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Indian Journal of Forensic Medicine and Pathology
Volume 16, Number 1, January-March 2023.
DOI: https://dx.doi.org/10.21088/ijfmp.0974.3383.16123.1

ORIGINAL ARTICLE

Analysis of Custodial deaths in Western Odisha

Abhishek Dash[1], Biren Xalxo[2]

ABSTRACT

Background: Death in custody is often associated with allegations of physical abuse by the police or jail authorities. Questions are always raised about violation of fundamental rights of a prisoner.

Aims: To study different epidemiological and medico legal aspects of custodial deaths.

Material and Methods: This is a five year retrospective study based on medicolegal records of custodial deaths.

Results: All the cases were male. As per manner of death 86.5% of cases were natural deaths while 13.5% of cases died due to unnatural causes. Age group of these cases were between 19 to 90 years. Maximum number of cases (29.8%) is between 51-60 years. Majority of deaths occurred in the hospital accounting for 97.29% of cases except one hanging death which occurred in police station. Majority of cases (91.9%) were in jail custody. In this study most common cause of death is chronic kidney disease which is found in 21.6% of cases. With respect to conviction status, 78.4% of cases were under trial prisoners while rest 21.6% were convicted.

Conclusion: Majority of deaths occurred due to natural causes. Proper care should be taken to reduce morbidity and mortality of prisoners.

Key message: Prior health checkup and timely medical treatment is needed to prevent custodial deaths. Maintenance of proper hygiene and steps to reduce overcrowding of jails should be done to curb the morbidity and mortality.

keywords | Chronic kidney disease; Custodial death; Natural death; Undertrial prisoner.

Author's Credentials:

[1]*Postgraduate 3rd year Student,* [2]*Assistant Professor, Department of Forensic Medicine & Toxicology, Veer Surendra Sai Institute of Medical Sciences and Research, Burla, Sambalpur 768017, Odisha, India.*

Corresponding Author:

Biren Xalxo, *Assistant Professor, Department of Forensic Medicine & Toxicology, Veer Surendra Sai Institute of Medical Sciences and Research, Burla, Sambalpur 768017, Odisha, India.*

Email: *dr.birenxalxo@gmail.com*

Received on: *10.11.2022*

Accepted on: *20.02.2023*

How to cite this article:
Abhishek Dash, Biren Xalxo/Analysis of Custodial deaths in Western Odisha. Indian J Forensic Med Pathol.2023;16(1):11-14.

INTRODUCTION

Custody is defined as any point in time when a person's freedom of movement has been denied by law enforcement agencies, such as during transport prior to booking, or during arrest, prosecution, sentencing, and correctional confinement.[5] The death of a member of the public whilst detained in police custody usually leads to intense media scrutiny and considerable public unease. Relatives of the deceased may express understandable concerns about the propriety of police behaviour and these anxieties may generate additional public disquiet.[8] It is found that the major reasons behind custodial deaths are

mainly unawareness and carelessness on the part of custodial authorities on the health status of the inmates and poor condition of the cells.[6] Sudden and unexpected death in custody is commonly associated with allegations of police misconduct, media speculation, rumours, and intense community concern.[1] Every case of custodial death must to be reported to the National Human Rights Commission (NHRC) and the police is also required to submit the findings of the magistrate's inquiry to the Commission along with the autopsy report in due time. Though most of custodial deaths are due to natural causes, but issues such as delay or negligence in seeking medical treatment, unhygienic conditions and improper healthcare facilities cannot be ruled out.

The usual questions that arise following a custodial death are whether it was natural or unnatural. If it is natural death then whether timely and proper treatment was given or not and if it is an unnatural one then whether it is suicidal, homicidal or accidental in manner. Hence meticulous autopsy should be done in such cases by panel of doctors along with videography to arrive at a conclusion based on findings.

MATERIALS AND METHODS

This is a retrospective autopsy based study on custody related deaths, during the period of five years from January 2017 to December 2021. The post-mortem examination of these cases were conducted in the mortuary of the institute, as per the guidelines laid down by the National Human Rights Commission. Postmortem reports were written in the prescribed proforma. The various records like inquest report, dead body challan, medico -legal case intimation form, bed head ticket, histopathological report and viscera report were analyzed for demographic profiles, previous history of disease or medication, signs of torture, cause, manner and place of death, and other relevant findings were taken in account. Study was done in different parameters like gender wise distribution, age group involved, cause of death, conviction status, admitted in hospital before death or brought dead etc. All the observations are tabulated and the results are compared with the previous studies done by different authors.

RESULTS

A total of 37 cases of custodial deaths were studied in this five year retrospective study. All the cases were male. As per manner of death 86.5% of cases were natural deaths while 13.5% of cases died due to unnatural causes. Age group of these cases were between 19 to 90 years. Maximum number of cases (29.8%) is between 51-60 years (Table 1).

Table 1: Age wise distribution of cases

Age group (in years)	Number of cases	Percentage (%)
11-20	1	2.7
21-30	3	8.1
31-40	8	21.6
41-50	6	16.2
51-60	11	29.8
61-70	3	8.1
71-80	3	8.1
81-90	2	5.4
Total	37	100

By religion, present study showed that 35 cases (94.5%) were Hindus and one case each belong to Muslim and Christian community. Majority of deaths occurred in the hospital accounting for 97.29% of cases except one hanging death which occurred in police station. Majority of cases (91.9%) were in jail custody (Table 2).

Table 2: Type of custody

Type of custody	Number of cases	Percentage (%)
Jail custody	34	91.9
Police custody	3	8.1
Total	37	100

With respect to conviction status, 78.4% of cases were under trial prisoners while rest 21.6% were convicted (Table 3).

Table 3: Conviction status

Conviction status	Number of cases	Percentage (%)
Convicted	8	21.6
Under trial	29	78.4

Table 4: Association of injuries

Injury	Number of cases	Percentage
Present	9	24.3%
Absent	28	75.7%

There is presence injuries in 24.3% of cases (Table 4).

In this study most common cause of death is chronic kidney disease which is found in 21.6% of cases (Table 5).

Table 5: Cause of death

	Cause of death	Number of cases	Percentage
	Acute kidney injury	2	5.4
	Acute myocardial infarction	3	8.1
	Acute respiratory distress syndrome	1	2.7
	Carcinoma lung	1	2.7
	Cirrhosis	2	5.4
	Chronic kidney disease	8	21.6
	Chronic myeloid leukaemia	1	2.7
	COVID	2	5.4
Natural	Cerebro vascular accident	2	5.4
	Extra pulmonary tuberculosis	1	2.7
	Malaria	1	2.7
	Pneumonia	2	5.4
	Pulmonary tuberculosis	1	2.7
	Severe acute respiratory illness	1	2.7
	Sickle cell disease	2	5.4
	Septicaemia	1	2.7
	Abdominal tuberculosis	1	2.7
	Tuberculosis lung	1	2.7
	Craniocerebral injury	1	2.7
Unnatural	Hanging	1	2.7
	Poisoning	2	5.4

Abbreviation: COVID=Corona virus disease

DISCUSSION

A person in the custody is under the supervision of the authorities and is dependent on them. So, any death occurring in the custody is considered to be a fault, in one way or other, on the part of the concerned authority.[6] In the present study we have retrospectively analyzed all the cases of custodial deaths that were brought for post mortem examination. Present study shows all the cases (100%) to be of male sex. Other researchers also found male preponderance.[1,3,4,6,7,9,10] This might be due to the fact that most of crimes are

usually done by male persons. With respect to manner of death 86.5% of cases died due to natural causes. Majority of authors have similar findings except Bhana BD et al. and Okoye M et al. where they have found that unnatural deaths are more common than the natural deaths. More number of natural deaths in custody may be due to unhygienic living conditions, overcrowding and lack of timely treatment. 29.8% of cases fall in the age group 51-60 years which is nearly similar with the study done by Kumar J et al. With respect to religion our study shows majority were Hindus which is consistent with the studies done by Jhamad AR and Kumar J et al. Sikhs were more common as per study conducted by Chahal PS et al. Most of the deaths occurred while in jail custody accounting for 91.9% of cases which is similar with study done by Vohra V K et al. With respect to conviction status, 78.4% of total custodial deaths were undertrial prisoners which is almost similar with Vohra VK et al. but it contradicts with the study of Kumar J et al. where majority of cases were convicted. Most of the authors agree that the majority of custodial deaths occurred in hospital.[4,6,7] Chronic kidney disease is the commonest cause of death in our study which is dissimilar with the findings of other authors where they have found tuberculosis is the most common cause of death.[4,6] Present study shows presence of injuries in 24.3% of cases which is in line with the study done by Jhamad AR et al. While Dutta S et al. found the presence of injuries in 40% of cases.

