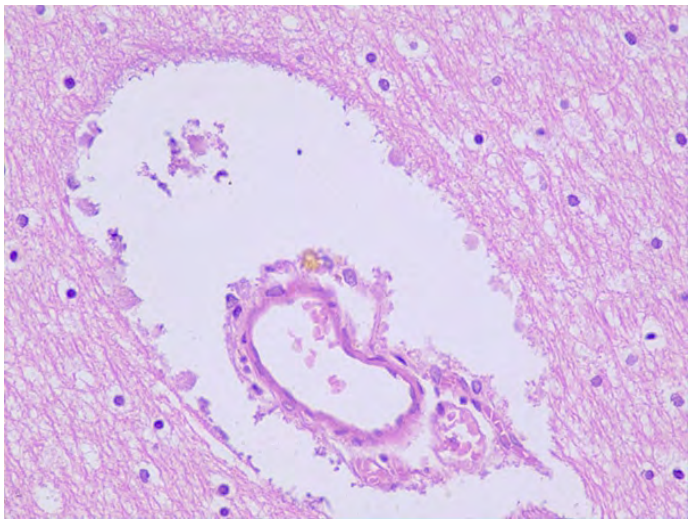

Figure 3: Photomicrograph showing mild cerebral edema, H&E 40X

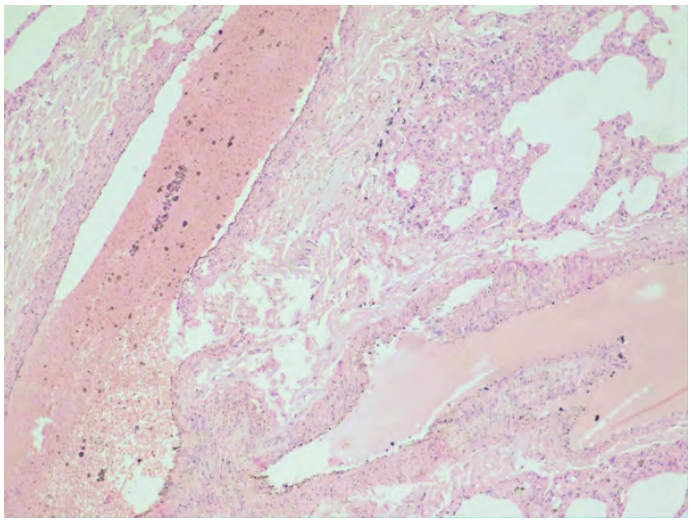

Figure 4: Photomicrograph showing congested pulmonary vessels, H&E 40X

Discussion

Myocarditis is reported as one of the rare causes of sudden cardiac death.[5] Acute myocarditis is often associated with sudden deaths among young adults and athletes.[6] A wide range of etiological agents may lead to myocarditis, ranging from systemic conditions such as sarcoidosis, Crohn's disease, therapeutic drugs, toxins, animal/insect bites, and stings, as well as multiple infectious agents. The majority of the cases of myocarditis are viral induced myocarditis. The causative agent remained obscure in 50% of the myocarditis cases and the infection was thought to be virally mediated. The most commonly involved viruses mentioned in the literature include enteroviruses, adenoviruses,

human herpesvirus 6 and parvovirus B19.[7]

Viral myocarditis is diagnosed usually based on the Dallas classification as *"an inflammatory infiltrate of the myocardium with necrosis and/or degeneration of adjacent myocytes"* or the World Health Organization (WHO) Marburg criterion as *"≥14 infiltrating leukocytes/ mm^2."*[8] The myocardial infiltration may be focal or diffuse and that can be infiltrating by both acute and chronic inflammatory cells.[7] Histologically, myocarditis is diagnosed by haematoxylin-eosin staining of tissue in the setting of an inflammatory infiltration of the myocardium with necrosis and/or degeneration of myocytes, not consistent with the presence of ischemic changes and patent coronaries.[6] The absence of myocytes necrosis and a sparser inflammatory infiltrate suggests borderline myocarditis.[8] The histopathological examination in the reported case showed diffuse sparse leukocyte infiltration with degeneration of myocytes suggestive of viral myocarditis. The absence of focal necrosis ruled out any possibility of mechanical trauma. The absence of eosinophils and negative history of any recent drug intake rules out the possibility of eosinophilic myocarditis, while the inadequacy of neutrophils and absence of necrosis ruled out the possibility of bacterial or fungal infection.[9] Considering the history of flu-like symptoms, a viral/post-viral rather than an immunological form of myocarditis seems more likely. Other conditions such as sarcoidosis or vasculitis were excluded in absence of inflammatory involvement of cardiac vessels.[9,10,11]

