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Estimation of Stature from Shoeprint Length in Central Indian Population

Divyesh Saxena[1], Bimbisar Mukherjee[2], Raviprakash Meshram[3], Pradeep Kumar Mishra[4]

Abstract

Shoeprints are one of the important trace evidences that are often overlooked at the crime scene. They may provide investigative leads in identification of the accused. This study aims to determine the relationship between shoeprint length and stature amongst Central Indian population. A total of 500 subjects comprising 250 males and 250 females, aged between 18 to 50 years, natives of Madhya Pradesh, a Central Indian state were selected for this study. The height and length of their shoeprints were recorded and a regression equation was devised along with multiplication factors. We found that as the length of the shoeprint increased there was an increase in the height of the individual representing a positive correlation between the two variables (r = +0.757 for males and r = + 0.887 for females).

Keywords: Stature; Shoeprint Length; Central India.

Introduction

Shoeprints left behind by the criminals at the crime scene can provide valuable evidence for the investigative agencies. Miscreants frequently wear gloves and masks to hide their identity, but hardly make any endeavor to conceal their footwear. Estimation of height of an individual from their footlength is more reliable compared to shoe prints, however in reality it is rare to find bare footprints at the scene of crime. Hence, in such circumstances we have to solely depend upon shoe prints for evidence instead.

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Cassidy in his study provided male height equivalents for calculating height from shoesize [1]. Eugene presented and evaluated newly determined percentages and linear regressions for measuring height from foot-length in young adults based upon U.S. army anthropometric databases [2]. In India, Raju showed significant correlation between the stature and shoe print length in females while walking [3].

According to 2004 London Metropoliton Police Report, the evidence recovery rate for shoeprint was 12.4% as opposed to 19% for fingerprints. The report also stated that with greater attention the recovery rate for shoeprints could be raised to 30% in case of burglaries [4]. Researchers have shown various methods for chemical enhancement of footwear impressions obtained at the crime scene [5,6]. In this study we have evaluated the relationship between shoeprint length and stature amongst Central Indian population.

Materials and Methods

The prospective cross-sectional study was carried out at the department of Forensic Medicine, Sri Aurobindo Institute of Medical Sciences, Indore, Madhya Pradesh, a state in Central India, over a

period of 1 year from July 2015 to June 2016. A total of 500 subjects comprising of 250 males and 250 females, all natives of Madhya Pradesh were randomly selected for the study. All the participants were above 18 years of age.

The participants were asked to stand firmly for 10 seconds on his/her right foot on a flat surface of a wooden box covered with thick cloth soaked in blue ink, ensuring every segment of shoe-sole was immersed and stained with ink. Then they were instructed to take a step on a thick white paper sheet placed over a wooden weighbridge. The length of the shoeprint was then measured from heel to toe. The height of the participants was calculated by asking them to stand erect on a stadiometer bare-footed. Both shoeprint length and height were measured in centimeters to the nearest millimeter. Data analysis was done by using Statistical package Microsoft Excel 2007 and regression formulae were calculated for various combinations to reach the best estimates.

Results

In the present study, shoeprint length of males ranged from 26 cms to 30.8 cms (Table 1) with a mean of 28.37 cms and S.D. of ±1.22 cm. The height of the male participants ranged from 167.2cms to 188.5 cms with a mean of 175. 52 cms and S.D. of ± 4.75cms (Table 2). For females, shoeprint length ranged from 21.4 cms to 28.1 cms (Table 3) with a mean of 24.508 cms and S.D. of ±1.55cm. The height of female partcipants ranged from 148 cms to 177.5 cms with a mean of 159.082cms and S.D. of ±6.33cms (Table 4).

Table 1: Shoeprint length and actual stature in males (n = 250)

Shoeprint length (cms)	Subjects	Mean Height (cms)	S.D.
26 – 27	28	168.99	1.16
27.1 – 28	87	172.83	2.43
28.1 – 29	61	175.73	2.30
29.1 – 30	40	179.94	2.69
30.1 – 30.8	34	182.17	3.40

Table 2: Correlation between shoeprint length and stature in males (n = 250)

Variable (cm)	N	Mean: ± S.D	Range	r – value Coefficient of correlation	b – value Regression coefficient	Regression equation
Shoeprint length	250	28.37 ± 1.22	26 – 30.8	+0.889	3.46	Height = 77.36 +3.46 (SPL)
Actual height	250	175. 52 ± 4.75	167.2 – 188.5			

*SPL – Shoeprint length

Table 3: Shoeprint length and actual stature in females (n= 250)

Shoeprint length (CMS)	Subjects	Mean Height (cms)	S.D.
21.4 – 23	50	153.05	3.18
23.1 – 24	67	155.30	3.10
24.1 – 25	42	158.34	2.54
25.1 – 26	46	162.40	2.88
26.1 – 27	29	166.61	2.41
27.1 – 28.1	16	172.46	3.87

Table 4: Correlation between shoeprint length and stature in females (n= 250)

Variable (cm)	N	Mean: ± S.D	Range	r – value Coefficient of correlation	b – value Regression coefficient	Regression equation
Shoeprint length	250	24.508 ± 1.55	21.4 – 28.1	+ 0.887	3.61	Height = 70.609 +3.61(SPL)
Actual height	250	159.082 ± 6.33	148 – 177.5			

*SPL – Shoeprint length

Table 5: Prediction of stature for different shoeprint length in males

Shoeprint length (cms)	Predicted height (cms)	Range	
		Min	Max
26	167.32	162.57	172.07
27	170.78	166.03	175.53
28	174.24	169.49	178.99
29	177.70	172.95	182.45
30	181.36	176.61	186.11

Table 6: Prediction of stature for different shoeprint length in females

Shoeprint length (cms)	Predicted height (cms)	Range	
		Min	Max
22	150.02	143.69	156.35
23	153.63	147.30	159.96
24	157.24	150.91	163.57
25	160.85	154.52	167.18
26	164.46	158.13	170.79
27	168.07	161.74	174.40
28	171.68	165.35	178.01

A regression equation was devised and values for a coefficient of co-relation was calculated for assessing the relationship between shoeprint length and height of an individual. We found that as the length of the shoeprint increased there was an increase in the height of the individual representing a positive correlation between the two variables (r = +0.889 for males and r=+0.887 for females). Height could be estimated by the regression equation - [Height (for males) = 77.36+3.46 x shoeprint length] and [Height (for females) = 70.609+3.61 x shoeprint length] (Table 2 and 5). Prediction of stature for different shoeprint length for both the sexes have been shown in Table 5 and 6.

Discussion

In Forensic Anthropology, estimation of stature plays a significant role in establishing the identity of a person. Our study has shown that as the length of the shoeprint increased there was an increase in the height of the individual representing a positive correlation between the two variables. A rapid classification of such shoeprints would assist investigative agencies not only to link different crimes but also to identify suspected criminals [7]. Bodziak has described the process of detection, recovery and examination of footwear impression evidence by manual human shoeprint classification [8]. Girod revealed that 35% of crime scenes in several jurisdictions of Switzerland had shoeprints usable in forensic science [9]. He also found that 30% of all burglaries provide usable shoeprints and proposed a semi-automatic scheme for classifying shoeprints from burglars [4]. Each sole was described by a number of geometric patterns which must be determined by a human expert. Examples of such pattern include zigzags, circles, squares and letters. A database of known shoe types was established using these geometric patterns and unknown shoeprints could be compared to shoeprints in the database to try and find a match.

In present study, regression equation for estimation of height from shoeprint length was 77.36+3.46 x (shoeprint length) for males. This slightly differs from Eugene's regression equation for estimation of height which was 82.206+3.447 x (foot length) [2]. Later on, he calculated height directly from shoe print length by the same regression equation replacing foot length by shoeprint length on a length 25.4 mm less than shoeprint length [2]. He proposed the height spread of ±6.35 cm and presumed that it would include 70% of men for that particular shoeprint length. Standard deviation of the present study was more precise and we found a significant positive coefficient of correlation for males - r = + 0.889. Subjects of this study were from a normal population as compared to Eugene's samples which consisted of healthy individuals from the U.S. army.

For females, regression equation for the estimation of stature was 70.609 + 3.61 x (shoeprint length) in our study. Raju estimated the height of females from their shoeprint length by the regression equation 91.4 + 3.09 x (shoeprint length) [3]. They measured a mean shoeprint length of 24.12 cms with a S.D. of ± 1.75cms

and a mean height of 165.87 cms with a S.D. of ± 9.05cms. Standard deviation of our study was closer to the mean with a coefficient of correlation r = + 0.887 as compared to Raju which was r = + 0.69, indicating a strong positive association. No equation has been prepared by Eugene for females [2]. Raju had selected the subjects for his study from Southern Indian population. The difference in results could be due to genetic and geographical variation.

Conclusion

Shoeprints are found virtually at every crime scene. They are often unnoticed, even though criminals presumably leave impressions routinely while entering and exiting crime scenes. Analysis of such traces more reliably would enable the judges to attach more weight to this evidence in assessing the probability of guilt. Further study and research will enhance the value of shoeprint evidence and its use in the identification of potential criminals. Nevertheless, we need to keep in mind that people from different ethnic origins and geographic regions have their own variations.

Declarations of Interest: None

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Original Article

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An Autopsy Based Retrospective Analytical Study about Demographic Profile of Decomposed Bodies at Raigarh (C.G.) Region

Rajesh Ban Goswami[1], A. Dutta[2]

Abstract

Introduction: Medico-legal autopsy of decomposed bodies are the most hectic task for an autopsy surgeon since he/she is liable to provide data for fixation of P.M.I, Type of injury, C.O.D, etc. These datas are crucial for the purpose of administration of justice. Once upon a time autopsy of decomposed bodies were known as most unrewarding one, but due to improvement in scientific techniques, such situation had been partially over come. An attempt has been made in survey form of cases autopsized in K.G.H. mortuary at Raigarh to examine the feasibility to overcome the effect of above obstacles in recent situation. *Aims & Objectives:* In order to assess whether it is easy to find out injuries, cause of death, pattern of changes after death etc. in decomposed bodies and to assess the extent of certainty, three years and seven months study had been conducted. Further it is also aimed at to study the age, sex and season wise incidents of cases, cause of death etc. *Materials & Methods:* 78 decomposed bodies were autopsized out of total 1763 autopsy cases during the period from Jan 2015 to July 2018 in KGH mortuary at Raigarh, Chhattisgarh. *Observations and results:* Main points of discussion confined to (i) Season, (ii) Identity, (iii) Age group, (iv) Sex, (v) C.O.D. Maximum cases (48.72%) were found in summer. In total autopsized cases male predominance (80.76%) was found with M:F= 4.2:1. Maximum number of deceased persons were found in adult age group (21-60) [71.79%] and maximum cases were found in advanced stage of decomposition (39.74%). The C.O.D was determined in 70.51% of cases.

Keywords: Decomposition; Autopsy; Mortuary; Identity; C.O.D.

Introduction

Decomposition is the process of conversion of complex organic tissues into simpler inorganic molecules [1]. It involves two processes putrefaction and autolysis [2]. Putrefaction is the process of gradual dissolution of the tissues into gases, liquids and salts. This process of transformation is caused mainly by proteolytic and other enzymes produced by certain group of pathogenic and non-pathogenic strains of bacteria [3]. The physio-chemical changes occurring in the dead body can be demonstrated by 4 D's i.e. Discoloration, Distension, Degradation and Dissolution. Autolysis is the breakdown of cells and organs through an aseptic chemical process caused by intracellular enzymes. Earliest sign of decomposition in human body is greenish discoloration of Rt. Iliac fossa, while earliest internal change is discoloration of under surface of liver. Cl. Welchii is the main causative organism, due to excretion of lecithinase, a proteolytic enzyme causes decomposition. According to environmental conditions decomposition usually starts in corpse within 36–48 hrs.

It is impossible to deduce any general rule for the rate of putrefaction of a dead body because of the number and variability of the factors which influence its development. The factors modifying decomposition are (1) Presence or absence of clothing, (2) Whether the body was floating or

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buried, (3) Env. Temperature, (4) Injury, (5) Preexisting disease, (6) Poisoning etc. Important rule for rate of decomposition is "Casper Dictum" i.e. degradation of body tissues in different environmental conditions i.e. air, water and soil, usually remains in proportion of 1:2:8 [4]. During medico-legal autopsy of decomposed bodies, an autopsy surgeon is liable to fix (1) Identity of the deceased, (2) P.M.I, (3) Recording of injuries, (4) Cause of death, (5) Manner of death. For the purpose of fixing absolute identity long bone (preferably) is needed to be preserved along with clothing and available articles. For fixing P.M.I. assessment of decomposition changes over the body and if maggots are crawling over the body, then preservation of entomological evidences are quite helpful [5,6,7]. Assessment of injuries in a decomposed body is a difficult task except for fractures of bones. Some poisons accelerate the process of decomposition like Chronic Alcoholism, while some poisons delay the process of decomposition like Heavy metal poisoning. Some poisons resist this process like Organophosphates, while some poisons are also destroyed during this process (Morphine) [8]. Pre existing disease and morbid conditions may affect the process of decomposition in either direction.

To opine cause and manner of death is quite difficult. Modi's Medical Jurisprudence [9] has discussed the process to conduct the medico-legal autopsy of decomposed and mutilated bodies in details with reference of cases like Alavandar murder case, The drum murder case, The Ruxton case etc.

Review of Literatures

Study of Cyriac job (2009) [10], Study of Singh et al. (2015) [11], Lessig R et al. (2006) [12], Mukhopadhyay et al. (2014) [13], Ambade et al. (2011) [14], Galloway et al. (1989) [15] had discussed the issue relating to medico-legal autopsy & their findings in cases of decomposed bodies in details.

Materials & Methods

The present study was conducted at mortuary of LSLAMGMC & Associated K.G. Hospital, Raigarh. Total 78 cases of decomposed bodies which were brought during the study period for post mortem examination, were included in study. In the present study all cases were included irrespective of age, sex, caste, religion, dietary habits and socio-economic status.

Study Site

Mortuary of KGH and Dept. of F.M.T., LSLAMGMC Raigarh, (C.G.)

Study Duration

03 years and 07 months (Jan 2015 to July 2018)

Study Type

Cross sectional retrospective study

Inclusion and Exclusion Criteria

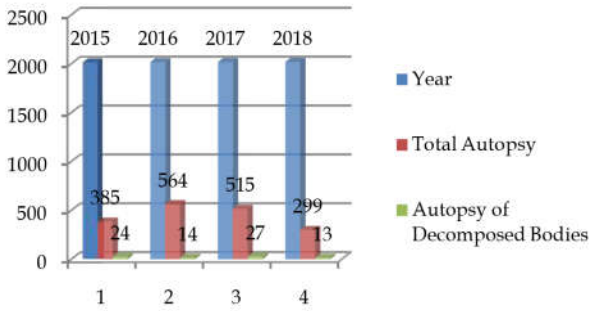
All cases of decomposed bodies were included for study except skeletonized bodies.