CONCLUSION

Article 21 of constitution of India states that "No person shall be deprived of his life or personal liberty except according to a procedure established by law." When the person's liberty is taken away by the state then it is the responsibility of it to protect human rights. Custodial deaths are primarily due to natural causes in developing countries. And most of them are due to lack of regular screening of diseases and delay in seeking treatment. Detailed history of the prison inmates regarding previous systemic diseases, any operation, any psychiatric illness, drug or substance abuse etc. should be obtained. Whenever necessary a prior medical evaluation should be done to prevent custodial death. Decongestion and proper fumigation of detention cells along with maintaining hygiene may help to reduce respiratory diseases. Separate dietary plan is also recommended for certain diseases like diabetes, heart diseases, chronic kidney disease, hypertension etc. The police and jail personnel should be trained for providing primary medical aid and to recognize the early signs when medical intervention is needed.

Conflict of Interest: *Nil*

Source of Funding: *Nil*

Acknowledgement: *Nil*

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STATEMENT ABOUT OWNERSHIP AND OTHER PARTICULARS

"Indian Journal of Forensic Medicine and Pathology" (See Rule 8)

1.	Place of Publication	:	Delhi
2.	Periodicity of Publication	:	Quarterly
3.	Printer's Name	:	**Dinesh Kumar Kashyap**
	Nationality	:	Indian
	Address	:	3/259, Trilokpuri, Delhi-91
4.	Publisher's Name	:	**Dinesh Kumar Kashyap**
	Nationality	:	Indian
	Address	:	3/259, Trilokpuri, Delhi-91
5	Editor's Name	:	**Dinesh Kumar Kashyap**
	Nationality	:	Indian
	Address	:	3/259, Trilokpuri, Delhi-91
6.	Name & Address of Individuals	:	**Red Flower Publication Pvt. Ltd.**
	who own the newspaper and particulars of	:	41/48, DSIDC, Pocket-II
	shareholders holding more than one per cent of the total capital		Mayur Vihar, Phase-1, Delhi-91

I, **Dinesh Kumar Kashyap**, hereby declare that the particulars given above are true to the best of my knowledge and belief.

Sd/-

(Dinesh Kumar Kashyap)

Indian Journal of Forensic Medicine and Pathology
Volume 16, Number 1, January-March 2023.
DOI: https://dx.doi.org/10.21088/ijfmp.0974.3383.16123.2

ORIGINAL ARTICLE

Firing Pin Micro-Printing for Identification of Firearm

Vikhyaat Kumar[1], Bhoopesh Kumar Sharma[2], Megha Walia[3], Vineeta Saini[4], Yogesh Sharma[5]

ABSTRACT

Any device of any kind that is built or modified to discharge a projectile of any kind using the force of an explosive or other types of energy is considered to be a firearm. The three basic components of a firearm are the breech, barrel, and stock. The firing pin and hammer are part of the breech. The firing is initiated when the hammer strikes the firing pin, which then forcefully impacts the percussion cap at the base of the cartridge containing the primary explosive substance. During this procedure, the firing pin leaves distinct markings on the percussion cap that help determine if the purported handgun can be positively or unfalsifiably identified during test firing. These markings, however, can occasionally be purposefully damaged or removed in order to lead the investigation officer or ballistic expert astray. Firing pin markings won't be useful for identification in these circumstances. The conceptual work in the current study involves using micro laser printing to engrave the serial number of firearms on the firing pin's surface as well as precise markings at the firing pin's tip. These carefully etched markings will make it easier to identify factory made weapons in shooting incident instances. However, the main goal of this effort was to increase the significance of firing pin marks for the identification and linkage of the fired cartridge case and firearm. Although there are other ways for identification, such as breech marks, extractor marks, chamber marks, etc.

KEYWORDS | Firearm; Firing Mechanism; Firing Pin; Micro-Printing; Identification; Ballistic Expert.

Author's Credentials:
[1]PG Student, [2]Professor, [3,4]Assistant Professor, Department of Forensic Science, [5]Assistant Professor, Department of Physics, SGT University, Gurugram 122505, Haryana, India.

Corresponding Author:
Bhoopesh Kumar Sharma, *Professor, Department of Forensic Science, SGT University, Gurugram 122505, Haryana, India.*

Email: *bhoopesh_fosc@sgtuniversity.org*

Received on: *21.10.2022*

Accepted on: *18.12.2022*

How to cite this article:
Vikhyaat Kumar, Bhoopesh Kumar Sharma, Megha Walia, et al./Firing Pin Micro-Printing for Identification of Firearm. Indian J Forensic Med Pathol.2023;16(1):17-23.

INTRODUCTION

Forensic ballistics is the branch of forensic science that deals with shooting incidents and examination of firearms and related evidences for the purpose of justice. A ballistic expert works on matching, and identification of empty cartridge cases and bullets to identify and link the alleged firearm.[1] In instances involving weapons and ammunition, a ballistic expert is a forensic scientist who works for the criminal justice system and provides testimony in accordance with it in court.[2]

Firearms and ballistic matching play a crucial role in criminal investigations because "every firearm tells a tale." The details required to tell their story can be found on a gun's exterior and interior as well as on the used ammunition. This information is further utilized to support

ensuing investigations and legal actions.[3] For instance, a ballistic comparison can demonstrate that a firearm was used in a murder case as well as other crimes committed abroad, which is already a sign of the weapon's routing.[4]

A firearm is a device of any description designed or adapted to discharge a projectile of any kind by the action of explosive or other forms of energy. Any firearm usually has three basic parts i.e. breech, barrel, and stock. The breech part consists of a firing pin and a hammer. During firing, the hammer strikes the firing pin and further firing pin strikes forcefully on the percussion cap located at the base of the cartridge that bears the primary explosive material to initiate the firing. During this process, the firing pin leaves specific markings (Fig. 1) on the percussion cap that aids in the positive or negative identification of the alleged firearm during test firing.[5] However, these markings sometimes may be disturbed or destroyed deliberately by using any tool to misguide the investigation officer or ballistic expert. In such cases firing pin markings will not serve the purpose of identification.[6]

Fig. 1: Showing the Comparison of firing pin marks under Stereoscopic microscope, Created after firing over the percussion cap on 0.32 caliber cartridges.

When the fired cartridge is examined then the examiner looks for certain marks those imprinted as a result of the firing pin striking the percussion cap (primer cap) or rim of the cartridge in rim fire cartridges.[7] On the other hand, when a cartridge is discharged in any firearm, very high pressure gases are generated inside the cartridge and forces the cartridge head back against the head of the breech block of the gun, imprinting the impression on the brittle material, often brass or germanium on the breech face, this creates an individual breech face markings at the base of the cartridge.[8] Similarly, the marks that are created when cartridge cases are ejected from the action block of a firearm are called ejector marks. Furthermore, the standard factory made firearms seldomly leave chamber marks on the fired ammunition when the chamber has some defects than it imprints its marks on the cartridge these types of marks are called chamber marks.[9]

However, these markings sometimes may be disturbed or destroyed deliberately to misguide the investigation officer or ballistic expert. In such cases firing pin markings will not serve the purpose of identification.[10] This conceptual work of creating specific markings at the tip of the firing pin of a firearm and engraving the serial number of the firearm on the surface of

the firing pin through micro-printing process have assisted in the identification of firearms in shooting incident cases of factory made firearms.