The involvement of the wall of the right and left ventricle may further be a reason for sudden death since ventricular function abnormalities due to myocytes degeneration and inflammatory infiltrate are strong predictors of death. There is a frequent association of myocarditis and sudden death in asymptomatic patients.[7,9] Viral myocarditis in the reported case resulted in cardiac arrhythmia as evidenced by the presence of cerebral oedema and pulmonary vascular congestion which had arisen out of sudden fall in cardiac output. On perusal of autopsy and histopathological observations, the cause of death was considered to be most likely viral myocarditis which resulted in cardiac impairment and subsequent death.

Conclusion

Investigation of sudden cardiac death is a vital and integral part of the autopsy. Viral myocarditis is an important cause of mortality especially in seemingly well adolescents and young adults without previous/family history of cardiac illness. The present case, confirms the crucial importance of a thorough investigation in SCD, particularly microscopic examination to see underlying pathological changes. The reported incident was a medico-legal case and an autopsy is mandatory in such cases in India. Investigating police officer is considered to be in charge of such cases and they are hence informed regarding its use for academic purposes.

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Contributors' statement

The scene of crime was visited by Dr. Navneet Ateriya, Dr. Ashish Saraf and Dr. Raghvendra Singh Shekhawat. Medicolegal autopsy was conducted by Dr. Navneet Ateriya and Dr. Puneet Setia. This article was conceptualised and designed by Dr. Navneet Ateriya, Dr. Tanuj Kanchan and Dr. Puneet Setia. Relevant literature was searched by Dr. Navneet Ateriya and Dr. Ashish Saraf. Dr. Navneet Ateriya and Dr. Ashish Saraf along with Dr. Raghvendra Singh Shekhawat and Dr. Meenakshi drafted the manuscript which was further edited and reviewed by Dr. Tanuj Kanchan and Dr. Puneet Setia. Histopathological slides were observed and reported by Dr. Meenakshi Rao. All authors read and approved the final manuscript.

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CASE REPORT

Combined effect of cold with heart pathology in old

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Abstract
Death due to hypothermia is because of exposure to cold temperature, usually during winter season and at high altitudes. Hypothermia occurs when the core body temperature drops below 35°C. Diagnosing hypothermia as the cause of death is very challenging in forensic medicine as the post-mortem findings are not consistent for all hypothermia cases. Therefore, history of the case and investigation of circumstances of the death, crime scene along with a meticulous post-mortem examination is very important in diagnosing cause of death as due to hypothermia. Paradoxical undressing and hide and die syndrome can sometime make the crime scene very suspicious. Hypothermia mainly affects homeless individuals, drug-dependent individuals and those of extreme ends of the age spectrum but can occur in any age group. Hypothermia is relatively rare in places like India with temperate climates as compared to places with colder climate. Hence, there is lack of knowledge about such a condition among both the medical professionals and the common people. Here we report a case of hypothermia in an 82 year old male who was found dead, half naked during the cold winter season and when stomach was opened, Wischnewsky spots were observed on the mucosa.

Keywords
Hypothermia; Wischnewsky spots; Frost erythema; Meticulous autopsy.

Introduction

Hypothermia is "decrease in the core body temperature to a level at which normal muscular and cerebral functions are impaired." Any temperature less than 98.6°F can be linked to hypothermia.[1] The severity of hypothermia is divided into mild (35–32°C), moderate (32–28°C) and severe (<28°C) according to the range of body temperature. [2] Individuals particularly vulnerable to the development of fatal hypothermia include those of the extremes of the age spectrum, the homeless, the chronically ill, the isolated or socially deprived individuals, and those suffering from psychiatric diseases as well as drug or alcohol intoxication. Alcohol intoxication prevents adaptation to cold stresses. The association between alcohol intoxication and hypothermia death has been well documented. [3-7] Diagnosis of hypothermia is based on core body temperature, circumstances surrounding death, the medical history and examination of the body. Findings of hypothermia are frost erythema, Wischnewsky spots, hemorrhaging into the synovial fluid, changes in kidney and pancreatic tissue. Several biochemical parameters are also altered in case of hypothermia. [2, 5, 7]