Observations & Results

Table 1: Total No. of Autopsy cases v. Autopsy of decomposed bodies

Year	Total Number of Autopsy cases	Total Number of Autopsy of decomposed bodies	%
2015	385	24	6.23
2016	564	14	2.48
2017	515	27	5.24
2018*	299	13	4.35
Total	1763	78	4.42

*Upto July 2018

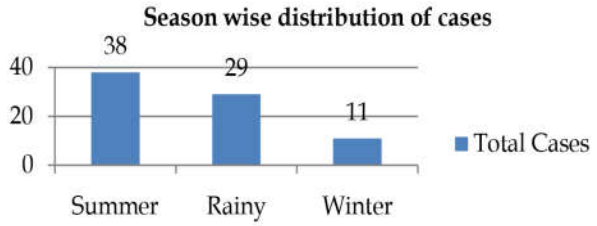


Graph 1: Month wise distribution of cases

Table 2: Month wise distribution of cases

Month	2015	2016	2017	2018	Total
Jan	-	-	-	-	0
Feb	-	-	-	4	4
March	2	2	1	3	8
April	1	2	4	-	7
May	3	2	4	2	11
June	4	1	6	1	12
July	8	-	2	3	13
Aug	1	2	3	*	6
Sept	1	1	1	*	3
Oct	-	3	4	*	7
Nov	2	-	2	*	4
Dec	2	1	-	*	3
Total	24	14	27	13	78

*Upto July 2018



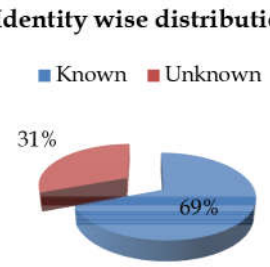
Graph 2: Month wise distribution of cases

During summer (March-June) season total number of decomposed cases were 38, which is 48.72% of total cases, in rainy season (July-October) total case were 29, which is 37.18% of total cases and in winter (Nov-Feb.) only 11 cases were autopsized, i.e. 14.10% of total cases during Jan 2015- June 2018 (Table and Graph 2).

Table 3: Identity wise distribution

Identity	2015	2016	2017	2018	Total
Known	18	9	19	8	54
Unknown	6	5	8	5	24
Total	24	14	27	13	78

Total number of Known and Unknown decomposed bodies were 54 and 24 respectively i.e. 69.23% and 30.77% during Jan 2015- July 2018. (Table and Graph 3).

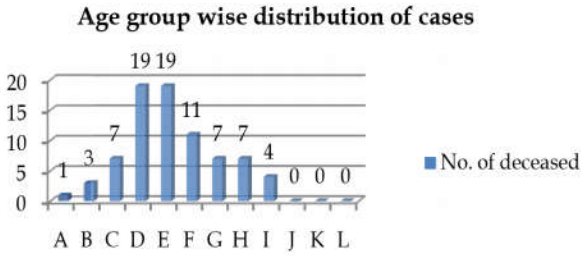


Graph 3:

Table 4: Age wise distribution of the dead bodies

Age	2015	2016	2017	2018	Total
Foetus (A)	-	1	-	-	1
0-10 (B)	1	-	1	1	3
11-20 (C)	3	1	3	-	7
21-30 (D)	3	4	7	5	19
31-40 (E)	3	5	5	6	19
41-50 (F)	4	1	5	1	11
51-60 (G)	4	1	2	-	7
61-70 (H)	5	-	2	-	7
71-80 (I)	1	1	2	-	4
81-90 (J)	-	-	-	-	-
91-100 (K)	-	-	-	-	-
101 & Above (L)	-	-	-	-	-
Total	24	14	27	13	78

According to age group maximum number of cases were found in age group of 21-30 (Total cases- 19) and 31-40 years (Total cases- 19), below 20 years total no. of cases were 11 (14.10%), From 21-60 age group total cases were 56 (71.79%), Above 61 total cases were 11 (14.10%). No cases were found above age 80 years. (Table and Graph 4).

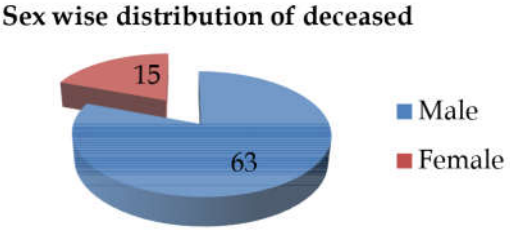


Graph 4:

Table 5: Sex wise distribution

Sl. No	Year	Male	Female	Total
1	2015	19	5	24
2	2016	12	2	14
3	2017	22	5	27
4	2018	10	3	13
Total		63	15	78

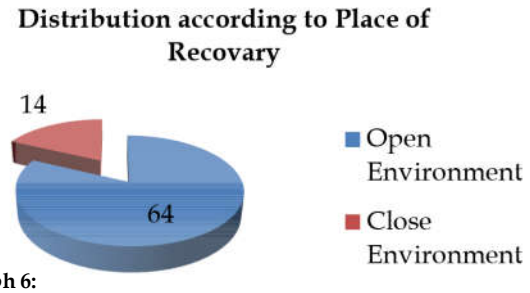
In sex wise distribution maximum case were found to be of male i.e. 63 (80.76%) and number of female case were 15 (19.23%). (Table and Graph 5).



Graph 5:

Table 6: Distribution of cases according to place of recovery

Year	Place of Recovery		Total
	Open environment	Close environment	
2015	20	4	24
2016	13	1	14
2017	22	5	27
2018	9	4	13
Total	64	14	78



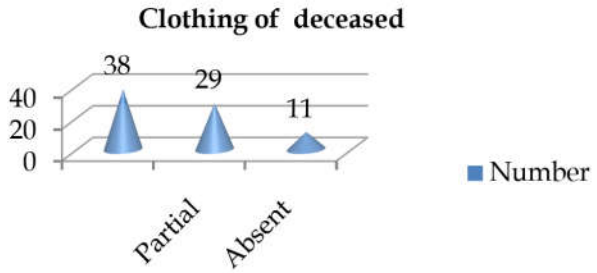
Graph 6:

Total no. of cases recovered from open environment were 64 (82.05%) and from closed environment 14 (17.95%) cases were recovered. (Table and Graph 6).

Table 7: Distribution of cases according to clothing

Year	Clothing Complete	Partial	Absent	Total
2015	15	5	4	24
2016	3	9	2	14
2017	15	10	2	27
2018	5	5	3	13
Total	38	29	11	78

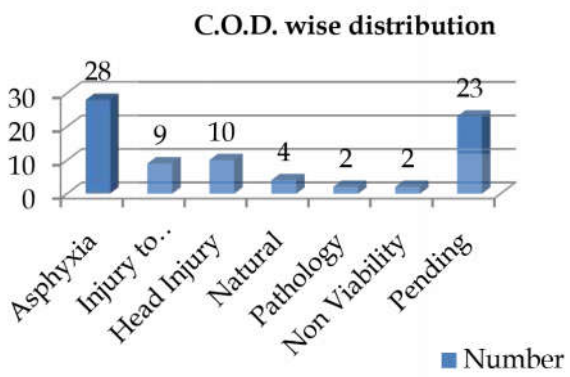
Total cases found with complete clothing were 38 (48.72%), partially clothed were of 29 (37.18%) and clothing were absent in 11 (14.10%) cases. (Table and Graph 7).



Graph 7:

Table 8: Distribution of cases according to stages of decomposition

Stages of decomposition	Year 2015	2016	2017	2018	Total	%
Initial Decomposition	9	2	9	3	23	29.48
Moderate Decomposition	5	7	9	3	24	30.77
Advanced Decomposition	8	3	5	5	21	39.74
Adipocere	-	1	1	2	4	
Mummified	2	1	3	-	6	
Total	24	14	27	13	78	



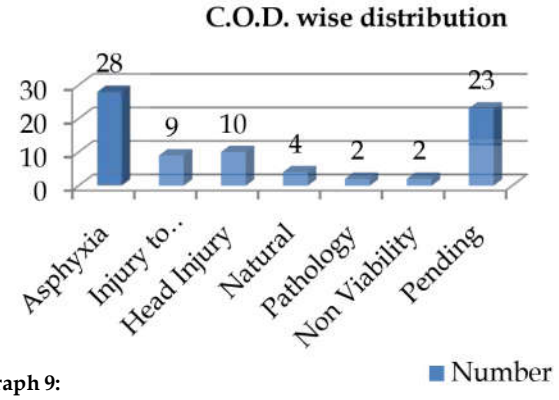
Graph 8:

Maximum number of cases were in advanced stage of decomposition followed by moderate and initial stage of decomposition. (Table and Graph 8).

Table 9: C.O.D. wise distribution

C.O.D.	2015	2016	2017	2018	Total	Total	%
Asphyxia	01	-	01	-	02	28	70.51
Hanging	02	01	07	03	13		
Drowning	04	03	06	-	13		
Injury to Vital Organs	04	01	02	02	09	09	
Head Injury	03	02	04	01	10	10	
Natural	02	02	-	-	04	04	
Pathology	01	-	01	-	02	02	
Non Viability	-	-	01	01	02	02	
Pending	07	05	05	06	23	23	29.49
Total	24	14	27	13	78	78	100

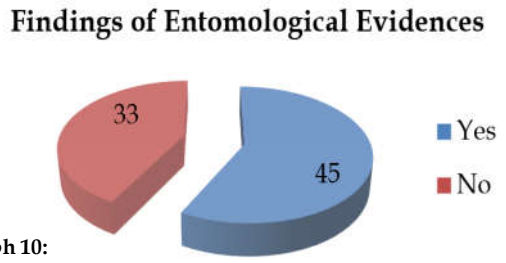
In total 55 cases (70.51%) C.O.D. was ascertained and in 23 cases (29.49%) C.O.D. was not ascertained. (Table and Graph 9).



Graph 9:

Table 10: Findings of entomological evidence in dead body

Year	Entomological Evidence Yes	No	Total
2015	13	11	24
2016	8	6	14
2017	11	16	27
2018	9	4	13
Total	41 (52.56%)	37 (47.44%)	78

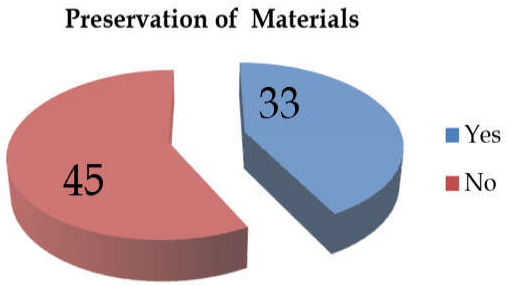


Graph 10:

In 41 (52.56%) cases entomological evidences were found and in 37 (47.44%) cases no such evidence was found. (Table and Graph 10).

Table 11: Preservation of Materials

Materials Preserved	2015	2016	2017	2018	Total
Yes	09	10	17	09	45
No	15	04	10	04	33
Total	24	14	27	13	78



Graph 11:

In 45 cases materials were preserved during autopsy and in 33 cases no such preservation was done. (Table and Graph 11).

Discussion

Total cases of decomposed bodies from Jan 2015 to July 2018 were 78 out of 1763 i.e 4.42% of total autopsy examination carried out during the above mentioned period. During summer (March- June) season total number of decomposed cases were 38, which is 48.72% of total cases, in rainy season (July-October) total case were 29, which is 37.18% of total cases and in winter (Nov- Feb.) only 11 cases were autopsized, i.e. 14.10% of total cases. Therefore our findings according to the season wise prevalence of decomposed bodies are matching with the findings of Singh et al. (2015) [11] Indore, Madhya Pradesh and Ambade et al. (2011) [14] Maharashtra, where maximum cases of decomposed bodies were autopsized in Summer followed by Rainy and Winter season. In our study total number of Known and Unknown decomposed bodies were 54 and 24 respectively i.e. 69.23% and 30.77%. According to age group maximum number of cases were found in age group of 21-30 (Total cases-19) and 31-40 years (Total cases- 19), below 20 years total no. of cases were 11 (14.10%), From 21-60 total cases were 56 (71.79%) 61& Above were 11 (14.10%). Therefore age group wise our finding matches with the study of Singh et al. (2015) [11] M.P. According to sex wise distribution maximum cases were found to be of male i.e. 63 (80.76%) and number of female case were 15 (19.23%), which shows male predominance in our study which matches with the study of Cyriac Job (2009) [10], Singh et al. (2015) [11] and Ambade et al. (2011) [14]. In our study we have also found M:F ratio to be 4.2:1, which closely matches with the study of Ambade et al. (2011) [14] where M:F ratio was 3.9:1.Total no. of cases recovered from open environment were 64 (82.05%) and from closed environment total 14 (17.95%) cases were recovered and the recovery ratio of open to closed environment is 4.57:1. Total cases found with complete clothing were 38 (48.72%), partially clothed were of 29 (37.18%) and clothing were absent in 11 (14.10%) cases. Since clothing of the deceased provides an unique opportunity of identification, therefore due to recovery of maximum number of complete and partial clothing in decomposed cases reduced the number of unidentified bodies. In our study maximum number of cases were in Advanced stage of decomposition i.e. 31 (39.74%), this data is matching with the study of Singh et al. (2015) [11], where % of advanced decomposed bodies were 39.66%. In our study, in total 55 cases (70.51%) C.O.D. was ascertained and in 23 cases (29.49%) C.O.D. was not ascertained. In our study maximum no. of cases belongs to death due to asphyxia, which is 28 (35.89%) followed by Head injury i.e. 10 (12.82%), which also matches with the study of Singh et al. (2015) [11], where 36.67% cases were of death due to asphyxia.

Utility of Entomological Evidences

Entomological evidences found on dead body in decomposed state can provide vital information relating to PMI, Detection of metabolites of poisons, Postmortem relocation of corpses etc which are quite helpful for investigation purposes. Kulshrestha et al. (2005) [5], Hitosugil et al. (2014) [6], Singh H (2014) [7] and Supreme Court Judges Library enlisted document of Deoskar and Dutta

(2009) [16] had discussed the utility of entomological evidences in detail with respect to criminal investigation. Even Honorable Madras High Court in M. Sakthivel v. The State by Inspector of Police [17], Division bench of the Court comprising M. Jaichandran and S. Nagamuthu JJ. While setting aside the conviction and sentence imposed on the appellant (i.e. M. Saktivel) by the learned Principal Sessions Judge, Erode in S.C.No.146 of 2012, dated 17.08.2012 had mentioned the submission of defense council regarding importance and utility of entomological evidence in death investigation. In our study entomological evidences were found in 41 (52.56%) cases and in 37 (47.44%) cases no such evidences were found.