LITERATURE

Eight fractal dimension features and eleven geometric moment features were recovered from firing pins from five handguns of the Parabellum Vector SPI 9 mm type by Norazlina Razak et al. (2020) using the system feature fusion of fractal dimension. Five different machine learning approaches were used to classify all the features. The outcome demonstrates that the neural classifier had a 99.3% classification accuracy rate. An excellent result for automatic firearm detection is obtained when fractal dimension approaches, geometrical moments, and neural networks are combined.[11]

The position and direction of a firearm at the moment of discharge are critical, according to Valentina Manzalinia et al. (2020). The study examined the cartridge cases that were discharged from three different revolvers with three different spatial orientations (vertical upwards, horizontal, and vertical downwards). Surface topography analysis and optical microscopy were utilized to quantify the firing pin impression and define its depth and form. The direction of the rifle had a significant impact on the size and depth of the firing pin impression: rounds fired upwards produced the deepest impression, while those discharged downwards left the smallest. This behavior was attributed to the changing shape of the firing pin-primer cup contact as well as the varied pressure applied by the primer as the weapon's orientation changed. This notion has shown that a sufficient morphological and topographical analysis technique may be constructed to ascertain whether a revolver shot was fired while the weapon was held horizontally, upwards, or downwards.[12]

In comparison research by Suresh R. (2017), four 0.22 rim fire cartridges from a known source were used, and following a test fire, two of them were stereo microscopically inspected. The characteristic marks were caught by the digital camera, and the results were then acquired by performing a comparative analysis of the striations utilizing various tools and a computer system. The results were crucial in locating a specific handgun. This study was completely based upon comparison of the photomicrographs that has already been done by several researchers before.[13] The study was limited for only two types of cartridges, whereas more study is needed in this area to link a particular firearm with the alleged cartridge cases.

Guns have been marked with a code by David H. and colleagues in 2008. If the code inscribed on the spent cartridge casing can be connected to a specific firearm in a database, the job of forensic scientists and police investigators can be greatly expedited. With the present direct-writing procedure, three alternative encoding formats may be applied to a single firing pin: an alphanumeric code, a gear code, and a radial bar code. Previously, this technology only allowed for the laser machining of a single alphanumeric code on the firing pin's face.[14]

The "Kanade Lucas Tomasi" (KLT) equation was utilised by Zeno G. et al. (2001) to apply a rapid signature-based pre-selection technique. Authors utilised this method to compare the computed points' positions. In this way, when paired with the third scale of the trous wavelet, 11 of the 49 photographs from their study were in the top spot. In large part, whether or not correct matches are found in the top ranking position depends on how prominent the markings are. The top 5% of the total database, where all of the photographs were found, was used. This procedure is easy to complete and can be done quickly such that comparisons can be made in only a few seconds.[15] In order to achieve higher accuracy levels, authors recommend conducting additional study in this field with more computed points.[16,17]

MICROPRINTING, PROCEDURE AND APPLICATIONS AS A NOVEL FEATURE

The major challenge face by the ballistic experts during the examination of firing pin marks under comparison or stereo microscope, are the identification of damaged or destroyed

firing pin marks after or before firing on the percussion cap of the cartridge case. Though identification and linkage of the fired cartridge case with the alleged firearm are still very much possible with the aid of other markings such as breech face, ejector, extractor markings, etc., however, many times these markings can also be damaged to an extent by various means, making it further difficult for the expert to perform a positive examination.[18,19]Also, it is very much evident from the previous studies that in most of the cases, the firing pin marks are primarily considered as an identification tool by the forensic experts.[20]

The present concept was to engrave a specific pattern on the firing pin's tip along with a serial number of the firearm on the firing pin's surface to provide a more sophisticated, accurate, and specific identification of the firearm from the fired cartridge case (Fig. 2). This will also help the investigators further in cases where the complete firing pin of the firearm is damaged or changed to misguide the investigator. Any such change can easily be pointed out by examining the serial number on the changed firing pin to serve as a strong clue of tampering with evidence.

Fig. 2: Image of the specially designed firing pin engraved with micro-printed numbers with an enlarged view.

A specific spiral pattern was engraved with the help of micro-printing during the manufacturing process of the firing pin, and at the time of firing, when the firing pin strikes the percussion cap of the cartridge during firing, that specific pattern will be imparted on the percussion cap making it easy and specific for identification without much labor as shown in Fig. 3.

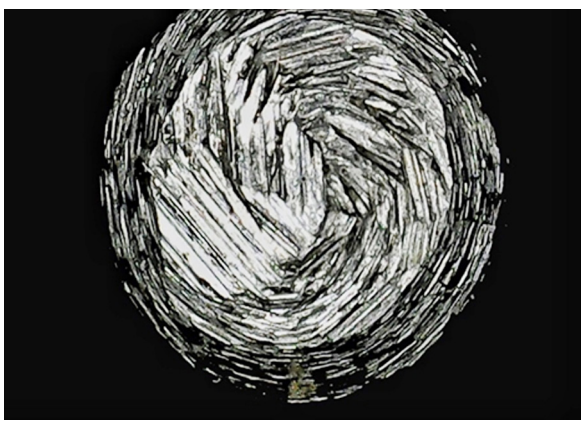

Fig. 3: The engraved markings at the tip of firing pin with the aid of Micro-Printing shown in magnified view under stereomicroscope.

MATERIALS AND METHODS

The main aim of the study was to:

- To design and inscribed a specific pattern at the tip of the firing pin with the help of Micro-laser Printing
- To conceptualize the micro-printing of the firearm serial number on the surface of the firing pin.
- To study the effectiveness of the concept in easy identification of the firearm with the help of stereomicroscope.

For the experiment an imitated firing pin of the dimension firing pin of 3.375 inches in length and diameter of 0.078 inch, the tip of the firing pin was 0.039 inches as shown in figure 3 was created with the help of an ironsmith with a special engraving on the tip of the firing pin and the surface using Micro-Laser Printing method. The ironsmith was provided with pre-design markings that need to be engraved with the help of micro-laser printing at the tip of the firing pin. The created marks were then imprinted on a hard metaling surface (aluminum and steel) and soft clay dough imitating the percussion cap of the cartridge case. The obtained marks were then analyzed using stereoscopic microscope under 50x magnification and by using a hand digital microscope.

RESULTS AND DISCUSSIONS

During the careful examination under stereomicroscope a clear, identifiable, and specific marks pertaining to the specific firing pin were observed on the hard metallic surface as well as on the soft dough clay surface (Fig. 4).

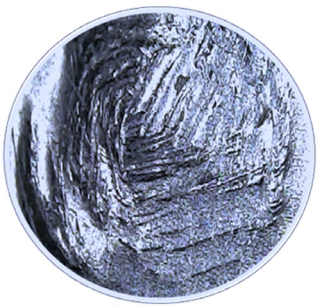

Fig. 4: The markings imprinted on the hard steel surface by the micro-printed firing pin and then examined under stereomicroscope.

From the experiment it became evident that on the harder steel and aluminum surfaces, exactly similar striations were imprinted those were engraved at the tip of imitated firing pin. Under stereomicroscope similar striation patterns were encountered and photographed and then compared with the markings created on different surfaces and it was found the concept of engraving the firing pin was quite successful and can definitely aid in more accurate and positive identification of the firearm in shooting incident cases. The marks were repeatedly imprinted on various hard surfaces as shown in fig. 5, then compared under stereomicroscope with a magnification of 50x. However, the marks imprinted on wooden surface was not as clear as on the other hard metallic surfaces (Fig. 6).

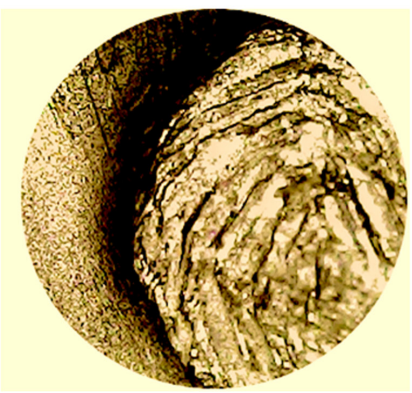

Fig. 5 and **Fig. 6:** The markings imprinted on the hard brass surface and wooden surface respectively.

CONCLUSION

In literature it was observed that there is no such phenomenon described to provide a complete identification of firing pin within a firearm as well as on the fired cartridge case. Till date, the examination is done with the aid of a comparison microscope in respect to specific markings caused by a particular firing pin of a firearm on the fired cartridge percussion cap. In this regard, a specific mechanism is needed to provide a more specific and accurate identification on the basis of firing pin marking that can link a fired cartridge case with an alleged firearm as well as which can help in identification with accuracy in cases where country made firearms are used as weapon of offence. Also, there have been instances as per the literature, where the firing pin of a firearm has been damaged/changed before the forensic examination. This problem can be addressed well when the serial number of a particular firearm will be inscribed over the firing pin along with a specific marking (that will be discussed in this concept) on the tip of the firing pin. This will definitely overcome the issues related to the examination and linkage of a firearm in a shooting incident. Forensic examiners after examination and identification can create a database of the same for further references. Also, if during manufacturing of the firearm this database is maintained, then this will be an additional proactive measure to combat the crime as well as a reactive measure to identify the shooter or the firearm. Additionally, the firing pin serial number will be provided in the license book to the license holder, which will make it further secure to prevent any improvisation in the firearm. This will be a proactive step taken by the firearm manufacturers and the license issuers to prevent the criminal activities and also tampering of the evidence later on.