Wischnewsky in 1895, first reported that the presence of numerous dark-brown coloured small spots similar to gastric haemorrhages, which now termed as "Wischnewsky spots," are frequently visualized in hypothermia-related death. Since then, these spots have been considered to be a classical sign of fatal hypothermia. Wischnewsky spots may vary in size and quantity from 1 mm upto about 2 cm in diameter and from only a few to more than 100 in number. [8]

Case Report

An 82 year old man was reported missing from his home for four days until his body was found half naked in a bushy water logged area near his house in the month of February. He was known to be suffering from diabetes mellitus and hypertension and was irregular with his medication. He had a history of forgetfulness and had gone missing from home even in the past. Environmental temperature recorded on those days was between 28.4°C and 10.5°C. He was last seen alive by a boy from his locality a day before the body was found.

Post-mortem examination revealed an averagely built body, half naked with mud stains and grass clinging over the body and shirt. Peeling of skin was present over both the forearm and legs (Figure 1) and reddish brown discoloration was seen over the knees, suggestive of, frost erythema. Lips were chapped and dry. Rigor mortis was in disappearing phase. Hypostasis was present on back except at pressure areas and was fixed. Cornea was opaque and there was no oozing from any of the natural orifices.

Skull was intact. The brain (1310g) was pale, edematous and soft. All coronaries were thick, calcified and gritty on cutting. The lumen of right coronary artery was about 70% occluded by atheromatous plaque 1 cm distal to its origin for a distance of

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about 2 cm. Atheromatous plaques were seen in the aorta from its origin upto a distance of 1 cm. Stomach contained 10 ml of brownish fluid with no specific smell. Multiple reddish brown discrete spots, ranging in size from 0.1 to 0.5 cm and about 50-60 in number, suggestive of Wischnewsky spots seen all over the mucosa of stomach (Figure 2,3). Kidneys were pale with multiple small cysts. From the autopsy findings and the circumstances in which death occurred, we opined the death is due to combined effect of cardiac pathology and hypothermia.