Management of Physical Evidence: Utility of preservation of viscera and other evidences during the course of autopsy can be referred from the case of *Dev Kanya Tiwari v. State of U.P. [18]* where the apex court division bench comprising N. V. Ramana and S. Abdul Nazeer JJ, while acquitting the appellant who was convicted in a case of 302 IPC held that " 17….non-preservation of viscera by the Doctor remains fatal to the prosecution case....." In *Md. Sayum v The State of Bihar [19]* where Navin Sinha J. of Patna High Court held that prosecution should sent viscera to FSL as early as possible**.** In *Joshinder Yadav v. State of Bihar [20]* division bench of apex court comprising Ranjana Prakash Desai and J. Chelameswar JJ. observed the essential need of scientific tests in criminal cases to counter the problem of hostile witness.

Conclusion

Autopsy in decomposed bodies are considered most difficult in forensic aspect, as changes in these bodies are influenced by various factors. C.O.D. can also be determined in decomposed cases if meticulous autopsy is carried out. Preservation of evidences are quite essential for the end of justice.

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Original Article

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Absolute Lymphocyte Count: A Probable Substitute Marker for CD4 Count in HIV-Infected Patients in Economically Restrained Countries

Ruchee Khanna[1], Vaishnavi Pahwa[2], Shashidhar V.[3], Vinay Khanna[4]

Abstract

Objective: CD4 count is the mainstay criteria for initiation of HAART (Highly Active Anti-retroviral Therapy) and assessment of disease progression in HIV patients. CD4 percentage adds additional prognostic information. Our study was aimed to find out if Absolute Lymphocyte Count (ALC) could serve as a substitute marker for CD4 count and percentage. *Methods:* A total of 455 EDTA blood samples from HIV-infected patients were analyzed for their ALC, CD4 counts and CD4 percentages, over a period of 6 months, from January 2015 to June 2015 in Kasturba Hospital, Manipal. Correlation analysis of ALC with CD4 count and percentage, and receiver operating characteristic (ROC) analysis at CD4 ≤ 200/μL andCD4 ≤ 350/μL were conducted as proposed by WHO guidelines. *Results:* The male to female ratio was 2:1 and age ranged from 11 to 78 years. The median ALC was 1600/μL, median CD4 count was 258.58/μL and the median CD4 percentage was 16.4%. A strong positive correlation (Pearson coefficient, r= 0.741) was obtained between CD4 count and ALC. However, a weak positive correlation (r= 0.276) was seen between ALC and CD4 percentage. Areas under the ROC curve for ALC with CD4 count ≤ 200/μL andCD4 count ≤ 350/μL were 0.901 and 0.911, respectively, both of which showed an excellent correlation. But area under the ROC curve for ALC and CD4 ≤ 20% was 0.659, which is poor in accuracy. Also, from the ROC analysis, the ALC cut offs at CD4 count ≤ 200/μL (Sensitivity-83.87%, specificity-81.41%) and CD4 count ≤ 350/μL (Sensitivity-80.22%, specificity-86.44%) were ≤ 1450/μL and ≤ 1650/μL respectively. *Conclusion:* ALC has a strong correlation with CD4 count and the ALC cut offs corresponding to CD4 counts ≤ 200/μL and CD4 count ≤ 350/μL were ≤ 1450/μL and ≤ 1650/μL, respectively. But ALC did not have a good correlation with CD4 percentage. Hence, ALC is a credible alternate marker for CD4 count, but not for CD4 percentage.

Keywords: Absolute Lymphocyte Count; CD4 Count.

Introduction

CD4 cell count is one of the most important clinical parameters used to determine the timing of initiation of HAART (Highly active anti-retroviral therapy), measuring the efficacy of anti-retroviral therapy and prophylaxis against opportunistic infections. The latest WHO (World Health Organization) guidelines state that as a priority, HAART should be initiated in adults infected with HIV with CD4 count ≤ 350/ μL [1]. CD4 percentage is occasionally useful while evaluating significant reductions in an individual's CD4 count, which may be associated with transient lymphopenia due to inter-current infection or pregnancy [2]. Prophylaxis of opportunistic infections is also dependent on CD4 percentage, when it falls below 20% [3]. But these clinical estimations are not available to all and not affordable by all in financially constrained regions like Asia and Africa which also happen to inhabit about two-thirds of the HIV- positive population [4]. In lieu of this problem, the World Health Organization (WHO) in 2002 suggested that ALC can be used as a surrogate marker for CD4 count in settings where the latter is not available. WHO recommended using a TLC of 1200 cells/μLas a surrogate marker

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for a CD4 count of 200 cells/ μLfor initiation of HAART [5]. Although the present guidelines do not mention the ALC cut off corresponding to CD4 count ≤ 350/ μL, but the debate regarding the use of ALC as a proxy marker for CD4 count in economically restrained settings hasn't died down yet. Many studies have been published on this subject all over the world, but with contradicting results [6-15].

Our study was aimed to determine the correlation of ALC with CD4 count and CD4 percentage respectively, and if any correlation existed, then to study the corresponding cut off values of ALC with maximum correlation at CD4 count ≤ 200/ μL, CD4 count ≤350/μL and CD4 percentage ≤20%, respectively.

Materials and Methods

This cross-sectional study was conducted in the Clinical Laboratory of Kasturba Hospital, a tertiary care hospital in Coastal Karnataka. All the HIV positive patients reporting to our hospital from 1st January 2015 to 30th June 2015 (6 months) were included in our study. Patients from the paediatric age group (<10 years of age) were excluded. Demographic details like age and gender of the patients were noted down. Finally a total of 455 blood samples were analyzed. A single sample of EDTA blood was collected for evaluating absolute lymphocyte count (ALC), CD4 count, CD4 percentage and CD45 count. ALC was calculated using a fully automated Coulter LH 780 Haematology Analyzer, and CD4 count, CD4 percentage and CD45 count were calculated using BD FACSCanto II Flow Cytometer.

Correlation of ALC with CD4 count and CD4 percentage was evaluated using Pearson correlation coefficient. Receiver operating characteristic (ROC) curve analysis was conducted to evaluate the diagnostic performance of ALC for predicting a CD4 count <200/ mm^3, CD4 count <350/mm^3 and CD4 percentage ≤20% respectively. Scatter plots depicting the relationship of ALC with CD4 count and CD4 percentage respectively, were also plotted. Statistical analysis was performed using SPSS software (version 21.0, SPSS, Chicago, USA).

Results

A total of 455 subjects were included in our study, of which 304 were males and 151 were females. The age of the subjects ranged from 11 to 78 years, mean age being 44 years. The median CD4 count was 258.58/μL, and it ranged from 2.72/μL to 2373/μL. The median CD4 percentage was 16.4% and the median CD45 count was 1580.68/ μL. Also the median ALC was 1600/μL, and it ranged from 100/μL to 6200/μL.

The mean ratio between CD45 and ALC was 1.03 with a standard deviation of 0.15. Hence, there was minimal error in lymphocyte count estimation while measuring ALC.

The Pearson correlation coefficient was calculated to determine any linear correlation of ALC with CD4 count and CD4 percentage, and it was found to be 0.741 and 0.276 respectively. Hence, a strong linear correlation was found between ALC and CD4 count, and a weak correlation was found between ALC and CD4 percentage. A scatter plot between CD4 count and ALC is shown in Figure 1, and that between ALC and CD4 percentage in Figure 2.

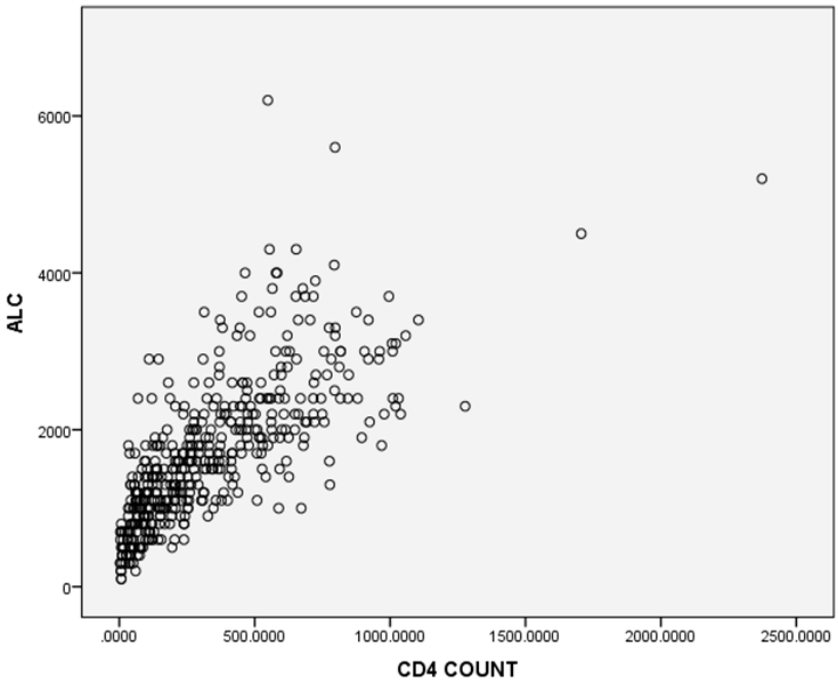

Fig. 1: Scatter diagram between CD4 count and ALC

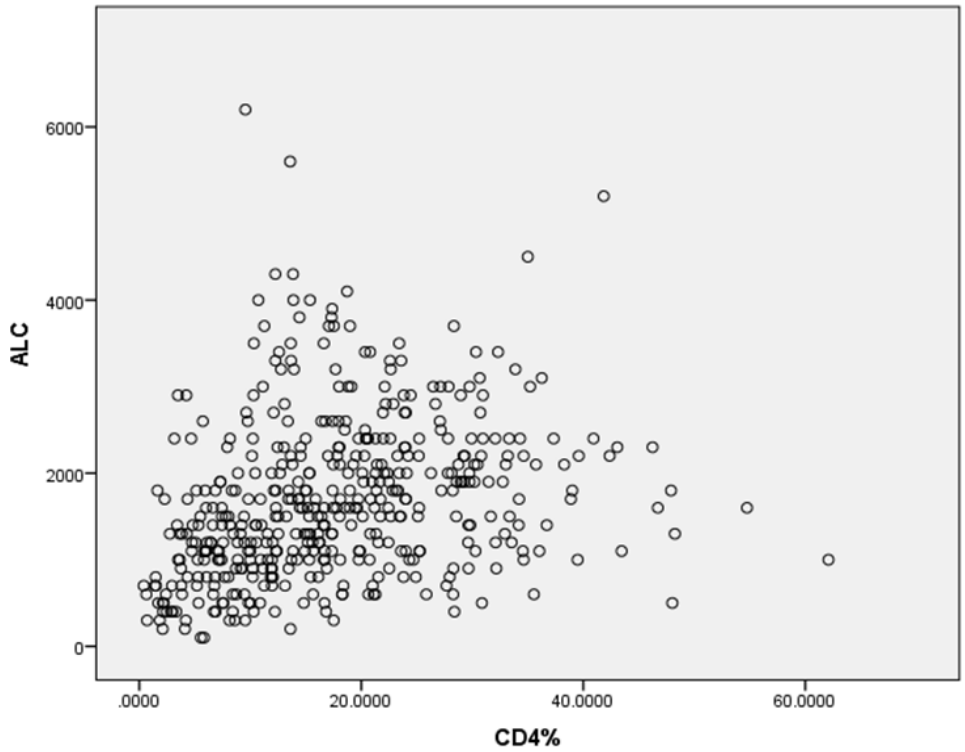

Fig. 2: Scatter diagram between CD4 percentage and ALC

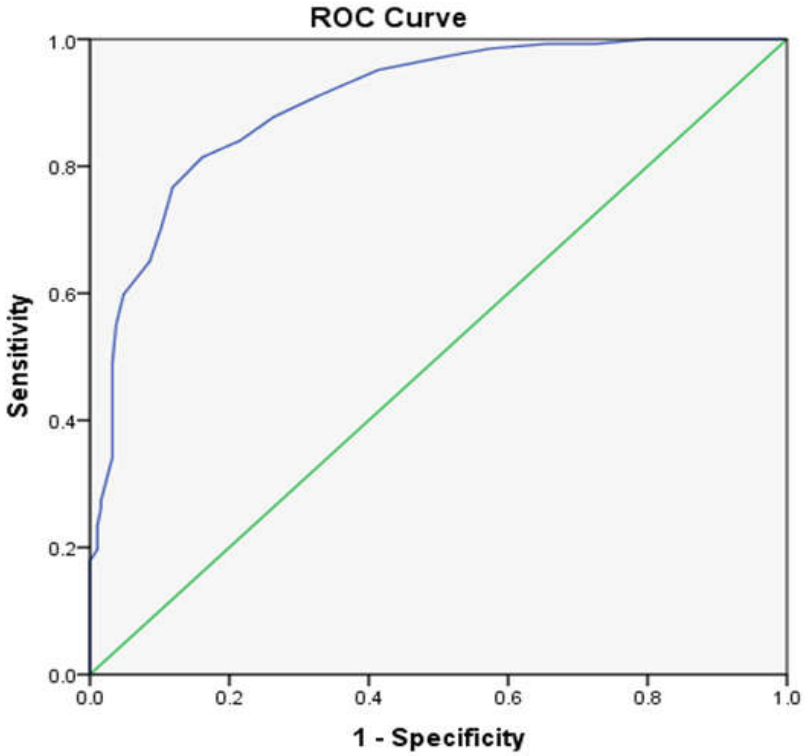

Fig. 3: ROC curve between ALC and CD4 countd″200/μL

The ROC curve was drawn between ALC and CD4 count ≤ 200/μL (Figure 3), and the area under the curve was calculated to be 0.901 (95% CI, 0.872-0.929). Therefore, ALC can be considered as an excellent predictor of the outcome at CD4 count ≤ 200/μL. Also, the optimum cut off value for ALC corresponding with CD4 count ≤ 200/μL would be 1450/μL (Table 1).

Table 1: Ability of ALC to predict CD4 count ≤ 200/μL

Statistic	Value	95% CI
Sensitivity	83.87%	0.777-0.888
Specificity	81.41%	0.762-0.858
Positive Predictive Value	75.73%	0.692-0.814
Negative Predictive Value	87.95%	0.832-0.917

Table 2: Ability of ALC to predict CD4 count ≤ 350/μL

Statistic	Value	95% CI
Sensitivity	80.22%	0.750-0.847
Specificity	86.44%	0.805-0.911
Positive Predictive Value	90.28%	0.858-0.936
Negative Predictive Value	73.56%	0.6701-0.794

The ROC curve was also drawn between ALC and CD4 count ≤ 350/μL (Figure 4), and the area under the curve was calculated to be 0.911 (95% CI, 0.885-0.937). Therefore, ALC is an excellent predictor of the outcome at CD4 count ≤ 350/μLalso. Moreover, the optimum cut off value for ALC corresponding with CD4 count ≤ 350/μL is 1650/μL (Table 2).