Conflict of Interest: *Nil*

Source of Funding: *Nil*

Acknowledgement: *Nil*

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Indian Journal of Forensic Medicine and Pathology
Volume 16, Number 1, January-March 2023.
DOI: https://dx.doi.org/10.21088/ijfmp.0974.3383.16123.3

ORIGINAL ARTICLE

Histopathological Spectrum of Atherosclerosis and its Occurrence in Coronary Arteries in Autopsy Heart Specimens: A Record Based Study in a Tertiary Care Hospital

Divya Jayaram[1], M.S. Siddegowda[2], Muralidhar Bhat Y[3]

ABSTRACT

Background: Cardiovascular disease is a leading cause of death in men and women worldwide. Atherosclerosisis the most important cause of cardiovascular disease. Based on the severity, atherosclerosis can be graded histopathologycally from Type I to Type VI. Cardiac autopsy is the main diagnostic tool to study various histopathological changes in autopsy heart specimens.

Objectives: To study the histopathological spectrum and determine the occurrence of atherosclerosis in coronary arteries in autopsy heart specimens.

Materials and Methods: This is a retrospective record based study on autopsy heart specimens received at the department of pathology from January 2020 to December 2021. Gross and histopathological findings were recorded from autopsy register. The histopathological spectrum of atherosclerosis and its occurrence were studied and analyzed.

Results: A total of 141 heart specimens were considered for the study out of which 131 cases (92.9%) showed coronary atherosclerosis ranging from Type I to Type VI lesions. Age of the deceased ranged from one month to ninety two years. One hundred four cases (79.38%) were males and twenty seven cases (20.62%) were females. Fifty four cases (41.2%) belonged to the age group of 41-60 years. Type III–VI lesions were considered significant. 70.87% of right coronary arteries, 76.8% of left circumflex arteries and 76.9% of left anterior descending arteries showed significant atherosclerosis. Left anterior descending artery was found to be the most commonly involved by atherosclerosis (79.4%).

Conclusion: Examination of coronary arteries in autopsy heart specimens plays an important role in determining the cause of cardiovascular diseases and gives an idea about the frequency at which atherosclerosis is encountered among the general population.

keywords | Atherosclerosis; Autopsy; Coronary; Histopathology; Occurrence; Spectrum.

Author's Credentials:
[1]Postgraduate Student, [2]Professor and Head, [3]Associate Professor, Department of Pathology, Mandya Institute of Medical Sciences, Mandya 571401, India.

Corresponding Author:
Divya Jayaram, *Postgraduate Student, Department of Pathology, Mandya Institute of Medical Sciences, Mandya 571401, India.*

Email: *dr.divyajayaram@gmail.com*

Received on: *17.12.2022*

Accepted on: *18.02.2023*

How to cite this article:
Divya Jayaram, M. S. Siddegowda, Muralidhar Bhat Y/Histopathological Spectrum of Atherosclerosis and its Occurrence in Coronary Arteries in Autopsy Heart Specimens: A Record Based Study in a Tertiary Care Hospital. Indian J Forensic Med Pathol.2023;16(1):25-33.

INTRODUCTION

Cardiovascular disease is one of the leading causes of death in men and women worldwide.[1] Atherosclerosis/Coronary artery disease (CAD) accounts for about one-third of all deaths in the country.[2] The major risk factors of atherosclerosis are broadly divided into non-modifiable (constitutional) and modifiable ones. The constitutional risk factors include family history, age and gender, whereas the modifiable ones are hyperlipidemia, hypertension, diabetes mellitus and cigarette smoking.

Atherosclerosis is a chronic inflammatory and healing response of the vessel wall to endothelial injury. It progresses in the following sequence:

- Endothelial injury and dysfunction
- Accumulation of lipoproteins, mainly Low Density Lipoprotein (LDL)
- Monocyte adhesion to endothelium
- Platelet adhesion
- Factor release from activated platelets, inducing smooth muscle cell recruitment
- Smooth muscle cell proliferation, extracellular matrix production and recruitment of T cells
- Lipid accumulation both extracellularly and intracellularly
- Calcification of extracellular matrix and necrotic debris

The key processes in atherosclerosis are intimal thickening and lipid accumulation which lead to the formation of plaques. Atheromatous plaques are yellow-tan and are raised above the surrounding vessel wall. A superimposed thrombus over an ulcerated plaque appears red brown. Plaques may vary in size and coalesce to form large masses.

Atherosclerotic lesions are patchy, involving only a portion of any given vessel wall and the lesions therefore appear eccentric. This is because local flow disturbances, like turbulence at branch points, make certain portions of a vessel wall more susceptible to plaque formation. Over time, these lesions enlarge, become more numerous and broadly distributed.

Atherosclerotic plaques have 4 principal components:

- Smooth muscle cells, macrophages and T cells
- Extracellular matrix including collagen, elastin and proteoglycans
- Intracellular and extracellular lipid
- Calcification in later stages of plaques

The periphery of the lesions displays neovascularization. Most plaques contain abundant lipid but few are composed exclusively of smooth muscle cells and fibrous tissue.

Atherosclerotic plaques are prone to the following pathological changes:

- Rupture, ulceration or erosion leading to thrombus formation
- Hemorrhage into plaque
- Atheroembolism
- Aneurysm formation

The major consequences of atherosclerosis are myocardial infarction, cerebral infarction, aortic aneurysms and peripheral vascular diseases.[3]

Hence the study was undertaken aiming to determine the occurrence of atherosclerosis as well as the histopathological spectrum of atherosclerotic lesions in autopsy heart specimens received at our hospital.

MATERIALS AND METHODS

All autopsy heart specimens referred to the Department of Pathology during the study period of 24 months from January 2020 to December 2021 were taken as study samples. Relevant data was collected from autopsy registers of Pathology department. The slides prepared from the specimens received in histopathology section following standard

procedure were studied and the data was analyzed.

A prior approval from Institutional Ethics Committee of MIMS, Mandya was obtained for the study (ethical code: MIMS/IEC/562 dated 30.03.2022).

Inclusion criteria:

All autopsy heart specimens with definitive diagnosis of coronary atherosclerosis were included in the study.

Exclusion criteria:

All autopsy heart specimens which were partially or completely autolyzed were excluded.

Histopathologically, atherosclerotic lesions were graded as follows:

- Type I (initial) lesion showing isolated macrophages and foam cells (Fig. 1).
- Type II (fatty streak) lesion showing predominantly intracellular lipid accumulation (Fig. 2).

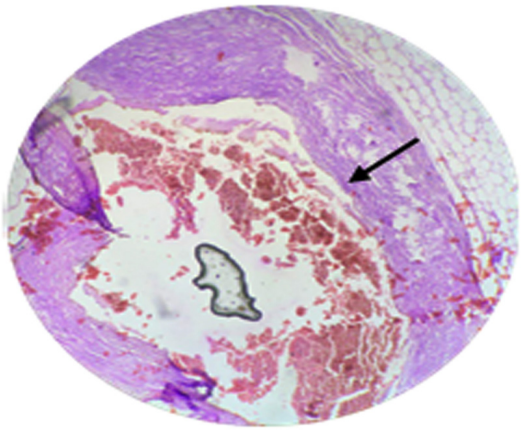

Fig. 2: Type II lesion showing intracellular lipid pool (H & E;10x)

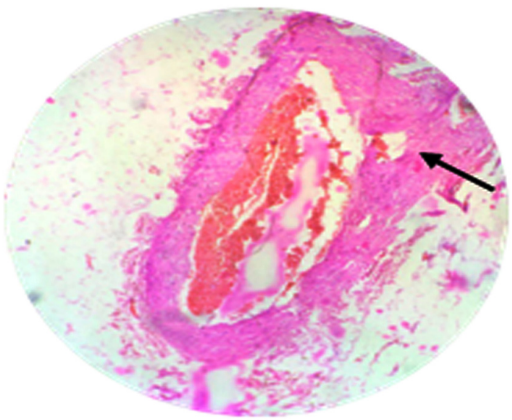

Fig. 1: Type I lesion showing foam cells and macrophages (H & E; 10x)

- Type III (intermediate) lesion showing type II changes and extracellular lipid pools (Fig. 3).
- Type IV (atheroma) lesion showing type II changes and core of extracellular lipid (Fig. 4).