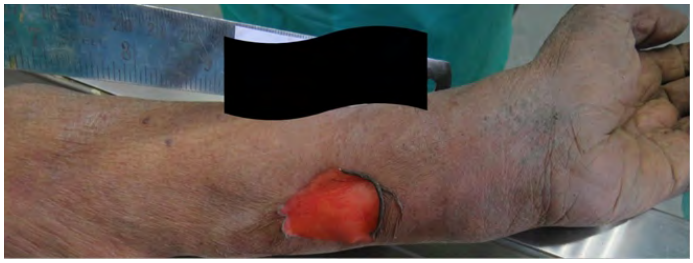

Figure 1: Peeling of skin

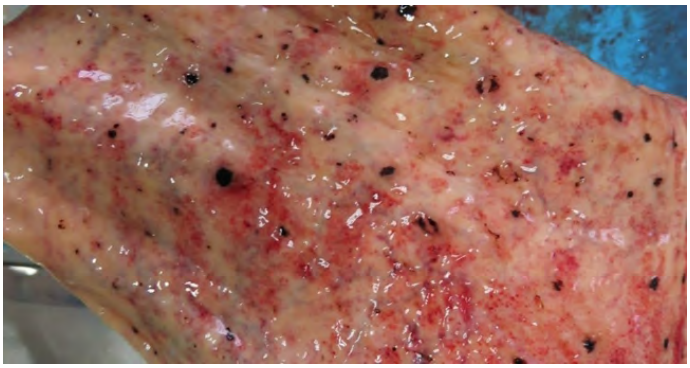

Figure 2: Wischnewsky Spots

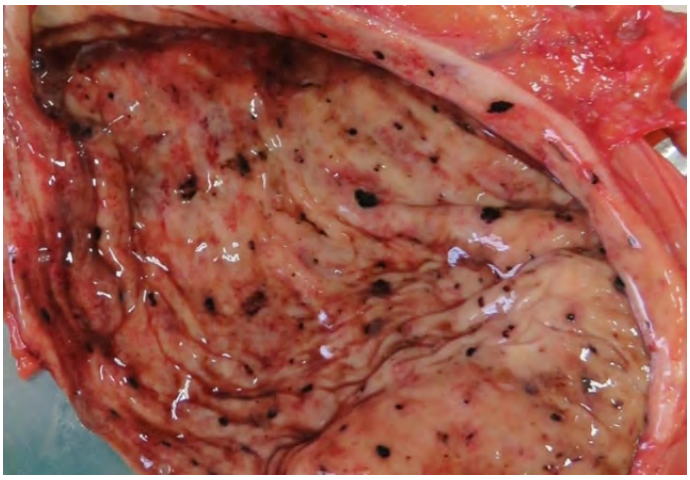

Figure 3: Wischnewsky Spots

Discussion

Hypothermia is a diagnosis of exclusion and a challenge for forensic expert to resolve. From history, circumstances of death and autopsy findings the case reported is deduced to be a case of hypothermia. The mean age among such cases is 68 years. Older people may have a reduced ability to generate heat because of reduced body mass, impaired mobility, inadequate diet, and reduced shivering in response to cold. [9-11] The mortality of patients with moderate to severe hypothermia is high. [12]

Patients with hypothermia present with maladaptive behavior like paradoxical undressing, which is inappropriate removal of clothing in response to a cold stress. [2] Undressing may also be attributed in some cases to dementia due to Alzheimer disease before they become hypothermic. [10] Duguid et al. (1961) reported that 16 out of 23 (69.6%) elderly patients who were the victims of accidental hypothermia were scantily clothed or almost naked. [7] Clothes are often found near the body. Hide and die syndrome may also be observed in some cases of fatal hypothermia. The corpse is generally found in a strange location, under or behind furniture or other objects, re-enacting a primitive, burrowing-like behavior of hibernating animals. 5 The scene of death can be misleading and may rouse suspicion.

Hypothermia can occur in association with hypothyroidism, metabolic disorder, hypothalamic lesion, etc. History regarding pre-existing co-morbidities and medication can also help in determining the cause of death. Hypothermia can lead to organ dysfunction and altered biochemical parameters as a result of physical and metabolic adaptation. [9-11] Certain parameters like blood ketones, cortisol, and free fatty acids as well as urine catecholamine and cortisol are considered to be reliable markers of fatal hypothermia. [5] These investigations can be undertaken if hypothermia is believed to be the cause of death. Imbalanced electrolytes and altered endocrine function leads to myocardial irritability resulting in arrhythmias. [11] Hypothermia in an already existing coronary artery disease can be fatal. Basal vacuolation of the renal tubular epithelial cells and pancreatitis is often observed. [5] Gross findings like Wischnewsky spots and frost erythema are found more frequently in cases of hypothermia. [5, 12] Wischnewsky spots present on the gastric mucosa at autopsy are considered a reliable indicator of hypothermia. [8,9] Microscopic examination showed brown to black pigmentation in Wischnewsky spots and neutrophil infiltration and other vital reactions were absent. A possible explanation could be that hypothermia may activate the secretion of gastric acid and pepsin, leading to development of Wischnewsky spots. The incidence of expression of Wischnewsky spots range from 40- 100%. [12, 13]

In the present case, the deceased was an old man with a history of diabetes mellitus, hypertension, forgetfulness and had also been reported missing from home in the past. People with such

conditions have a chance of wandering off and getting exposed to cold environments unintentionally. Exposure to the above mentioned range of temperature for long duration without proper protection can lead to cold stress and bring about adaptation failure resulting in death due to hypothermia. Circumstances of death is suggestive of paradoxical undressing. Autopsy findings of Wischnewsky spots and frost erythema point towards hypothermia.

There are no specific findings in hypothermia, and thus, it is a diagnosis of exclusion. Meticulous investigation of how, where, and, in what condition the body was found and a diligent autopsy is mandatory. Biochemical analysis and histopathological examination can be helpful in analysing the body responses and metabolic changes in response to cold stress.

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CASE REPORT

Accidental All Out mosquito repellent ingestion in girl child – A case report

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Abstract
All Out liquidator containing Allethrin, a pyrethroid used as mosquito repellant is present in nearly all households. A 1-year-old baby girl drank a sip of all-out liquid while playing with her toys in the presence of her family members. They tried to make her vomit by inserting finger in her throat but failed. Within 5 minutes after ingesting the liquid, she was taken to nearby hospital and gastric lavage was initiated. Later on she was referred to a higher centre. She was kept under observation and was given charcoal after 1.5 hours of drinking all out liquid. This case emphasizes the importance of awareness amongst parents about household poisons and obtaining information through poison information centers. Various issues have been highlighted in this case report.