The ROC curve was drawn between ALC and CD4 percentage ≤ 20% (shown in Figure 5), and the area under the curve was calculated to be 0.659 (95% CI, 0.608-0.710). Hence, ALC is a poor predictor of the outcome at CD4 percentage ≤ 20%. Also, the optimum cut off value for ALC corresponding with CD4 percentage ≤ 20% would be 1650/μL (see Table 3).

Table 3: Ability of ALC to predict CD4 percentage ≤ 20%

Statistic	Value	95% CI
Sensitivity	64.3%	0.608-0.710
Specificity	65.2%	0.608-0.710
Positive Predictive Value	51.9%	0.449-0.590
Negative Predictive Value	75.7%	0.698-0.810

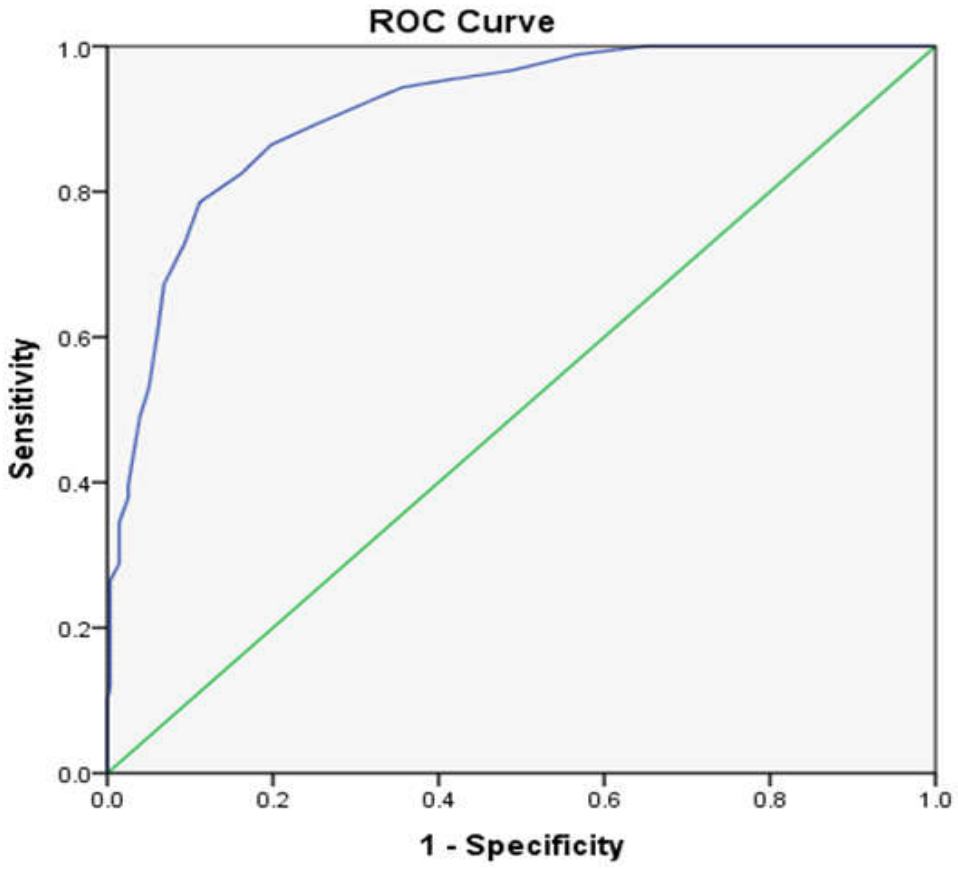

Fig. 4: ROC curve between ALC and CD4 count ≤ 350/μL

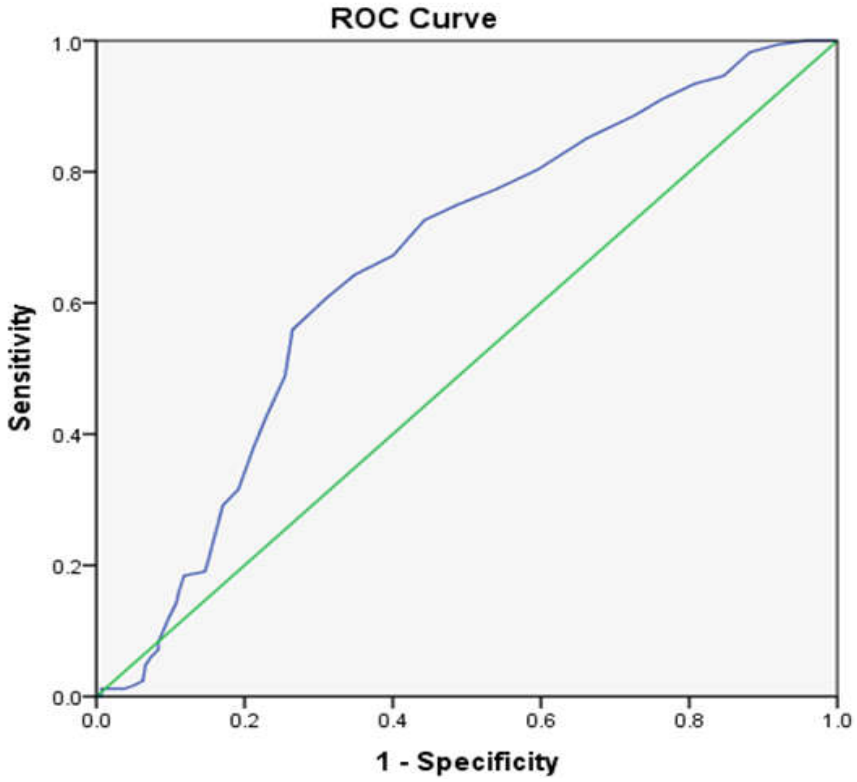

Fig. 5: ROC curve between ALC and CD4 percentd"20%

There were 54.7% of patients with an ALC ≤ 1450/μL and 45.3% patients with an ALC > 1450/μL. There were 59.1% patients with CD4 count ≤ 200/μL and 40.1% patients with CD4 count > 200/μL. Table 4 depicts the distribution of ALC with respect to CD4 count at CD4 count ≤ 200/μL.

There were 45.7% of patients with an ALC ≤ 1650/μL and 54.3% patients with an ALC>1650/μL. There were 38.9% patients with CD4 count ≤ 350/μL and 61.1% patients with CD4 count>350/μL. Table 5 depicts the distribution of ALC with respect to CD4 count at CD4 count ≤ 350/μL.

There were 45.7% of patients with an ALC ≤1650/μL and 54.3% patients with an ALC>1650/μL. There were 36.9% patients with CD4 percent ≤ 20% and 63.1% patients with CD4 percent>20%.

Table 4: Distribution of ALC with respect to CD4 count at CD4 count ≤ 200/μL

	CD4 count≤200/μL (n=269)	**CD4 count>200/μL(n=186)**
ALC≤1450/μL (n=249)	88.0% (219)	12.0%(30)
ALC>1450/μL (n=206)	24.3%(50)	75.7%(156)

Table 5: Distribution of ALC with respect to CD4 count at CD4 count ≤ 350/μL

	CD4 count≤350/μL (n=177)	**CD4 count>350/μL(n=278)**
ALC≤1650/μL (n=208)	73.6% (153)	26.4% (55)
ALC>1650/μL (n=247)	9.7% (24)	90.3% (223)

Table 6: Distribution of ALC with respect to CD4 percentage at CD4 percent ≤ 20%

	CD4%≤20% (n=168)	**CD4%>20%(n=287)**
ALC≤1650/μL (n=208)	51.9%(108)	48.1% (100)
ALC>1650/μL (n=247)	24.3% (60)	75.7% (187)

Discussion

CD4 count and percentage are cardinal aids in the management of an AIDS patient. But, these are expensive investigations, which are not readily available or affordable in developing and under-developed countries, where majority of HIV-positive patients reside. Hence, it becomes necessary to find a substitute marker which is inexpensive, easily retrievable and clinically plausible, but at the same time provides accuracy similar to the gold-standard, in order to provide quality healthcare to the patients. To overcome this problem, WHO has recommended that irrespective of the CD4 cell count, ART can be started on patients who have WHO stage III or IV disease and on patients who have WHO stage II disease with an ALC of ≤ 1200 /μL (which can substitute CD4 cell count of ≤ 200/μL), especially in resource constrained areas [5].

In our study, we found a strong correlation between ALC and CD4 count (Pearson correlation coefficient=0.741), but a weak correlation between ALC and CD4 percentage (r=0.276). Several authors have found varying results in this respect. A good correlation between ALC and CD4 count has been observed by workers from India like Kumaraswamy et al. [6] (r=0.744), Jain et al.[7](r=0.77) and Gogia et al.[8] (r=0.714), and also by workers from other parts of the world like Beck et al. in England[9] (r=0.76), Ryste et al. in South Africa[10] (r=0.70), Chen et al. in China[11] (r=0.60) and Badri & Wood in South Africa[12] (r=0.61). In contrast, some authors did not find a very strong correlation between CD4 count and ALC, like Akinola et al.[13] (r=0.43), Sagar et al.[14] (r=0.38) and Angelo et al. [15] (r=0.581).

Similar to our results, studies conducted by Gogia et al.[8], Angelo et al.[15] (r= -0.019), Beck et al.[9], Blatt et al.[16] and Van Der Ryst et al.[18] also found either a poor correlation or no correlation between ALC and CD4 percentage.

The variability of results can be accounted by ethnic differences, diurnal variation, inter-current illness and age differences. For example, CD4 counts in HIV-infected Asians have been reported to be lower than those of European and North American HIV-infected patients. Some studies have also shown that West African adults have physiological lymphocytosis which leads to higher ALC and CD4 counts as compared to those of Europeans [7].

In our study, we also found out the ALC cut off value corresponding to CD4 count ≤ 200/μL, CD4 count ≤350/μL and CD4 percent ≤20% respectively. CD4 count ≤ 200/μL corresponds to a cut-off value of ALC ≤ 1450/μL in our study. Kumaraswamy et al.[6] found a cut off value of ALC ≤ 1400/μL, Jain et al.[7] found a cut off of ALC ≤1700/μL, Gogia et al.[8] found a cut off of ALC ≤ 1520/μL in India. Blatt et al.[16] found a cut off of ALC ≤ 1400/μL in USA, Mwamburi et al.[18] found a cut off of ALCd"1500/μL in USA, Stebbing et al.[19] found a cut off of ALC ≤ 1500/μL in London and Spaeck et al.[20] found a cut off of ALC ≤ 1200/μL in USA, corresponding to CD4 count ≤ 200/μL.

CD4 count ≤350/μL corresponds to a cut off of ALC ≤1650/μL in our study. Kumaraswamy et al.[6] found that ALC ≤ 1700/μL was suitable for predicting CD4 count ≤ 350/μL in India (Sensitivity 70%, specificity 86%, PPV 86%, NPV 69%). Moore et al.[21] found an ALC threshold of 2250 cells/μL as the most accurate predictor of CD4 cell count ≤ 350/μL in Uganda (Sensitivity 81% and specificity 54%). Chen et al.[11] found that ALC ≤ 1570/μL corresponded to CD4 count ≤ 350/μL in a study conducted in China (Sensitivity 65% and specificity 80%).

Also, we found that CD4 percent ≤ 20% corresponds to ALC ≤ 1650/μL with a significant compromise in sensitivity (64.3%) and specificity (65.2%).

Pertaining to the variations in region-wise results and in CD4 cell counts seen among patients of different ethnic and geographic backgrounds, there is need to establish region-wise ALC cut offs. The major limitation of our study was a small sample size. Hence, larger studies should be done to reproduce and confirm these results.

The cost of CD4 analysis imposes a tremendous economic burden on the patients suffering from HIV infection. On the basis of our study, ALC can be used as an inexpensive alternative to reduce the financial burden of the patients.

Conclusion

Our study suggests a strong correlation between ALC and CD4 count (Pearson correlation coefficient=0.741) which is statistically and clinically significant. But there is a very weak correlation between ALC and CD4 percentage. Hence, ALC can be used as a substitute marker for CD4 count, but not for CD4 percentage. We would recommend a cut off of ALC ≤ 1450/μL corresponding to CD4 count ≤ 200/μL, and ALC ≤ 1650/μL corresponding to CD4 count ≤ 350/μL.

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A Profile of Fatal Snakebite Cases in Rural Mandya: A Retrospective Study

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Abstract

Introduction: Deaths resulting from snake envenomation is a public health problem particularly in rural India. Varieties of venomous snakes inhabit in India which take thousands of human lives every year. Establishing the accurate database of snakebite in humans from rural areas of India lackcertainty due to difficulty in the accessibility to health care, lack of proper reporting system, management of snakebite cases by untrained quacks and deaths prior to reaching hospital. Snakebite deaths are routinely subjected to autopsy for compensatory claims from the government as wild animal attacks. The WHO reported that in some countries the degree of under-reporting is greater than 70% especially in rural areas with poor infrastructure. In this context the present study was undertaken in our setup to see the extension of problem incorporated in our area. *Materials and Methods:* This is a retrospective descriptive study conducted from January 2014 to December 2017 at the Department of Forensic Medicine, Adichunchanagiri Institute of Medical Sciences, B G Nagara, Mandya district, Karnataka. The incidence and determinants of snakebite related mortality with reference to sex, age, occupation, season, time, place, site of bite, envenomation type and hospital treatment, history prior to the death and cause of death were recorded and the data was analyzed by using Excel 2010 and SPSS (Version 23) software and the results were expressed in percentages. *Results:* Amongst 23 fatal snakebite cases, 52.2% were males, the vulnerable age group were those in 31-60 years age group, farmers (43.5%) weremostly commonly affected, maximum number of deaths reported during rainy season (39.1%)and occurred during morning hours (30.5%) and most cases (82.6%) suffered outdoor bites. The lower limb (78.3%) was themost common site of biteand most common type of envenomation was vasculotoxic (56.6%). Haemorrhagic shock (47.8%)was the most common cause of death and only 56.5% received treatment in hospital. *Conclusion:* Snakebite is invariably an accident. As it is an accident, it can be avoided in many cases, but need some judicious, timely precautions to avoid the risk of snakebite and mortality associated with it. People should be made aware of such preventive measures by educating them.

Keywords: Snakebite; Rural Area; Death.