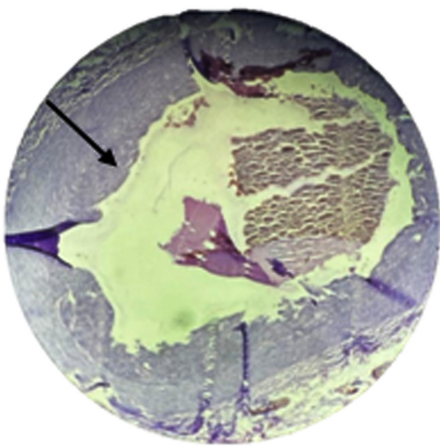

Fig. 3: Type III lesion showing extracellular lipid pool (H & E; 10x)

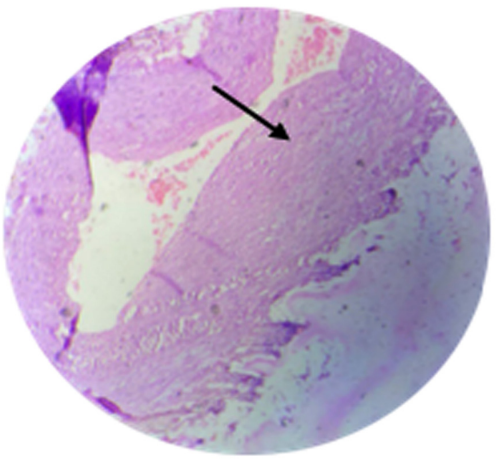

Fig. 4: Type IV lesion showing extracellular lipid core (H & E; 10x)

- Type V (fibroatheroma) lesion showing a well developed lipid core covered by fibrous capsule, or predominantly calcification, or predominantly fibrosis (Fig. 5).

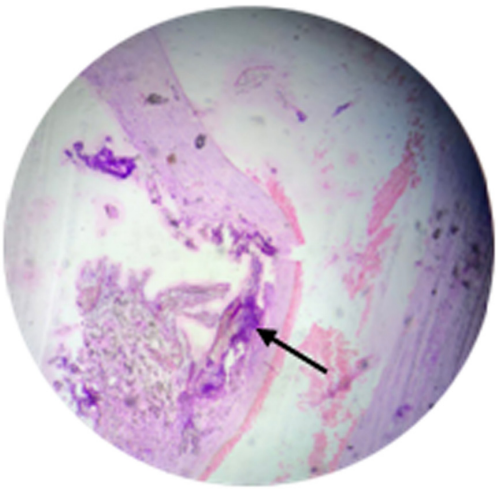

Fig. 5: Type V lesion showing calcification of vessel wall (H & E; 10x)

- Type VI (complicated) lesion showing surface defect, hematoma or thrombosis. (Fig. 6).[4,5]

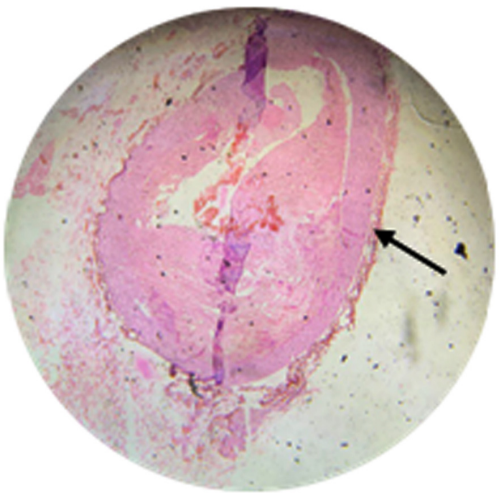

Fig. 6: Type VI lesion showing thrombosis of the vessel (H & E; 10x)

RESULTS

A total of 149 autopsy heart specimens were received during the study period. Out of this, 8 specimens were autolyzed. The remaining 141 specimens showed intact coronary vessels, out of which 10 cases (7.1%) showed no specific pathology in all coronary arteries.

The study population constituted 104 (79.38%) males and 27 (20.62%) females. Age of the deceased ranged from one month to 92 years. (Fig. 7)

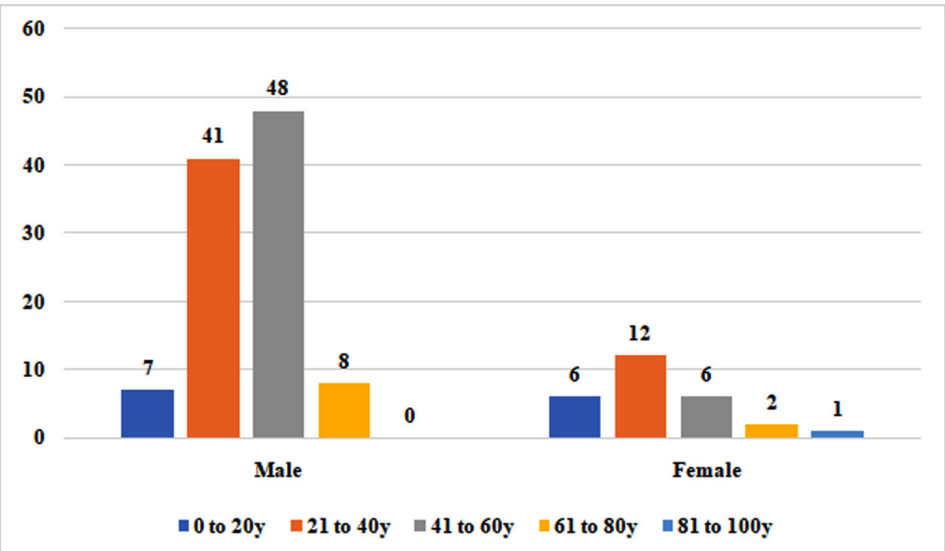

Fig. 7: Age distribution of males and females with coronary atherosclerosis

One hundred three cases of right coronary artery, ninety five cases of left circumflex artery and one hundred four cases of left anterior descending artery showed atherosclerotic lesions ranging from Type I – VI. The percentage-wise distribution of histopathological spectrum of atherosclerosis in right coronary artery (Fig. 8), left circumflex artery (Fig. 9) and left anterior descending artery (Fig. 10) was analyzed.

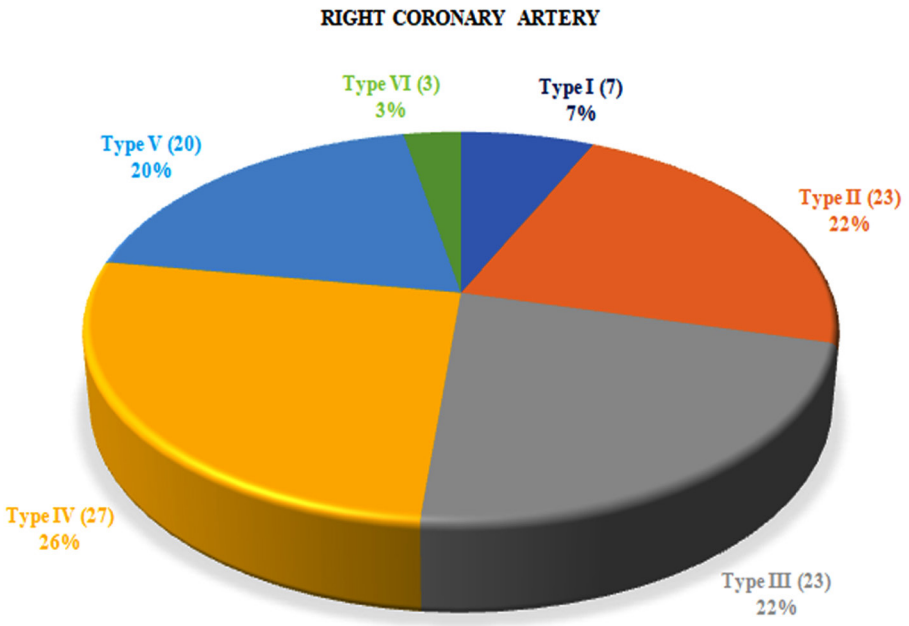

Fig. 8: Percentage-wise distribution of histopathological spectrum of atherosclerosis in right coronary artery