Keywords
Mosquito repellant; Charcoal; Poison Information Centre

Introduction

Allethrin, a pyrethroid is a compound in mosquito repellants with lesser toxicity for human beings. There are few poisoning cases reported in adults [1-5] and few in children.[6] Clinical picture in such cases varies widely depending upon the amount of compound consumed. Kerosene (hydrocarbon) and alletherin (pyrethroid) present in All Out mosquito repellent produces different signs and symptoms. This case is unique and important as it signifies the importance of information obtained from PIC in poisoning cases and associated satisfaction the information brought to worried parents.

Case Report

The 1 year old baby girl accidently consumed the all-out refill in the presence of family members. They tried to make her vomit by inserting finger in her throat to no avail. Then they took her to the nearest hospital within minutes of ingesting the liquid. Gastric lavage was performed during which she kept gaining and regaining consciousness. The treating doctor was not in a condition to say whether she was out of danger or not. So, she was referred to another hospital. En route the other hospital she failed to respond to the treatment properly. As soon as they reached second hospital, hospital staff started questioning the mother suspecting something fishy as patient was a baby girl. Meanwhile the father called the author and on reference had conversation with Poison Information Centre, Amritha Institute of Medical Sciences, Cochin. Father was satisfied after talking as he was explained that this liquid is less dangerous and advised corresponding treatment. Pediatrician examined the patient and instructed the staff to give activated charcoal which was given after 1.5 hours of All Out ingestion. Subsequently she developed a fever that night and was sleepy till noon of the following day. Thereafter she became active with slight weakness. She was discharged from hospital the next day.

Discussion

Accidental poisoning is the 12th leading cause of admission in the paediatric ward in India and accounts for 1% hospitalization. [7] Hydrocarbons are among the most common cause, not only in India, but also in the developed world. [9] In India, accidental kerosene ingestion is common, especially in rural households, due to its easy availability as a cheap fuel and storage in inappropriate containers which children often mistake for water. [9] However, lately, liquid mosquito repellent ingestion is emerging as a leading cause of hydrocarbon (kerosene) poisoning in urban households. [8] Children with accidental liquid mosquito repellent ingestion presented with predominant aspiration pneumonitis due to the hydrocarbon content rather than neurological complications associated with synthetic pyrethroids. [8] All out liquid is used to control adult mosquitoes. The chemical composition of all out is Transfluthrin 0.88% (w/w), Butylated hydroxytoluene 1.00% (w/w), Perfume drakker 1.00% (w/w) and Deodorised kerosine 97.120% (w/w) as per the information contained on its outer covering. There is no specific antidote known and treatment is purely symptomatic. First Aid, if swallowed does not induce vomiting. There are only few reports of pyrethroid poisoning from India. [6, 14] Pyrethroids are generally considered to be safe insecticides in humans because of their rapid biotransformation by ester hydrolysis and hydroxylation to inactive acids and

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alcohols. The fatal dose for Allethrin is not known. Most cases of acute pyrethroid poisoning recover within 1-6 days with a normal neurological outcome during the follow up. [13] As in this case, most the children with mosquito repellent poisoning are referred to other healthcare facilities; with more than half subjected to induced vomiting or gastric lavage prior to referral. [8] As with other hydrocarbons, induced vomiting and gastric lavage are contraindicated unless the neurological manifestations due to the pyrethroid component predominate. [10-12] Lavage in such cases is then done after airway has been secured with a cuffed endotracheal tube. [8] Seizure in pyrethroid neurotoxicity is believed to be due to its ability to modify sodium, chloride and calcium channels of the neurons. [13] The signs and symptoms of pyrethroid toxicity are similar to those of organophosphate poisoning. It is essential to differentiate between the two as inappropriate atropine use (for Organophosphorus poisoning) should be avoided in pyrethroid poisoning. [6] Poison control centres should be established by tertiary care centres and the numbers should be displayed for first aid and more severe poisoning cases should be further referred for appropriate treatment. [15]

Conclusion

The case emphasized the importance of Poison Information Centres for rapid information and to pacify the relatives, patient or the treating doctor as many general physicians are not well versed with different types of poisoning. All the information regarding the toxicity and treatment is there on a wrapper inside the box provided by the company but nobody reads the small worded paper inside the box as these Cautions/ Pamphlets are written in small fonts and are rarely readable. Providing only the relevant and most important information in a readable form on the pamphlet alongside link of website for further information may be beneficial.