Introduction

There are 2400 species of snakes distributed around the world; of them 10% are venomous [1]. Amongst 52 poisonous species are reported to be found in India [2]. In this majority of bites and consequent mortality is attributable to only 5 species viz. *Bungarus caeruleus* (krait), *Ophiophagus hannah* (king cobra), *Naja Naja* (common cobra), *Daboia rusellii* (Russell's viper) and *Echis carinatae* (saw-scaled viper). WHO said, the available epidemiological data are fragmented and lack both resolution and completeness. Despite such shortfalls with the available data, it is estimated that more than 4.5-5.4 million people in the world suffer snakebite every year, among them that 1.8–2.7 million of them develop clinical illness (envenoming) after snakebite, and the death toll could range from 81,000 to 138,000 [3]. The distribution of envenoming and mortality worldwide is variable; while numerically lowest in Europe, Australia and North America, it is highest in sub-Saharan Africa, South Asia and South-East Asia. This is also where most of the world's

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population lives, bringing humans and snakes into direct conflict. Surveys in India have also shown that the scale of this problem is far greater than suggested by hospital-based statistics and that these global figures greatly underestimate the actual incidence of snakebite envenoming and the resultingmortality and disability. Further the accuracy is still more reduced by the fact that many victims in the rural areas, do not attend health centers or hospitals, and instead rely on traditional treatments. If the victim survives the incident, he/shewill never turn up, but if death occurs, it will be reported to legal authority for conducting autopsy and to claim compensation from government as wild animal attacks. Such reporting helps the autopsy surgeon to know the exact number of deaths occurring in respected jurisdiction by snake bite. In this context the present was undertaken in our setup to know the incidence and determinants of snake bite related mortality.

Materials and Methods

This is a retrospective descriptive study conducted on all fatal cases of snakebite autopsied during January 2014 to December 2017 at Department of Forensic Medicine, AIMS, BG Nagara, Mandya district were included. A detailed review of the first information report, post mortem report and medical records were done to collect the information regarding the incidence and determinants of snakebite related mortality with reference to sex, age, occupation, season, time, place, site of bite, envenomation type and hospital treatment history prior to the death and cause of death were recorded. The data was analyzed by using Excel 2010. and SPSS (Version 23) software and the results were expressed in percentages.

Results

A total of 596 autopsies were conducted during the study period, amongst 23 (3.86%) fatal snakebitecases were reported (Table 1). Maximum number of fatal snakebite cases occurred in the year 2017 (39.1% cases). In relation to sex 52.2% were males and 47.8% females, the vulnerable age group among both men and women were those in the 31- 60 years age group (65.2%), (Table2). By occupation, 43.5% were farmers, 26.1% were homemakers, 21.7% were children and 8.7% were labourers, (Table 3). In relation to season (Table 4), maximum number of deaths reported during rainy season (39.1%) followed by autumn and summer (21.7% each). The peak incidence of snakebite occurred during morning hours (30.5%) and most cases (82.6%) suffered outdoor bites (Table 5,6). The lower limb (78.3%) was themost common site of bite (Table 7). The most common type of envenomation was vasculotoxic (56.6%). Haemorrhagic shock (47.8%)was the most common cause of death followed byrespiratory failure (39.1%), multi organ dysfunction (8.8%) and neurogenic shock(4.3%), (Table 8). Among the victims, 56.5% received treatment in hospital, 17.3% from quacks and the remaining 26.1% not received treatment in time and /or died before reaching hospital (Table 9).

Table 1: Profile of fatal snakebites among autopsy conducted during study period

Year	No of Post Mortem conducted	Total fatalities due to snakebite
2014	130	3
2015	157	5
2016	151	6
2017	158	9
Total	596	23

Table 2: Age and Sex wise distribution of cases

Age (Years)	Male	Female	Total	Percentage
0-18	3	2	5	21.7
19-30	1	0	1	4.3
31-60	7	8	15	65.2
>61	1	1	2	8.7
Total	12	11	23	100.0

Table 3: Occupation wise distribution of cases

Occupation	Frequency	Percentage
Farmers	10	43.5
Laborer's	2	8.7
Homemakers	6	26.1
Children	5	21.7
Total	23	100.0

Table 4: Distribution of cases based on season

Season	No of cases	Percentage
Summer season (Mar to May)	5	21.7
Rainy season (Jun to Sep)	9	39.1
Autumn season (Oct to Nov)	5	21.7
Winter season (Dec to Feb)	4	17.4
Total	23	100.0

Table 5: Distribution of cases based on time of occurrence

Time of Occurrence	Frequency	Percentage
Morning	7	30.5
Afternoon	6	26.1
Evening	5	21.7
Night	5	21.7
Total	23	100.0

Table 6: Distribution of case based on place of victim at the time of bite

Indoor	**4**	**17.4**
Outdoor	19	82.6
Total	23	100.0

Table 7: Distribution of case based on site of bite

Site of Bite	Frequency	Percentage
Head and Neck	1	4.3
Upper limb	4	17.4
Lower limb	18	**78.3**
Trunk	0	0.0
Total	23	100.0

Table 8: Distribution of case based on type of envenomation of toxinand cause of death

Envenomation	Causes of Death	Frequency	Percentage	Total percentage
Neurotoxin	Respiratory failure	9	39.1	43.4
	Neurogenic Shock	1	4.3	
Vasculotoxic	Haemorrhagic Shock	11	47.8	56.6
	Multiple organ failure as a result of DIC	2	8.8	
	Total	23	100.0	

Table 9: Distribution of case based on whether patient was treated in hospital or not

	Frequency	Percentage	
Treated in hospital	13		56.5
Treated by quack medicine	4	17.4	43.5
Not treated	6	26.1	
Total	23		100.0

Discussion

A death due to snake envenomation is a public health problem particularly in rural India. The accurate database of snake-bites in rural areas is at necessity in spite of lack in certainty due to the well known facts like difficulty in the accessibility to health care, treating by quacks, lack of proper reporting system and death occurring outside health care facilities. Mohapatra B, et al., conducted a nationally representative study of 123,000 deaths from 6,671 randomly selected areas in 2001–03. A total of 562 deaths (0.47% of total deaths) were reported due to snake bites, of which 97% occurred in rural areas itself [4]. Since our medical college and hospital, a tertiary centre located in rural area, the present study thought to spot light exact extension of problem.

In the present retrospective descriptive study, all fatal cases of snake bite autopsied during January 2014 to December 2017 were included, a total of 596 autopsies were conducted during the study period and amongst, 23 cases were fatal snakebite cases. Table 1, shows increase in the rate of incidence every year towards the maximum number (39.1%) of cases in the year 2017. Of total, 52.2%were males and 47.8% were females with sex ratio of 1.09:1. The vulnerable age groups among them were those in the 31- 60 years (65.2%). The reason could be attributed to the fact that they form the productive age group and population (Table 2).

In an epidemiological field survey by Hati AK et al., on snake bite was conducted on 26 randomly selected villages with a population of 18,892 in the district of Burdwan, West Bengal India. He reported, males (54.72%) were bitten more than females (45.23%) and highest incidence of snake bite was found in the age group of 21-30 years [5]. In a similar study by Kumar AGV et al., reported, 69.1% of cases involved were males and 30.9% cases were females and maximum number of victims were in the age group of 41-50 years (33.8%), followed by 21-30 years (25%) [6]. In another study, Mohapatra B, et al., reported that, death is more common in males (59%) than females (41%) and peaked at ages 15–29 years [4].

The occupations (Table 3) of the majority of the cases in our study were farmers (43.5%), followed by homemakers (26.1%), children (21.7%) and labourers (8.7%). 39.1% of snakebite fatalities occurred during rainy season, i.e. in the month of June to September followed by 21.7% eachin autumn and summer season (Table 4).The peak incidence of snakebite occurred during morning hours (30.5%) and most cases (82.6%) suffered outdoor bites (Table 5,6). The lower limb (78.3%) was themost common site of bite (Table 7).

However it is as well know fact the majority of the rural population in India is dependent on the farming. Hence adults and children are often employed in the farm fields in early hoursduring raining season. Snakes tend to get attracted to agricultural areas, such as paddy fields, where they can find abundant food sources, such as rodents, which results in increase risk of making contact with snakes and this coupled with bare foot walking in the fields makes foot an easy accessible area for snake bite.

In a study by Hati et al., said snake bite cases occurs during the months of July and August.

Majority of the snake bites (53%) were encountered in the lower extremities [5]. Kumar AGV et al.,reportedmaximum number of cases occurs duringrainy season (60.3%), majority of the farmers (45.6%) become victims because during this period there is intense agricultural activity in the field. The peak incidence of snake bite occurred during night hours (63.2%) and most cases (70.6%) suffered outdoor bites and affected mainly the lower limbs (70.6%) [6].

Even though the incidences occurred commonly in farmer's peaking during the monsoon and outdoor bites as mentioned in other studies, contrarily, Snake bites were common in the day time hours in our study. This result was in accordance with Chattopadhyay et al., in his study reported that "Majority of the incidences occurred during the monsoon periods and at day time with male preference of age group 21–30 years [7].

Aramani CS et al., in his study quoted that snake bites and snake bite fatalities peak during the monsoon season, probably reflecting agricultural activity, flooding, increased snake activity, and abundance of their natural prey [8].

In our study, the most common type of envenomation was vasculotoxic (52.2%). Haemorrhagic shock (47.8%)was the most common cause of death followed byrespiratory failure (43.5%), multi organ dysfunction (8.8%)consequent upon disseminated intravascular coagulopathy and neurogenic shock (4.3%) (Table 8). Among the victims, 56.5% received treatment in hospital, 17.3% from quacks and the remaining 26.1% did not receive treatment in timeand/or died before reaching hospital (Table 9).

In a study by Kumar AGV et al., The most common type of envenomation was neurotoxic (76.5%) and cause for death was respiratory failure. Common krait was responsible for maximum mortality (61.8%) [6]. It is in contrast to our findings, however our results were corresponding to the findings of the study by Aramani CS et al,. In his study, the most common type of envenomation was vasculotoxic (37.02%), only 6.14 were neurotoxic and remaining were nonpoisonous snakes [8]. However, in our study, the exact type of snake was not known in most of the cases, among known, 4 cases had cobra bite and 3 cases had common krait bite and 2 cases were due to saw-scalded viper bite. It may be attributed to lack of awareness of the public or snake could not be traced out. In the present study, we observed an increase in number of deaths due to snake bite every year and nearly half of fatal cases (43.5%) still failing to reach hospital within the reasonable time to get a proper care and orthey depend on potentially dangerous traditional treatments such as tight ligatures (tourniquets), incisions, suction and application of herbs, ice, chemicals, "snakestones" etc.andthis situation is not different in any rural part of India. At the same time, the lower level of health care facility which often are inadequately equipped and staffed in rural areas must be made to cope with the emergency services which may include adequate staff, a range of medical skills, equipment's, anti-venom etc [9].

Conclusion

Snakebite is invariably an accident. As it is an accident, it can be avoided in many cases, but need some judicious, timely precautions to avoid the risk of snakebites. People should be made aware of such preventive measures by educating about the local snakes, sort of places where they like to live and hide, at what times of year, at what times of day or in what kinds of weather they are most likely to be active. This helps to curtail many numbers of fatal incidences.

Still due the lack of knowledge and awareness among the public, the effort of government is going in vein in reducing deaths due to snake bite. So creating awareness and knowledge through media, street plays, or by educators/health workers, NGO's etc. may help to reduce such cases.

Recommendation

Systematic reporting on snake bite must be made mandatory throughout the country to generate accurate burden of snake bite incidences in different localities. Such database can play a significant role in making better health policy by identifying the regions which require urgent attention.

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Autopsy Based Study on Pattern and Distribution of Head Injuries in Victims of Fatal Road Traffic Accidents in A Rural Tertiary Care Centre

Murali Mohan[1], Shreedhara K.C.[2], Lohith Kumar R.[3], Abhishek Yadav[4]

Abstract

Background: Road Traffic Accidents (RTA) is increasing globally and India is no exception to it. RTA affects young males commonly. Head injury was the most common site to be injured in RTAs. Road traffic accident is a preventable cause of death. Objective was to determine the pattern and distribution of head injuries in victims of fatal road traffic accidents in a rural tertiary care centre. *Material and Methods:* Retrospective record based study in rural tertiary care centre among 345 head injury subjects for the duration of 5 years was carried out. Data was analysed using SPSS 17 version software. Chi-square test was the test of significance for qualitative data. p value of <0.05 was considered as statistically significant. *Results:* 260 subjects (75.4%) were males and 85 subjects (24.6%) were females. Majority of subjects were in the age group 31 to 40 years (28.11%), followed by 21 to 30 years (19.13%). 42.61% had Frontal injury, 24.64% had parietal injury, 18.84% had temporal injury and 13.91% had occipital injury. Contusion was seen in 38.55%, Abrasion was seen in 31.01% and Lacerations of the scalp were seen in 30.43% cases. *Conclusion:* Road traffic accidents in India are on rise and deaths due to head injuries are also increasing proportionately. Males and Middle age persons are dying in RTA due to head injury. This can bear a irreparable damage to the family and its members. Most of the head injuries in the study were found to be fatal.

Keywords: Head Injuries; Road Traffic Accidents; Intracranial Hemorrhage; Contusion of Brain.

Introduction

Road Traffic Accidents (RTA) is increasing globally and India is no exception to it. RTA affects young males commonly. According to an estimate, one RTA occurs in every four minutes in India, claiming atleast 25,000 lives every year. RTA not only affects primary victims but it has got innumerable secondary victims in the form of family and relatives who suffer financially, psychologically and socially though morbidity does not reckon with these social aspects of this problem [1].

Head injury is the most common site to be injured in RTAs [2]. Road traffic accident is a preventable cause of death. The exponentially increasing number of automobile vehicles, poor adherence to traffic rules and regulations such as maintaining lane discipline, driving in zigzag patterns by public, poorly maintained and congested roads, abuse of alcohol, and lack of awareness about helmets and new generation of high speed vehicles are altogether responsible for accidents. The mechanical forces like shearing, strains and biophysical motion that occur during accidents to the head are responsible for patterns of injuries [3,4]. This study was carried out to determine the pattern and distribution of head injuries in victims of fatal road traffic accidents in a rural tertiary care centre.

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Material and Methods

This study was carried out in rural tertiary care centre, Department of Forensic medicine and Toxicology, Sri Devaraj Urs Medical College, Tamaka, Kolar. The medical college is the sole source for fatal road accidents in National Highway 75, and located 70 Kms away from Bangalore. Record based retrospective study was done from 2012 to 2017 for a period of 5 years. Sample size was estimated by using the proportion of commonest type of scalp injury was contusion 66% from the study Sreekanth S Nair et al. [4] using the formula $N = Z\alpha p (100-p)/d2$ [5], p = 66, 100 – p = 34%, d = 5. Substituting the above values minimum sample size required was 345 subjects with head injuries associated with scalp injury and fractures of skull. Institutional ethical clearance was obtained prior to the start of the study. Data was analysed using SPSS 17 version software. Categorical data was represented in the form of Frequencies and proportions. Chi-square test was the test of significance for qualitative data. p value (Probability that the result is true) of <0.05 was considered as statistically significant after assuming all the rules of statistical tests [6].