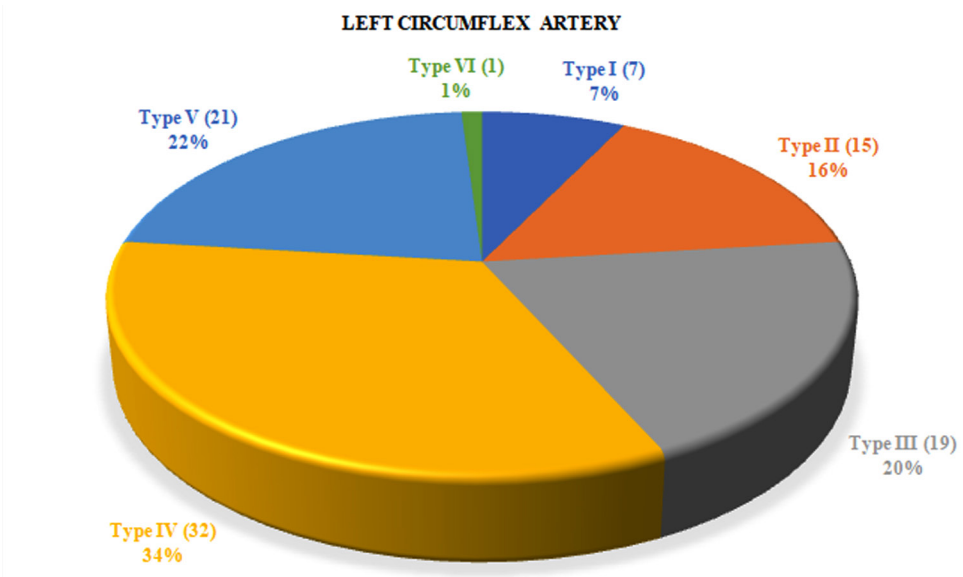

Fig. 9: Percentage-wise distribution of histopathological spectrum of atherosclerosis in left circumflex artery

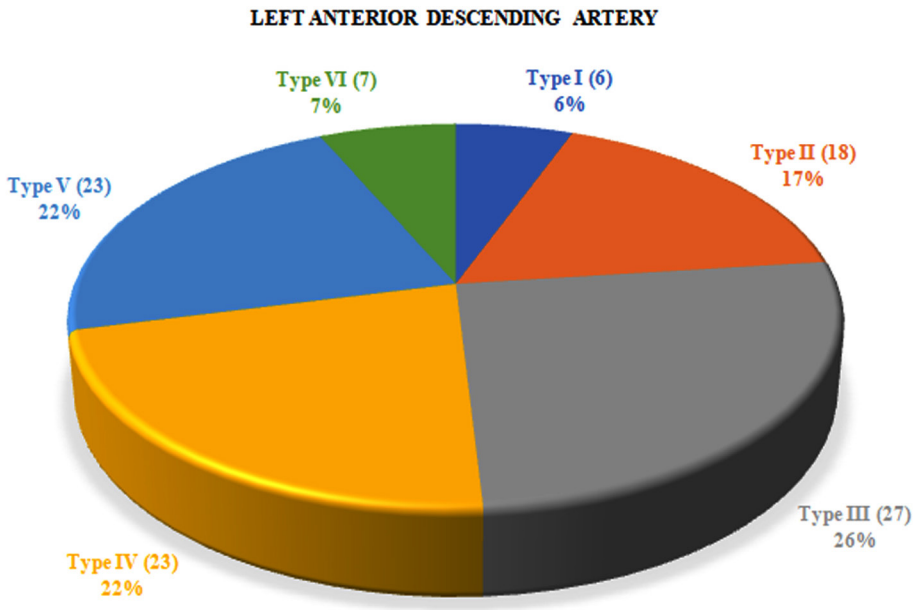

Fig. 10: Percentage-wise distribution of histopathological spectrum of atherosclerosis in left anterior descending artery

The distribution of histopathological spectrum of atherosclerotic lesions in accordance with age and sex of the deceased in right coronary artery (Table 1), left circumflex artery (Table 2) and left anterior descending artery (Table 3) was studied.

The distribution of single vessel, double vessel and triple vessel involvement of atherosclerosis in terms of the age and sex of the deceased was determined. (Table 4)

Out of all the cases that showed significant atherosclerosis, the number of cases, in terms of percentage, that grossly showed greater than 50% of the lumen obstructed in all the three coronary arteries were also determined. (Table 5)

Table 1: Age wise and sex wise distribution of histopathological spectrum of atherosclerosis in right coronary artery

	Right Coronary Artery									
	Number of males					Number of females				
	0 to 20 years	21 to 40 years	41 to 60 years	61 to 80 years	81 to 100 years	0 to 20 years	21 to 40 years	41 to 60 years	61 to 80 years	81 to 100 years
Type I	3	2	1	Nil	Nil	1	Nil	Nil	Nil	Nil
Type II	2	8	8	1	Nil	1	2	1	Nil	Nil
Type III	1	9	5	2	Nil	1	3	1	1	Nil
Type IV	1	9	11	3	Nil	Nil	2	Nil	Nil	1
Type V	Nil	2	16	2	Nil	Nil	Nil	Nil	Nil	Nil
Type VI	Nil	2	Nil	Nil	Nil	Nil	Nil	1	Nil	Nil

Table 2: Age wise and sex wise distribution of histopathological spectrum of atherosclerosis in left circumflex artery

	Left Circumflex Artery									
	Number of males					Number of females				
	0 to 20 years	21 to 40 years	41 to 60 years	61 to 80 years	81 to 100 years	0 to 20 years	21 to 40 years	41 to 60 years	61 to 80 years	81 to 100 years
Type I	1	1	Nil	Nil	Nil	1	3	1	Nil	Nil
Type II	1	5	4	1	Nil	2	1	Nil	Nil	1
Type III	1	7	4	1	Nil	Nil	3	2	1	Nil
Type IV	Nil	13	15	2	Nil	Nil	1	Nil	1	Nil
Type V	1	4	14	1	Nil	Nil	Nil	1	Nil	Nil
Type VI	Nil	Nil	1	Nil	Nil	Nil	Nil	Nil	Nil	Nil

Table 3: Age wise and sex wise distribution of histopathological spectrum of atherosclerosis in left anterior descending artery

	Left Anterior Descending Artery									
	Number of males					Number of females				
	0 to 20 years	21 to 40 years	41 to 60 years	61 to 80 years	81 to 100 years	0 to 20 years	21 to 40 years	41 to 60 years	61 to 80 years	81 to 100 years
Type I	Nil	2	Nil	Nil	Nil	1	2	1	Nil	Nil
Type II	Nil	5	5	4	Nil	1	1	2	Nil	Nil
Type III	1	9	5	1	Nil	2	3	2	3	1
Type IV	Nil	9	10	2	Nil	1	1	Nil	Nil	Nil
Type V	Nil	4	18	1	Nil	Nil	Nil	Nil	Nil	Nil
Type VI	1	3	3	Nil	Nil	Nil	Nil	Nil	Nil	Nil

Table 4: Age-wise and sex-wise distribution of pattern of involvement of vessels by atherosclerosis

	Pattern of Involvement									
	Number of males					Number of females				
	0 to 20 years	21 to 40 years	41 to 60 years	61 to 80 years	81 to 100 years	0 to 20 years	21 to 40 years	41 to 60 years	61 to 80 years	81 to 100 years
Single Vessel	4	10	9	Nil	Nil	4	6	2	Nil	Nil
Double Vessel	1	5	4	1	Nil	1	1	1	1	Nil
Triple Vessel	2	27	34	7	Nil	1	5	3	1	1

Table 5: Percentage wise distribution of degree of obstruction of lumen in coronary arteries with significant atherosclerosis

Artery involved	No. of cases with <50% lumen obstructed	No. of cases with >50% lumen obstructed
Right coronary artery	51.50%	48.50%
Left circumflex artery	43.20%	56.80%
Left anterior descending artery	49.10%	50.90%

DISCUSSION

Histopathological examination plays an important role in diagnosis and grading of atherosclerotic lesions.