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CORRESPONDENCE

Differential development of the ribs – Exploring the unexplored

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Introduction

Age estimation is a crucial aspect of establishing the biological profile of an individual, which has profound medicolegal significance in the living as well as the dead.[1,2] In the living, age estimation is routinely assessed in a variety of situations including cases of cross border migrations, asylum seekers, refugees, underage solicitation, assigning criminal responsibility and eligibility to participate in sporting events among many others.[3-7] However, despite this eclectic mix of modern applications, age estimation has a more traditional evidence base in the analysis of deceased individuals for the purpose of establishing identification in the context of a medico-legal investigation.

Age estimation is typically achieved by analysis of skeletal indicators of maturity in juvenile skeletons or by studying degenerative changes in selected skeletal elements in the adult skeleton, following the completion of their growth and development. The most commonly used methods of age estimation include dental mineralisation and eruption patterns, analysis of the degree of ossification and epiphyseal fusion of the long bones and morphological changes observed in the pelvis, ribs and cranium.[1,2] These methods can be achieved through direct visualisation of skeletal remains or alternatively, when soft tissues are present or invasive analysis is not possible, analysis can be achieved through interpretation of clinical imaging modalities.

An area of skeletal development that may exhibit potential for the purposes of age estimation, is the ossification progression of the vertebrochondral joints and specifically the heads of the developing ribs. Despite a paucity of research in this area of skeletal development, the available literature suggests that the ossification centres for the heads of the ribs appear around puberty, and are completely ossified by the age of 22-25 years.[8-14] It has been reported that there is a differential development of rib ossification dependant on the position of the rib within the thorax; with superior ribs (ribs 1-2) and the inferior ribs (ribs 9-12) being observed to ossify first, while the middle ribs (ribs 3-8) ossify later. The cause for this phenomenon has not been discussed or explained by the existing literature. Some of the possible causes for this differential development are presented and discussed in this correspondence.

Hypothesis

It has been observed that the ossification of the skeletal components of the ventrochondral junction, including the head of the rib, occurs earlier in atypical ribs (ribs 1-2, and 10-12) compared to the typical ribs (ribs 3-9). This could be due to the superior most ribs having a greater interaction with postural muscles, thus resulting in advanced mechanical interactions associated with head and neck movement during development.[15-17] Additionally, the lower most ribs terminate in the abdominal musculature and attach to the diaphragm (ribs 11-12) or articulate with the costal margin (ribs 9-10), this association may result in increased mobility during respiration and thus increased biomechanical loads during early development 15,16. Conversely, the typical ribs have a direct connection with the sternum via single costal cartilages, thus it can be argued that these ribs experience more limited movements and therefore reduced biomechanical loads due to the relative stability of this anatomical configuration of the rib during development.[15,16]

Explanation

The ribs are attached posteriorly to the thoracic vertebrae at the costovertebral and costotransverse joints. These two joints are considered to be a part of the Functional Spinal Unit (FSU) in the biomechanical model of the thorax.[17] During deep respiratory inhalation, the first rib gets raised due to the attachment of the scalenus anterior and the scalenus medius muscles, while the second rib is raised due to the attachment of the scalenus posterior muscle.[15,16] The movement of these muscles also raise and tilt the first two ribs in the direction of neck movement. The vertebral ribs or the floating ribs only have costocentral articulations, and are depressed due to the action of the quadratus lumborum muscle and movement of the diaphragm during respiration.[15,16] Thus, due to the interactions of these powerful muscles, there are increased biomechanical loads associated with the posterior regions of the superior and

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the inferior ribs compared to the typical ribs.

Conclusion

It is proposed that the differential loads experienced by the upper and lower ribs will result in greater mechanical loading compared to the mid-positioned typical ribs. This in turn, may lead to the earlier skeletal maturation which has been observed and reported by other studies.[8-14]

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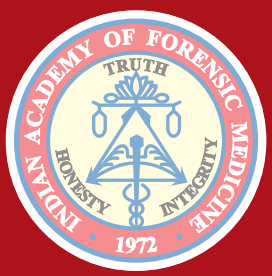
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