Results

In the study 345 autopsies were included, 260 subjects (75.4%) were males and 85 subjects (24.6%) were females. Majority of subjects were in the age group 31 to 40 years (28.11%), followed by 21 to 30 years (19.13%). There was no significant difference in age and gender distribution (Table 1). 42.61% had Frontal injury, 24.64% had parietal injury, 18.84% had temporal injury and 13.91% had occipital injury. There was significant association between site and type of scalp injury (Table 2). Contusion was seen in 38.55%, Abrasion was seen in 31.01% and Lacerations of the scalp were seen in 30.43% cases. Skull fractures was seen in 259 (75.07%) of subjects. Of them 43.24% had depressed fractures, 27.41% had linear and 29.34% had communited fractures. There was significant association between site and type of skull fractures (Table 3). In the present study 53.62% had

Table 1: Age and sex distribution of Head Injury Victims

Age (yrs)	Males		Females		Total	
	Count	%	Count	%	Count	%
0-10	14	5.38	8	9.41	22	6.37%
11-20	30	11.53	16	18.82	46	13.33%
21-30	46	17.69	20	23.53	66	19.13%
31-40	84	32.30	13	15.29	97	28.11%
41-50	38	14.61	12	14.12	50	14.49%
51-60	15	5.769	6	7.06	21	6.08%
61-70	23	8.84	5	5.88	28	8.11%
> 70	10	3.84	5	5.88	15	4.34%
Total	260	75.36	85	24.64	345	100%

÷ 2 = 13.4, df = 7, p = 0.0062

Table 2: Association between Site and type of Scalp injuries among Head injury subjects

	Contusion		Abrasion		Laceration		Total#	
	Count	%	Count	%	Count	%	Count	%
Frontal	66	49.62	47	43.93	34	32.38	147	42.61
Parietal	40	30.08	28	26.17	17	16.19	85	24.64
Temporal	19	14.29	13	12.15	33	31.43	65	18.84
Occipital	8	6.02	19	17.76	21	20.00	48	13.91
	133	38.55%	107	31.01%	105	30.43%	345	100%

÷ 2 = 31.63, df = 6, p <0.001*

Table 3: Association between Site and type of skull fractures among Head injury subjects

	Frontal		Parietal		Temporal		Occipital		Total #	
	Count	%	Count	%	Count	%	Count	%	Count	%
Depressed	63	52.07	27	67.50	8	20.00	14	43.75	112	43.24
Linear	31	25.62	18	45.00	17	42.50	5	15.63	71	27.41
Comminuted	27	22.31	21	52.50	15	37.50	13	40.63	76	29.34
	121	46.72	40	15.44	40	15.44	32	12.36	259	100%

÷ 2 = 67.16, df = 6, p <0.001*

Table 4: Intracranial injuries in the victims of RTA Intracranial Injury

	Number of Victims#	%
Subarachnoid haemorrhage	185	53.62
Contusions	31	8.99
Subdural haemorrhage	66	19.13
Intracerebral haemorrhage	43	12.46
Extradural haemorrhage	14	4.06
Lacerations	6	1.74
Total	345	

Combination of sites and types of were not included in tables

subarachnoid haemorrhage, 8.99% had Contusions, 19.13% had subdural haemorrhage, 12.46% had intracerebral haemorrhage, 4.06% had extradural haemorrhage and 1.74% had lacerations (Table 4).

Discussion

In the study head injuries were seen in majority among males (75.4%), middle aged subjects (31 to 40 years). This distribution suggests that males are predominantly occupied in outdoor activities to earn the livelihood of the family. Similar observations were made by Sreekanth S Nair et al. [4], in their study observed that 92.5% were males and 7.5% were females. The findings were also consistent in the studies done by Sonawane [7], Ngo Anhl [8] and Dovom [9].

Middle aged (21 to 50 years) individuals were most common age group with head injuries (61.73%) in the present study. Similar findings were made by Nair et al. [4], 64.3% were in the age group b/w 21 to 50 years. Similar observations were made by Sinha and Sengupta [10] and Salgado [11]. Age distribution in the study reconfirms the risk behaviour of males and middle aged people due to outdoor exposure for various reasons and hence more prone for Road traffic injuries with head injuries. Also restricted use of helmets can lead to exponential increase in head injuries especially among two wheelers. In our study there was no significant difference in gender and age distribution of head injury.

Most common site of scalp injury was Frontal site in 42.61%, 24.64% parietal, 18.84% temporal and 13.91% occipital. 38.55% had contusion, 31.01% had abrasion and 30.43% had laceration. Similarly Nair [4] observed that most common anatomical site of scalp injury was frontal, temporal, parietal and occipital region respectively. These findings were also consistent in the studies done by Kakaeri SR [12], Shivakumar BC [13] and Pothireddy S [14]. There was significant association between site and type of scalp injury in the present study.

Contusion was seen in 38.55%, Abrasion was seen in 31.01% and Lacerations of the scalp were seen in 30.43% cases. Skull fractures was seen in 259 (75.07%) of subjects, out of them 43.24% had depressed fractures, 27.41% had linear and 29.34% had communited fractures. There was significant association between site and type of skull fractures. In the study by Nair et al. [4], 75% had skull fractures and similar findings were made by Fimate [15]. Nair [4] found that most common type of fracture in the base of skull was linear fracture (77%) and Comminuted fracture of the base of skull was seen on 23%.

In the present study 53.62% had subarachnoid haemorrhage, 8.99% had Contusions, 19.13% had subdural haemorrhage, 12.46% had intracerebral haemorrhage, 4.06% had extradural haemorrhage and 1.74% had lacerations. In the study by Nair [4], Subarachnoid haemorrhage was noted in 90 (84.9%) cases, Subdural haemorrhage was seen in 79 (74.5%) cases, 35 cases (33.01%) showed intravertebral haemorrhage. Intraventricular haemorrhage was seen in 19 (17.92%) cases followed by extradural haemorrahage in 18 (16.98%) cases.

Conclusion

Road traffic accidents in India are on rise and deaths due to head injuries are also increasing proportionately. Males and Middle age persons are dying in RTA due to head injury. This can bear an irreparable damage to the family and its members. Most of the head injuries in the study were found to be fatal. This highlights the need for measures to ensure the safety of vehicle riders and pedestrians. Road traffic policies such as pedestrian paths, separate lanes for light motor vehicles and heavy motor vehicles, and strict

implementation of traffic rules and regulations may decrease the incidence of road traffic accidents and its fatalities. Reinforcement of Awareness regarding the importance golden hour and prompt transportation of victims to specialized trauma centres among public will be helpful in long run.

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Original Article

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Effect of Neural Mobilsation on EMG and Disabilty Index in Lumbar Radicular Pathology

Saurabh Sharma

Abstract

Background: Adverse neurodynamic tension is a commonly seen clinical condition. It is found in across all age groups. The lumbar radiculopathy can be quite disabling as well. Therefore we sought to find out the effect of neural mobilisation on muscle activity and the disability caused by this problem. *Methods*: 24 male athletes were recruited from university clinic after clinical diagnosis. They were allocated to two different arms ie experimental arm (Group A n=12, age-22.2±3.51) and conventional PT arm (Group B n=12, age 24.8±4.06). Measurements for s EMG of ipsilateral and contralateral multifidus and disability (Oswestry disability index) were taken at baseline and after 14 treatment sessions. *Results:* Mixed model ANOVA showed significant main effects for time F (1,21) = 32.11, p <0.001 and time-group interaction F (1,21) = 6.871, p = 0.016 while for group F (1,21) = 0.931, p = 0.346. there was more interaction effect in neural mobilisation group than conventional treatment group which implies that increase in ipsilateral and contralateral EMG is more in neural mobilization group. The disability index (ODI) improvement in both groups remained the same. *Conclusion:* lumbar radiculopathy patients had better clinical outcomes in terms of ipsilateral and contralateral EMG .The improvement is related to correction of the neural mobility impairment. Further studies are needed including randomized controlled trials to confirm these findings, neural mobilization effects as a standalone treatment and establish possible mechanism for neurodynamic treatment in lumbar radiculopathy.

Keywords: Lumbar Radiculopathy; Disc Herniation; Neural Mobilisation; EMG; ODI.

Introduction

Lumbar radiculopathy is a combination where there is adverse neural tension in the nerves which supply the lower quadrant. a retrospective study done on professional football players found that most of the dischernation occurred at lumbar L5 S1 level nerve root. 97% of Players were able to return to sports after average of 6.6 months after diagnosis of disc herniation. Lumbar disc herniation results in neuromuscular imbalance in the lumbar region. EMG isa important tool in development, recording and analysis of the myoelectric signals. Chronic low back pain results in lowering the lumbar multifidus myoelectric activity. Similar findings were recorded by another author who found that lumbar radiculopathy resulted in severe and extensive atrophy of the lumbar multifidus in patients with lumbar disc herniation with radiculopathy and without radiculopathy [11].

Low back exercises program resulted in increase in superficial erector spinae activity. Lumbar disc herniation results in compressive, tensile and shear loading of the neural structures. This leads to decrease inintraneural blood flow andaxoplasmic flow leading to ischaemia and impaired function [2]. External compression leads to increase intrafasciular pressure which again decreases blood flow resulting in downward spiral.

Lumbar disc herniation, osteophyte, spinal stenosis cause compressive load on the nerve fibres. Decrease in the intraneural blood flow leads to upregulation of inflammatory mediators which stimulate further pain. Inflammation also leads to

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adhesions between herniated disc and nerve root impairing nerve glide.

Neurodynamic concept was given by Shacklock in 1995 [4]. It deals with concept of interaction between physiological and mechanical systems. Body is considered tobe the container and muscular system is the interface of this neural system. During body movements the neural system undergoes mobility to compensate or adapt. The nerve glides, elongates, slides, alteration of cross-sectional area occurs, angulates as part of the bodily movements.

During early range of motion, nerve slack is taken up, midrange includes nerve gliding and in the last range nerve tension occurs. Neuraltissues possess viscoeleastic properties. If constant loading occurs there are chances that there can be plastic deformation of the nerve roots and peripheral nerves [4]. There are two techniques according to butler and Shacklock - Gliding technique and Tensile loading technique. Gliding technique also known as sliders. These are the manoeuvre causing sliding movements between the non-neural and neural structures. Wiederien RC et al. in 2002 conducted a randomised controlled trial which found that neural gliding techniques along with cervical lateral gliding were effective in reducing outcomes of pain and disability [5].

Another study demonstrated that incorporating tendon and nerve gliding techniques in the treatment protocol along with the conservative treatment reduced the need of surgical intervention by 30% in cases of carpel tunnel syndrome. Tensile loading technique – these techniques enable the neural tissue to movements which causes lengthening of nerves. These are not stretches. Tensile loading techniques are performed in an oscillatory manner gently engaging resistance during the movement thereby eliciting gentle stretching sensations [6,3]. These techniques are employed with the purpose of restoring physical capabilities of nerve so that the movements that cause lengthening of the nerve beds can be tolerated. These are contraindicated in cases with evidence of impulse conduction impairment. According to a clinical trial conducted by Kornberg & Lew in 1989 on American Rules Football players suffering from hamstring strain (Grade 1) and positive slump test, providing tensile loading techniques along with conservative management led to faster return to play [7]. EMG is a technique which involves the development, recording and analysis of myoelectric signals. In lumbar radiculopathy, neuromuscular imbalance is found in the lumbar region. Danneels et al. (2002) reported significantly lower electromyographic activity of lumbar multifidus in chronic low back patients [8]. Min et al. (2013) concluded from his study that more severe and extensive atrophy in the lumbar multifidus muscle was present in radiculopathy as compared to low back pain without radiculopathy [9]. Tobias renkawitzin 2006 study found that there is a clinical significant association exists between neuromuscular imbalance and low back pain erector spinae activity was increased in patients with low back pain. It was found that there is decrease in EMG activity of ipsilateral and contralateralerector spinae after self neurodynamic sliding technique [10].

Methodology

Subjects

Twenty four (24) referred maleathletes attended the physiotherapy clinic at JamiaMilliaIslamia, new Delhi. Patients with clinically diagnosed lower lumbar radiculopathy were recruited for the study. There was one drop out in the study as the subject got relieved with the intervention and he was not able to come to give his post intervention readings due to his busy schedule. Institutional review board gave the ethical clearance for the study.

Sample Size

The number of subjects are determined using Software G Power 3.15 using data of changes in erector spinae EMG activity from a similar study done by Giselle Horment-Lara et al. (2015). The sample size was calculated as per effect size of 1.58, alpha level of 0.05 and power (1- beta) of 0.95.

Inclusion Criteria

1. Athletes from Jamia Millia Islamia aged between 18 years and 35 years
2. Clinically diagnosed lower lumbar radiculopathy as per Luijsterburg PAJ et al. [11]:
3. Pain extending distal to knee joint
4. Increased pain on manoeuvres which increase intraabdominal pressure (IAP)
5. Positive straight leg raising test
6. Suffering from lumbar radiculopathy for 3 months or more than 3 months
7. NPRS > 4/10

8. Greater than 10 percent increase in baseline Oswestry Score

Exclusion Criterion

1. Patients with inflammatory, infectious, metabolic diseases of spine, malignancy and lumbar spinal stenosis
2. Subjects with history of vertebral fractures and spinal surgery
3. Red flag signs such as sinister pathology.
4. Subject with cardiovascular and neurological disorders

Study Design

Two arm parallel pre-test post-test experimental design.