The present study was a retrospective study in which all autopsy heart specimens received in Pathology department for a period of two years have been included. A total of 141 cases were included in the study.

The current study shows male predominance which is similar to the study conducted by Purushottam R et al.[6] Yogender Singh Bansal et al.[7] and J Golshahi M D et al.[8]

In our study, maximum number of cases belonged to 41 – 60 years of age, out of which majority were males (88.9%) which is similar to the study conducted by Renuka Verma et al (41-50 years)[1] and Md Ibrahim Siddiqui et al (51-60 years).[2]

The present study showed that left anterior descending artery was the most commonly involved by atherosclerosis (79.4%) which is similar to the study conducted by Renuka Verma et al.[1] Purushottam R et al.[6] Yogender Singh Bansal et al.[7] and Marwah Nisha et al.[9]

Type IV atherosclerotic lesion was more common in right coronary artery and left circumflex artery, whereas Type III lesion dominated in left anterior descending artery in the present study. Also, Type VI lesion was found to be of higher occurrence in left anterior descending artery.

In the present study, Type V lesion was found to be the most commonly occurring in the age group of 41-60 years, whereas Type III and Type IV dominated in the 3rd and 4th decades.

In the present study, triple vessel involvement was most common (61.8%) which was similar to the study conducted by Purushottam R et al.[6] Marwah Nisha et al.[9] and Pratima Khare et al.[10] This was followed by single vessel and double vessel involvement respectively. Triple vessel involvement was found to be of highest occurrence in the 5th and 6th decades in the present study.

Left circumflex artery showed highest occurrence of cases with >50% obstruction of lumen followed by left anterior descending artery and right coronary artery.

CONCLUSION

Histopathology plays a very important role in the diagnosis and grading of atherosclerotic lesions. This study has evaluated the occurrence of atherosclerotic lesions in autopsy heart specimens received at our hospital. Most of the cases were in the age group of 41-60 years with male predominance. The histopathological spectrum of lesions varied from Type I to Type VI as seen in our study. The grading of lesions, especially for the lower grades, is subjective and varies from pathologist to pathologist. Opinions from multiple pathologists on a single case can help to overcome this limitation.

Conflict of Interest: *The authors declare that there is no conflict of interest regarding publication of this article.*

Source of Funding: *The authors received no financial support for the research, authorship and/or publication of this article.*

Acknowledgement: *We would like to acknowledge the support given by the Director, MIMS, Mandya and the Department of Pathology, MIMS, Mandya in conducting the study.*

Ethics approval and Consent to Participate: *This was a retrospective study conducted based on the records maintained in the Department of Pathology. Ethical approval was obtained by the Institutional Ethics Committee (ethical code: MIMS/IEC/562 dated 30.03.2022).*

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Indian Journal of Forensic Medicine and Pathology
Volume 16, Number 1, January-March 2023.
DOI: https://dx.doi.org/10.21088/ijfmp.0974.3383.16123.4

ORIGINAL ARTICLE

Stature and its Estimation Utilizing Hand and Foot Measurements in North Indian Population

Aditi Mishra[1], Deepika Kakkar[2], Gurpreet Kaur[3], Tanya Chauhan[4], Ulhas Gondhali[5], Krit Pal Singh Kushwaha[6]

ABSTRACT

Background: Stature estimation from body measurements is an important part of forensic and medico-legal cases especially in victim identification, where mutilated and amputated body parts are encountered at the crime scene. Hand and foot dimensions are the important features in context of stature estimation. The present study was conducted to find out the correlation of length and breadth of hand and foot in the stature of the North Indians.

Methods: Anthropometric data from 413 males and 413 females were collected. Simple and multiple linear regression methods were used for estimation of stature from hand length, hand breadth, foot length and foot breadth measurements.

Results: Statistically significant results ($p < 0.001$) are obtained with each measurement when the derived model is tested for stature estimation. Hand length in both sexes showed highest correlation with the stature whereas foot breadth showed the lowest. Multiple regression models showed low standard error of estimate (SEE).

Conclusion: The results of this study showed that, from a forensic stand point, measurements of the hands and feet may be employed to estimate the stature of North Indian populations.

keywords | Forensic anthropology; Foot anthropometry; Hand anthropometry; Stature; North India.

Author's Credentials:
[1,2]Student, [3]Junior Research Fellowship, [4,6]Assistant Professor, Department of Forensic Sciences, National Forensic Sciences University, Rohini 110085, Delhi, India, [5]Lecturer, Jindal Institute of Behavioural Sciences, O.P. Jindal Global University, Sonipat 131029, Haryana, India.

Corresponding Author:
Ulhas Gondhali, *Lecturer, Jindal Institute of Behavioural Sciences, O.P. Jindal Global University, Sonipat 131029, Haryana, India.*

Email: *gondhali.ulhas@gmail.com*

Received on: *17.09.2022*

Accepted on: *21.01.2023*

How to cite this article:
Aditi Mishra, Deepika Kakkar, Gurpreet Kaur, et al./Stature and its Estimation Utilizing Hand and Foot Measurements in North Indian Population. Indian J Forensic Med Pathol.2023;16(1):35-43.

INTRODUCTION

Stature estimation plays a vital role in identification of human remains encountered in criminal cases and natural disasters. Since in normal human beings, the measurements of different body parts exhibit interse correlation as well as with stature of an individual. This phenomenon has been exploited by the forensic anthropologists to estimate the stature of the individual from different body parts or skeletal remains. However, the work of a forensic anthropologist is not just restricted to dried or skeletal

remains. Metric data collecting from living people has a long history in anthropology. The applications of anthropometric data has been utilized for various purposes such as to study the variation among different endogamous human populations, in garment and shoe industry to understand the body proportions and foot dimensions for designing of clothing and equipment. Additional anthropometric investigations have been carried out to assess the nutritive and medicinal condition of communities. The role of anthropometric measurements has been witnessed in sports to create a profile of athletes within specific sport and measure their fitness level. In a clinical environment, medical workers may utilize anthropometric measures to assess the height of the living (especially the elderly and crippled) who are unable to stand upright. Presumably, patients in a clinical situation are known to be a certain age, and the purpose of a height estimate in that setting is very different from one in a forensic setting. When the status of the deceased is unknown or uncertain for forensic investigations, stature would need to be calculated. As a result, including known age as a variable in the regression model is inappropriate since it could only be feasible to produce a very broad age estimate (especially in circumstances of body fragmentation). The identification of gender, race, age and stature are the difficult task for an anthropologist in order to establishing or developing the biological profile of an unknown individual.[1] This becomes more challenging in case of dismembered/partial /disfigured bodies and that's why searching the accurate method and developing various regression model from different body parts encountered at the crime scene becomes significant for estimating the above mentioned parameters of the individual characteristics.[2]

These findings play a major role and lead the forensic investigator to positive personal identification. Gender and stature are considered as the most important parameters for personal identification in forensics.[3] The anthropometry measurements are considered as an individual tool to determine the stature of living individuals.[4] Therefore, several studies have been attempted in the past to estimate stature from different body dimensions such as head, cephalometric facial dimensions[5], hand length[6], hand breadth[7], four fingers such as index, thumb, middle and ring[4], handprints[7], navicular height[3], foot length[8], foot breadth[9], malleol height[3], footprints[10], radius and ulna[11], cranium[12] and knee length[12] etc.