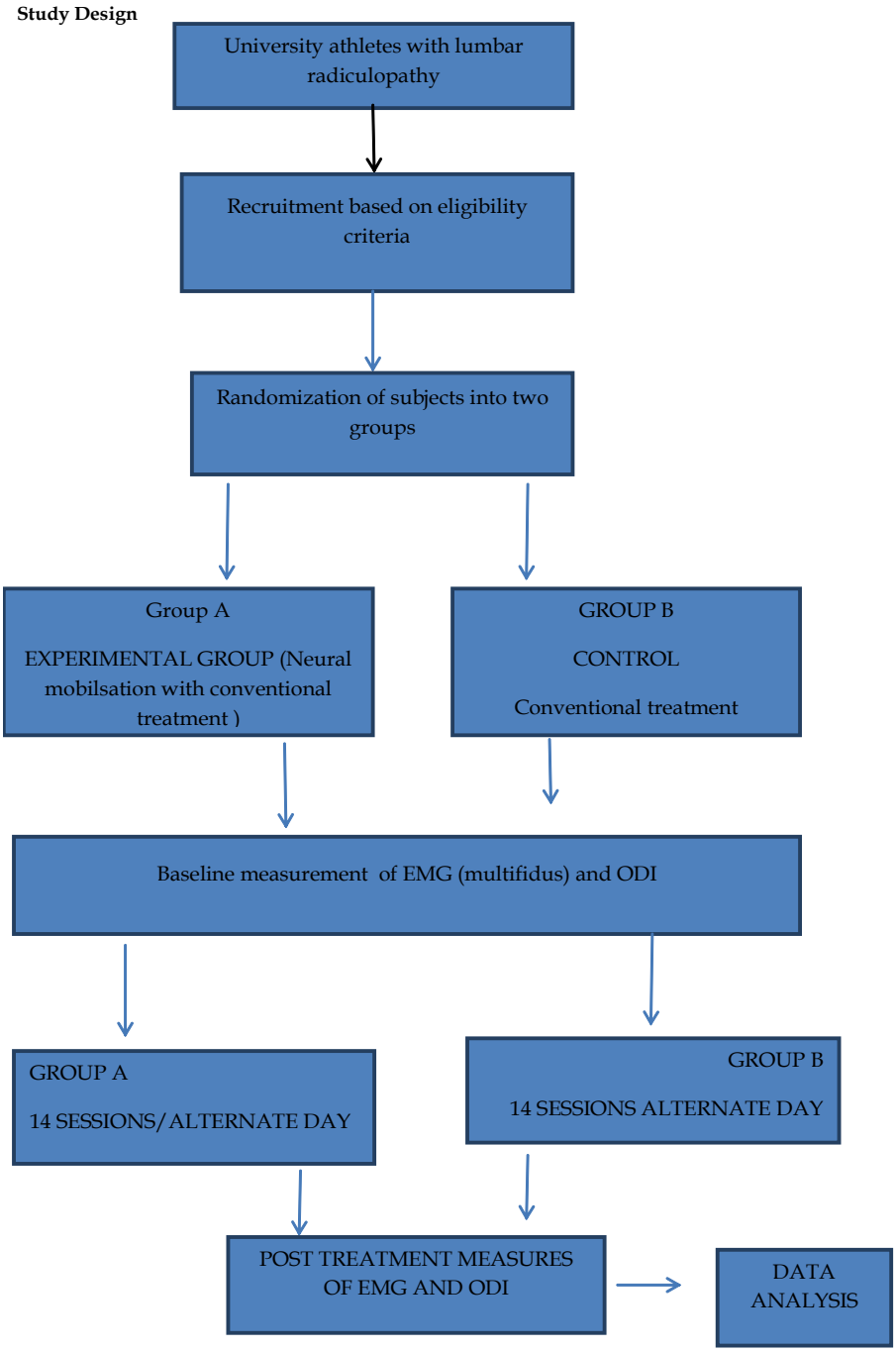

Fig. 1: Depiction of study flow from enrollment to data analysis

Independent Variables

Neural mobilization, Conventional Physiotherapy

Dependent Variables

Electromyographic (EMG) response

Oswestry Disability index (ODI)

Equipment used

AD instrument Power Lab EMG system (Australia).

Procedure for Data Collection

After recruiting patients as per inclusion criteria, written consent was obtained .confidentiality was maintained regarding details of the patient. Each patient was allocated a number to prevent revealing identity. Patients were selected on above mentioned criteria and then divided into 2 groups: group A and group B. Patients in group A were treated with neural mobilisation along with conventional therapy and patients in group B were treated with conventional treatment alone.

Fig. 2A: Ankle Plantarflexion

Fig. 2B: Ankle Dorsiflexion/Eversion

Fig. 2: Neural mobilization technique of tibial nerve A) Ankle Plantarflexion B) Ankle Dorsiflexion/Eversion

Patients on both the groups were treated for 14 sessions on alternate days (Figure 1).

Protocol

Group A: neural mobilization with conventional physiotherapy

Neural mobilization with tibial nerve bias (David S. Butler, mobilization of the nervous system). The patient was supine lying relaxed on the treatment couch with the trunk and pelvis in neutral position. The therapist was standing on the opposite side to the patient placing one hand under the ankle joint and the other above the knee joint. Affected leg was raised from the bed with knee kept in extension as in SLR testing position. This was progressed to a point where symptoms were reproduced or where the resistance to movement was encountered [12]. From this symptomatic position limb was lowered a few degrees down. At this point, ankle dorsiflexion/eversion was performed to mobilize the sciatic nerve. This was performed for 5 sets of 30 repetitions with a break of 10 seconds between the sets [3]. A total of 14 sessions on alternate days were performed. Patient response a clinical situation directed amplitude of treatment [13]. [Figure 2(a) and(b)].

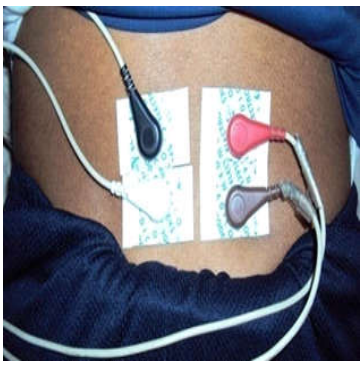

Fig. 3(a): Electrode placements for forlumbar multifidus bilateral

Fig. 3(b): Ground electrode placement

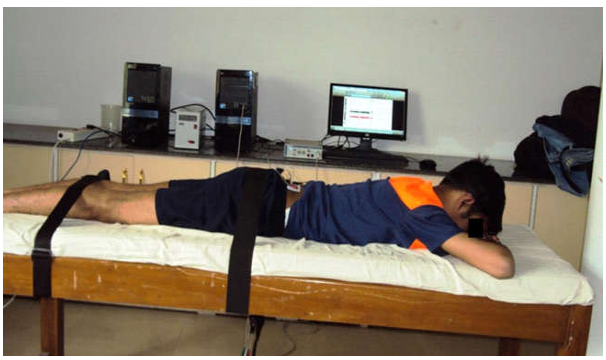

Fig. 4: Patient position for recording s EMG

Group B: Conventional Physiotherapy alone

This group received Postero – anterior lumbar spine mobilization, stretching of unilateral piriformis and bilateral rectus femoris and lumbosacral stabilization exercises for 14 sessions on alternate days 13. The program consisted of abdominal bracing, Bridging, pelvic tilts and alternate arms/legs raise(which had been shown to give clinically meaningful improvements in functional disability. Patients were asked to perform 2 sets of 10 repetitions in each session. Patient's exercise routine was progressed according to the symptoms [14].

Fig. 5: MVC procedure for lumbar multifidus

Fig. 6: AD instrument Power Lab EMG system (Lab chart, Australia)

Criterion Measures

Disposable Ag/Ag Clsurfaceelectrodes diameters of 1cm were placed on the shaved skin surface (alcohol swab wipe to decrease impedance). For lumbar multifidus, electrodes were placed lateral to the midline of the body on both the sides, above and below a line connecting both posterior superior iliac spines [8,15,16]. The inter electrode distance was kept at 2.5 cm an grounding was by placing electrode at the left superior iliac crest [Figure 3(a) and(b)].

Maximal Voluntary Contraction (MVC) Assessment

Exercise is used as a measure to normalise EMG signals. Three trials of MVIC are one before experimental test. The maximal activation of multifidus of multifidus was done by resisting the posterior aspect of scapula. Maximumeffort was put in for 5 seconds.Then 1 minute rest is given in between trials. During this five second manoeuvre only the peak 3 second period is taken for, measurement to minimise error.

Exercise procedure

The subjects were asked to lie in the prone position while resting their arms on a plinth. The patient extended the trunk as far as possible with their hands over their head and legs resting on the plinth. The isometric contraction for maintained for 5 seconds and the exercise was performed three times (Figure 4, 5).

Instrumentation

The raw surface EMG signals were band passed – filtered between 10 and 500 Hz and amplified 1000 times. The sampling frequency was 1000 Hz. The root mean square (RMS) of EMG amplitude was calculated for MVC from the prone trunk extension. The mean RMS of three MVC trials for EMG amplitudes obtained normalization of data (%MVC). The static phase of the prone trunk extension was analyzed, using

Table 1: Comparison of demographic data between groups

Variables	Group A mean±SD	Group B mean±SD	t - value	p-value
Age	22.25±3.51	24.83±4.06	1.665	0.110
Weight (kg)	65.94±7.80	65.68±5.88	0.883	0.387
Height (m)	170.83±3.56	169.67±2.87	0.094	0.926
BMI	22.80±2.16	22.83±1.72	0.033	0.974

mean of three trials for each muscle of three seconds after starting point of the holding position. The mean of root mean square (RMS) for the three repetitions of prone trunk extension after normalization (%MCV) was used for the comparison [17]. Oswestry disability questionnaire (ODI) was used to calculate low back pain related disability, Subjects were asked to fill this scale before and after 14 treatment sessions. Total score was added and calculated to help in categorization of disability (Figure 6).

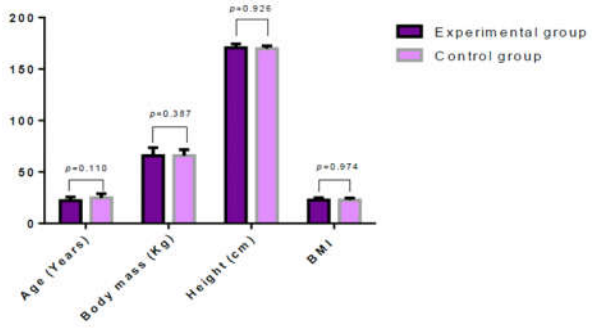

Fig. 7: Demographic data of subjects included in both groups

Statistical Analysis

The SPSS version 21.0 software program was used for data analysis. The Shapiro – Wilk test was used to verify the normality of variables distribution. Those data which did not met to normal distribution then the data was log transformed. After that mixed model analysis of variance (ANOVA) was used to compare the sEMG and ODI between the 2 groups. Independent t test was used to compare the baseline criterion measurement between the 2 groups to prove their homogeneity. The confidence interval used was 95% with level of significance set at $p<0.05$ (Table 1 and Figure 7).

Table 2: Comparison of baseline criterion measures

Variable	Group A mean±SD	Group B mean±SD	t-value	p- value
S EMG IL	72.50±28.84	73.78±25.38	0.115	0.909
S EMG CL	88.20±25.62	75.40±20.55	1.349	0.191
ODI	31.29±12.58	33.69±4.90	0.616	0.544

SEMG IL- Electromyography ipsilateral , s EMG CL -Electromyography contralateral ODI= Oswestry disability index

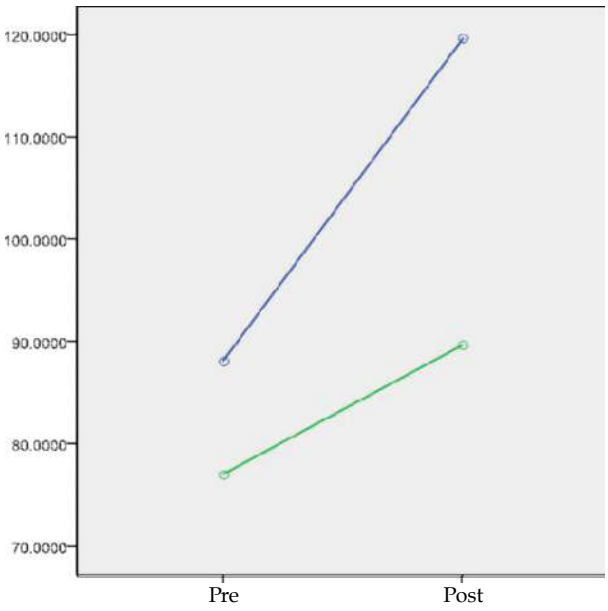

Fig. 8: Changes in surface electromyography on ipsilateral side in both the groups

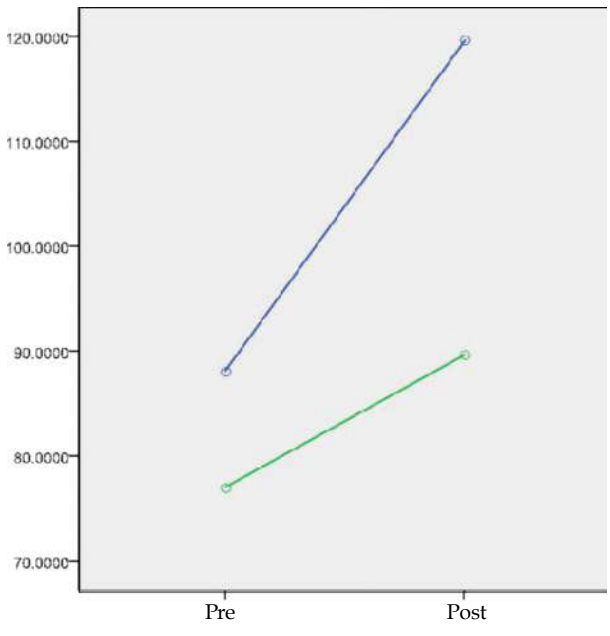

Fig. 9: Changes in surface electromyography on contralateral side in both the sides

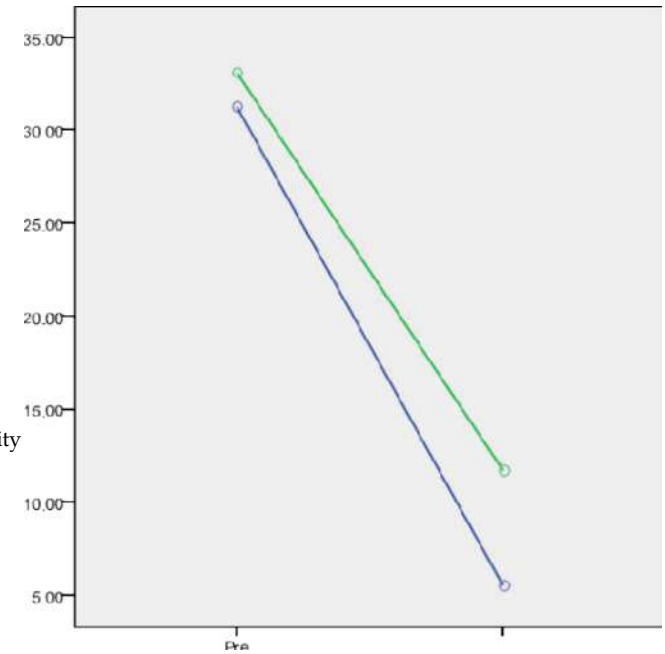

Fig. 10: Changes in Oswestry disability index score in both the groups

Table 3: Comparison of mixed model ANOVA

Variable	Source	DF	F value	Sig	Partial Eta squared
S EMG IL	Time	1	32.117	<0.001*	0.605
	Group	1	0.931	0.346	0.042
	Time group	1	6.871	<0.016*	0.247
S EMG CL	Time	1	47.291	<0.001*	0.692
	Group	1	5.208	0.033	0.199
	Time group	1	8.645	0.008*	0.292
ODI	Time	1	157.91	<0.001	0.883
	Group	1	2.384	0.138	0.102
	Time group	1	1.351	0.258	0.060

sEMG IL- Electromyography ipsilateral , sEMG CL - Electromyography contralateral ODI= Oswestry disability index
* Significant difference

Results

Comparison of baseline criterion measurement between the two groups was doneusing independent t –test to prove the homogeneity between the groups. No significant difference in surface electromyography (sEMG) and Oswestry disability Questionnaire (ODI) was found between the groups (Table 2).

Surface Electromyographic activity of ipsilateral multifidus-Mixed model ANOVA showed significant main effects for time F (1, 21) = 32.11, p <0.001 and time-group interaction F (1, 21) = 6.871, p = 0.016 while for group F (1, 21) = 0.931, p = 0.346, it was non-significant. The results showed significant improvement in sEMG IL post intervention, in boththe groups. Despite the main effect for group was insignificant, the group and time interaction showed that sEMG IL was more improved in group 1 following intervention than group 2 (Table 3) (Figure 8).

Surface Electromyographic activity of Contralateral multifidus- Mixed model ANOVA demonstrated significant main effects for time F (1,21) =47.29, p <0.001, group F (1,21) = 5.20, p = 0.033 and time – group interaction F (1,21) = 8.64, p = 0.008. The results suggested significant improvement in sEMG CL following intervention, in both the groups. Interaction effect implies that there was significantly higher improvement in group 1 post intervention as compared to group 2 (Table 3) (Figure 9).

Oswestry Disability Index (ODI)

Mixed model ANOVA showed significant main effect for time F (1, 21) =157.91, p <0.01 while for group F (1, 21) = 2.384, p = 0.138 and time × group interaction F (1,21)=1.351, p = 0.258, it was non-significant. The results showed significant improvement in functional disability post intervention, in both the groups. However, the interaction effect showed that both the groups improved in a similar pattern with time (Table 4, Figure 10).

Discussion

The purpose of this study was to examine the effect of neurodynamic technique on pain, functional disability and electrophysiology in university athletes with Lower lumbar radiculopathy. The results of this study showed that both groups had significant improvement in functional disability and muscle activation pattern of lower lumbar multifidus. All the outcome parameters were measured before and after 14 sessions of intervention in both the groups and it was found that both the groups showed significant improvement in all the parameters post intervention. However, the group which received neurodynamictechnique along with conventional physiotherapy showed greater improvement in, surface electromyography of lumbar multifidus bilaterally and as compared to the other group. But in relation to Oswestry Disability Index, both the group followed similar pattern of improvement.

Muscle activity of lumbar multifidus was evaluated bilaterally before and after 14 sessions of intervention and it was seen that after intervention surface electromyographic activity of lumbar multifidus on ipsilateral and contralateral sides improved significantly in both the groups. However, improvement was more in group receiving neural mobilisation. Danneels et al. (2002) reported significantly lower electromyographic activity of lumbar multifidus in chronic low back patients [8]. Min et al. (2013) concluded from his study that more severe and extensive atrophy in the lumbar multifidus muscle was present in radiculopathy as compared to low back pain without radiculopathy. The improvement seen in the group 2 can be explained by the effect of lumbar stabilisation exercises on lumbar multifidus [9].

Freeman 2010 demonstrated that lumbopelvic exercises provided stability of the spine. Prolonged long term exercises increase the physiologic cross sectional area of the lumbar multifidus. This also results in lesser disability. Lumbar stabilisation exercises improve strength of lumbar multifidus and prevent atrophy of multifidus in low back pain patients [19]. The outcome of our study is also in line with the study done by Puntumetakul et al. [20]. He reported significant increase in the lumbar multifidus electromyography activity after 10 weeks of lumbar stabilisation exercise program. The more increase in the group receiving neural mobilisation could be explained as a result of a modification in motor strategy after neural mobilisation.

Neural mobilisation leads to positive alteration in the motor control after neural mobilisation treatment.Neural mobilisation upregulates the discharge of the alpha motor neurons to the multifidus. Due to this the inhibit multifidus starts functioning with proportionate decreasein activity of the erector spinae. Multifidus are stabiliser group of muscles which help in maintaining neutral zone of the spine. Over this stable base larger cross sectional area erector spinae executes physiologic action.

Both groups showed clinically significant decrease in ODI scale score. Improvement in the functional disability can be attributed to the lumbar stabilisation exercises performed by subjects in both the groups. Sekendiz et al reported that stabilisation exercises help to decrease the neutral zone whichreduces the joint interplay. This gives the larger erector spinae group to work on a stable and strong background. The dual onus of physiologic action along with vertebral stability is cut short [21]. Igsoo et al. (2015) concluded from his study that Lumbar stabilization exercise is more effective than conservative treatment for improving functional disability [1]. However some studies are available which supports neural mobilisation with lumbar stabilisation exercises to be more effective in reducing functional disability than lumbar stabilisation exercises alone [22,23]. The results in the present study found no difference in reduction of ODI between the two groups.

Clinical relevance of the study- Neurodynamic technique can be used as an advanced physiotherapy procedure which provider quicker relief in athletes. Clinically, these results may also have implications for the selection of neurodynamic techniques as a treatment protocol for managing lumbar radiculopathy in athletes. Utilising this technique for managing lumbar radiculopathy will help in avoiding unnecessary

operative management in athlete. This will help an athlete to return to his sport as early as possible.

Limitations of the study-No long term follow up were taken to determine the sustainability of results. Results of this study cannot be generalized to all the all patients and athletes suffering from lumbar radiculopathy as the subjects included in the study were of non-elite level

From this study, we conclude that neurodynamic techniques have a positive effect on the electrophysiological parameters likesurface electromyographic activity of lumbar multifidus. Also, we found that neurodynamic techniques when added to the conventional physiotherapy were more efficient in reducing pain and functional disability in athletes suffering from lumbar radiculopathy. Hence, for the effective management of lumbar radiculopathy, neurodynamic technique should be combined with conventional treatment protocol.

Conclusion

The study concludes that neurodynamic techniques have a positive effect on the electrophysiological parameters like surface electromyographic activity of lumbar multifidus. Also, the study demonstrated found that neurodynamic techniques, when added to the conventional physiotherapy, were more efficient in reducing pain and functional disability in athletes suffering from lumbar radiculopathy. Hence, for the effective management of lumbar radiculopathy, the neurodynamic technique should be combined with the conventional treatment protocol.

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Pattern of Homicidal Deaths in Autopsies Conducted at Rural Tertiary Care Centre

Murali Mohan[1], Shreedhara K.C.[2], Abhishek Yadav[3], Lohith Kumar R.[4]

Abstract

Background: Killing of human being is one of the most serious of major crimes. Since very long time laws were framed by different judicial authority in a bid to prevent its further occurrence. In spite of all there has been a phenomenal rise in the incidence of homicide all over the world and also in India, perhaps due to a highly intensified struggle for survival in the face of industrialization and urbanization. This study was undertaken with and objective to study the pattern of Homicidal Deaths in Autopsies Conducted at Rural Tertiary care centre. *Material and Methods:* A Record based retrospective study was conducted at the Sri Devaraj Urs Medical College, Kolar from January 2015 to December 2017 for a period of three years. A total of 71 cases were included in the study period. Data was entered in to SPSS 17 statistical package and analyzed. *Results:* In the study 63.4% were males and 36.6% were females. Majority of subjects were in the age group 21 to 30 years (28.2%). Hard blunt weapon was commonly used in 78.9%. Majority were from rural area 60.6%. Most common finding was ligature mark in 22.5%. Most common cause of death was head injury in 23.9%. *Conclusion:* Most of the victims were in the middle age indicated social problems in the society as one of the reason. Strict enforcement of law on possession of dangerous weapons like sharp heavy cutting weapons/firearms should be made and punishment for such people should occur in the court of law.

Keywords: Homicide; Autopsy; Blunt Force; Ligature Mark; Rural Tertiary Centre.

Introduction

Homicide is considered has one of the most serious crimes in the mankind. The case of Homicide was reported as early as in Bible [1]. When an Human being is Killed by another human Being it is called as Homicide. It is one of the leading causes of Unnatural Death throughout the world. The dilemma of violent crime including that of murder has baffled equally all the developed and the underdeveloped societies of the world and it is the highest level of Aggression found in all the cultures throughout the world [2]. Since very long time laws were framed by different judicial authority in a bid to prevent its further occurrence. In spite of all there has been a phenomenal rise in the incidence of homicide all over the world and also in India, perhaps due to a highly intensified struggle for survival in the face of industrialization and urbanization [3]. This study was undertaken with and objective to study the pattern of Homicidal Deaths in Autopsies Conducted at Rural Tertiary care centre.

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Materials and Methods

A Record based retrospective study was conducted at the Sri Devaraj Urs Medical College, Kolar from January 2015 to December 2017 for a period of three

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years. All the cases which were bought to the Department of Forensic Medicine for autopsy and suspected to be a cases of Homicide by police as per the requisition given by the Investigating Officer at the Autopsy centre of the College were included in the study. A total of 71 cases were included in the study period. All the information regarding the circumstances of crime was sought from the victim's relatives and police, visits to the scenes of crime or photographs of the scene of crime was collected by the author in a structured questionnaire. The Post Mortem examination was carried out as per the standards. Data was entered in to SPSS 17 statistical package and analyzed. Categorical data was represented as Frequencies and Proportions. Institutional ethical clearance was obtained prior to the start of the study.

Results

In our study a total of 71 cases of homicide were reported and Post mortem was conducted in the study duration. Out of 71 cases, only 8 victims (2 cases in 2015, 03 cases in 2016 and 03 cases in 2017) were hospitalised and treated before death. 63.4% were males and 36.6% were females. Majority of subjects were in the age groups 21 to 30 years (28.2%), followed by 31 to 40 years (22.5%). Among both males and females majority were in the age group 21 to 30 years, 31.1% and 23.1% respectively (Table 1).

Hard blunt weapon was used in 78.9%, soft blunt weapon was used in 8.5%, sharp cutting weapon was used in 21.1%, firearms were used in 1.4% and pointed weapon was used in 1.4%. 39.4% were from urban area and 60.6% were from rural area. 19.7% had lacerations. 22.5% had ligature mark, 18.3% had contusion, 12.7% had stab injury, 23.9% had fractures, 5.6% had burns, 7% had chop wounds and 12.7% had Incised Wound/ Cut Throat (Table 2). 23.9% death was due to head injury, 18.3% due to asphyxia, 33.8% due to Hemorrhagic shock, 2.8% due to burns, 4.2% due to Cut throat injury, 1.4% due to Blunt trauma to chest, 8.5% due to natural death and 7% had unknown cause (Table 3). Head and face, neck was the most commonly injured region 28 cases, followed by involvement of more than one body region in 18 cases.

Table 1: Age and Gender distribution of subjects

Age	Male		Female		Total	
	Count	%	Count	%	Count	%
≤ 10	01	2.2	03	11.5	4	5.6
11-20	00	0.0	05	19.2	5	7.0
21-30	14	31.1	06	23.1	20	28.2
31-40	12	26.7	04	15.4	16	22.5
41-50	08	17.8	05	19.2	13	18.3
51-60	07	15.6	02	7.7	9	12.7
61-70	02	4.4	01	3.8	3	4.2
70-80	01	2.2	00	0.0	1	1.4
Total	45		26		71	100%

Table 2: Year wise distribution of Domicile and type of injury among cases

		2015		2016		2017		Total	
		Count	%	Count	%	Count	%	Count	%
Domicile	Urban	12	52.2	10	45.5	06	23.1	28	39.4
	Rural	11	47.8	12	54.5	20	76.9	43	60.6
Type of Injury	Laceration	06	26.1	07	31.8	01	3.8	14	19.7
	Ligature Mark	06	26.1	04	18.2	06	23.1	16	22.5
	Contusion	03	13.0	06	27.3	04	15.4	13	18.3
	Stab Injury	00	0.0	04	18.2	05	19.2	9	12.7
	Fractures	07	30.4	02	9.1	08	30.8	17	23.9
	Burns	01	4.3	03	13.6	00	0.0	4	5.6
	Chop Wounds	02	8.7	02	9.1	01	3.8	5	7.0
	Incised Wound/ Cut Throat	02	8.7	05	22.7	02	7.7	9	12.7

Table 3: Year wise Distribution of assault cases according to Cause of death

Cause of death	2015		2016		2017		Total	
	Count	%	Count	%	Count	%	Count	%
Head injury	07	30.4	06	27.3	04	15.4	17	23.9
Asphyxia	05	21.7	02	9.1	06	23.1	13	18.3
Hemorrhagic shock	06	26.1	07	31.8	11	42.3	24	33.8
Burns	00	0.0	02	9.1	00	0.0	2	2.8
Cut throat injury	01	4.3	02	9.1	00	0.0	3	4.2
Blunt trauma to chest	01	4.3	00	0.0	00	0.0	1	1.4
Natural death	01	4.3	01	4.5	04	15.4	6	8.5
Unknown	02	8.7	02	9.1	01	3.8	5	7.0
Total	23		22		26		71	

Discussion

During the study period out of three years from 2015 to 2017, total of 71 cases of homicide were analyzed. The maximum number of deaths occurred in the age group of 21-30 years in both gender and overall. This can be due to marital disputes, infidelity, unemployment, gang rivalry and arguments during the alcohol consumption. The death of the children was due to suicide events committed by the parents along with them being unable to cope up with poverty and low socio economic conditions. The findings of our study were found to be similar to the findings of the Hugar S [4], Scott KWM [5] and Bhupinder S [6]. The studies done by Kominato Y [7], Henderson JP [8] and Saint Martin [9] showed majority of the homicides occurred after 30 years of the age which is contrasting to our study findings. Males constituted nearly 71.5% of the total homicidal cases in our study which was similar to Hugar S [4] Alan Fox [10] and Rygol K [11]. The aggressive nature of the male could be the reason of the more homicidal deaths amongst them.

Death due to injury from Hard and soft blunt weapon was common in our study, which could be due to most of the cases of homicide were not premeditated and used the blunt weapon available at the site of the crime. Sharp weapons were the next commonly used tool for homicide. Most of the sharp weapon homicides was premeditated and involved rivalry and intension to cause fatal injury to the victims. Firearms usage was very minimal in our study due to strict rules of government regarding the selling of fire arms. The findings of our study was contrast to the findings of Hugar S [4], Wahlsten and Gupta A [12] where sharp weapon injuries was most common than blunt weapon. Majority of the injuries occurred over the head and neck, thorax region and multiple sites showed the intension of the assaulter to kill and grievously injure the victim. The pattern of the injury depended upon the instrument used in the homicide.

Conclusion

Homicidal death due to blunt injury indicated the event would have happen in the rage of anger. Most of the victims were in the middle age indicated social problems in the society as one of the reason. Strict enforcement of law on possession of dangerous weapons like sharp heavy cutting weapons/firearms should be made and punishment for such people should occur in the court of law. In the Indian scenario the investigating officer, the forensic pathologist and the judiciary system work independently and not in tandem as in the western countries where the homicide unit is constituted who share their knowledge in solving a crime. Investigating officer should work/co-ordinate with the forensic pathologist in solving homicides cases.

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[1] Flink H, Tegelberg Å, Thörn M, Lagerlöf F. Effect of oral iron supplementation on unstimulated salivary flow rate: A randomized, double-blind, placebo-controlled trial. J Oral Pathol Med 2006; 35: 540-7.

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Corporate (collective) author

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