The various studies published from the different regions have established correlation relationship between stature and body dimensions including hand and foot anthropometry.[4,13–16] This motivates the anthropologist and forensic professionals to evaluate stature from hand and foot dimensions. Regression analyses such as linear or multiple regression are usually executed to estimate the parallel between stature and different body dimensions. Various regression models have been developed using hand and foot measurements in order to estimate stature for diverse races.[13,17–19] The stature is directly proportional to different body parts and hence, shows a definite biological and genetic relation with each other. The study of specific ethnic group becomes important as change in ethnicity brings differences in anthropometric relations.[20]

Kim et al[9] employed both simple and multivariate regression analysis to estimate stature in 5,195 people using hand length, hand breadth, foot length, and foot breadth. (2,750 men and 2,445 women) south-Korean adults. This study reported the highest correlation in foot length and least correlation was observed in hand breadth for both genders. They also observed that both the hand and foot measurements were statistically significant ($p < 0.01$) with stature. Thus, these methods are found to be highly reliable and could be use to predict the stature of individuals. Krishan and Sharma[13] also examined hand and foot measurements in 246 (123 males and 123 females) North Indian adults. Both simple and multiple regression analysis are performed for stature estimation. Hands and foot measurements were significantly and positively correlated ($p < 0.01$) with stature. Additionally, they looked at the fact that, compared to other measurements, foot length

had the strongest association with height and the lowest standard error of estimation. 250 Slovak students' (120 males and 130 females) height was predicted using hand length, hand breadth, foot length, and foot breadth by Uhrová et al.[8] The dimensions of the hands, feet, and stature were estimated using three distinct techniques, including stepwise regression, multiple regression, and linear regression. The height and measures showed a significant and positive correlation (p 0.01). The study reported that foot length of both the genders had higher correlation coefficient than any other measurements. Similarly, several studies using the hand and foot dimensions have been reported by researchers from different populations, race, regions, sex etc. These findings are very useful in forensic cases such as natural disasters, calamities, airplane crash where skeletal or body remains are found at the scene of crime.[21]

Therefore, the main objective of this research is to investigate the relationship between stature and different hand and foot dimensions such as hand length, hand breadth, foot length and foot breadth. The findings would help to deduce the linear and multiple equations for Indian people. This study will also explore significant correlation between stature and hand-feet dimensions.

MATERIALS AND METHODS

Material

The present research was conducted in the Department of Biology, Lok Nayak Jai Prakash National Institute of Forensic Science and Criminology, India. A total of 826 test subjects (413 males and 413 females) aging 18-69 years without having any physical/medical abnormality of hands and foot were measured. The average age of males was 34.65 years; while that of females was 35.95 years. The anthropological measurements were collected from the male and female subjects of the Jat Population of delhi and Khatri population of Delhi. Anthropometric rod and sliding calipers were used to take measurements.

The temperature of the environment during the data collection was ranged from 24°C to 32°C. All the measurement of the participants was taken in broad daylight to avoid diurnal variation. The information about the research study was given to each subject. They were questioned about their age, sex, medical history, ethnicity, and data was collected as per their consent. A written valid informed consent was taken from each of the participants. No subject in any way was forced to contribute to the data collection. This study was conducted in accordance with the Declaration of Helsinki, and was approved by the Institutional Ethical Committee.

Methods

Four anthropometric measurements such as hand length, hand breadth, foot length and foot breadth were measured using sliding caliper. The stature of each subject was measured using anthropometer instrument. The subjects were asked to stand upright, barefooted on the flat platform with heels placed together, buttocks and back touching the wall. Each participant was instructed to maintain head alignment with the Frankfort Horizontal plane. The individuals' height was measured in centimeters to the closest millimeter by placing the horizontal sliding bar on the vertex of their heads.[22] The accuracy and reliability is of great importance with forensic analyses therefore, each variable was measured by one researcher. All the required precautions were considered while measuring the subjects. All the measurements were taken three times and means of them were taken as the final value.

Landmarks

Stature: It is the vertical distance from highest point to the floor.[23]

Hand length: The distance measured the most forwarding points on the bracelet crease to the midpoint of the middle finger at metacarpo-phalangeal crease using sliding calipers.[23]

Hand breadth: The distance measured between metacarpal radial and metacarpal ulnar sliding calipers.[23]

Foot length: The distance measured from

pternion (most posterior point of the heel) to acropodion (most anterior point of the toe).[23]

Foot breadth: It reflects the distance between metatarsal tibiale (most prominent inner side) and metatarsal fibulare (most prominent outer side) of the foot.[23]

STATISTICAL ANALYSIS

Data was manually entered into Microsoft Excel Spreadsheet and was analyzed using Statistical Package for Social Sciences (SPSS) 23.0 tool. A significance level of $p<0.05$ was considered for data analysis. The Shapiro -Wilk Test was applied to evaluate the normal distribution of data. For measurements of males and females, descriptive statistics were performed on stature, hand, and foot dimensions (cm). To find the significant differences between males and females for each parameter, the Mann-Whitney test was used. Measurements of the hands and feet were used to calculate the stature using linear and multiple regression analysis. Using Pearson correlation coefficient, a relationship between stature and hand foot measurements was deduced.

RESULT

Descriptive Statistics

Descriptive statistics such as mean, median, standard deviation, minimum and maximum for stature, hand foot measurements for males and females are illustrated in Table 1. The mean value of measured dimensions has greater range of value for males than that for female. The hand and foot measurements for both males and females were not distributed normally as shown in Table 2. Hence, non-parametric test such as Mann-Whitney test was conducted to assess the sexual dimorphism as presented in Table 1. All the measured parameters were found to be statistically significant between both the genders. The largest difference in U value (U = 35788.00) was observed in foot length whereas stature displayed the smallest difference in U value (U = 22178.00).

Table 1: Descriptive statistics for stature, hand and foot dimensions (cm) in males and females.

Variable	Male (n= 413)					Female (n= 413)						
	Mean	SD	Median	Min	Max	Mean	SD	Median	Min	Max	Mann-Whitney test (U)	P
S	168.43	8.19	168.2	145	193.8	156	7.19	155.4	135.1	181	22178	.000**
HL	18.46	1.07	18.5	15.2	22.1	17.12	0.94	17.1	14.5	20.3	28716	.000**
HB	8.22	0.53	8.2	6.2	9.6	7.46	0.46	7.5	6.1	8.8	23384	.000**
FL	24.55	2.08	24.9	18.1	28.6	22.62	1.4	22.6	17.4	26.5	35788	.000**
FB	9.41	0.8	9.4	6.9	11.5	8.51	0.65	8.5	6.1	10.8	32605	.000**

Note: S (Stature), HL (Hand length), HB (Hand breadth), FL (Foot length), FB (Foot breadth).

SD: standard deviation

** The t-test was significant at the <0.05 level

Table 2: Measures of Shapiro-Wilk test to check normality for stature, hand and foot dimensions in males and females.

S. No.	Variable	Test		Measures of Shapiro-Wilk Normality	
		Male	P- value	Female	P- value
1	Stature	0.99	0.005	0.972	<0.001
2..	HL	0.987	0.001	0.862	<0.001
3	HB	0.983	<0.001	0.992	0.023
4	FL	0.962	<0.001	0.973	<0.000
5	FB	0.031	<0.001	0.992	0.024

Note: S (Stature), HL (Hand length), HB (Hand breadth), FL (Foot length), FB (Foot breadth).

Correlation analysis

Table 3 shows the correlation coefficients of hand and foot dimensions with stature in males and females. Measured dimensions were found to be positively significant (P-value <0.01) with stature. The correlation coefficient value between stature and hand-foot measurements ranged from +0.216 to +0.489 in males and from +0.052 to +0.436 in females. Hand length showed the highest correlation coefficients for both males and females (r=0.489 for males and r= 0.436 for females) whereas foot breadth showed the lowest correlation coefficients were for males as well as females (r=0.216 for males and r= 0.052 for females).

Table 3: Correlation values of different body dimension with stature among males and females of North Indian population.

S. No.	Variable	Value of correlation	Value of correlation
		Male	Female
1	HL	0.489**	0.436**
2	HB	0.271**	0.178**
3	FL	0.352**	0.166**
4	FB	0.216**	0.052**

Note: S (Stature), HL (Hand length), HB (Hand breadth), FL (Foot length), FB (Foot breadth).

** Significant at 0.001% level

Linear Regression Analysis

In order to estimate stature from hand and foot dimensions of male and female, the linear regression analysis were conducted as shown in Table 4. We also calculated standard error of estimate (SEE) for both males and females that helps in prediction of deviation of the estimated stature from the actual stature as shown in table 4. In males, standard error of estimate varied (hand length) from ± 7.157 to ± 8.013 (foot breadth) whereas in female, varied from ± 6.488 (hand length) to ± 7.198 (foot breadth). To estimate stature from given dimensions, the coefficient of determination was also calculated and found to be statistically significant for all the derived equations in males and females. The coefficient of determination value varied from + 0.046 to + 0.239 in male and from + 0.002 to + 0.189 in female. Hand length showed higher value of coefficient of determination lower in foot breadth in males and females.

Table 4: Simple linear regression equation for stature estimation from males and females.

Males			Females		
Regression equation	**R^2**	**SEE**	**Regression equation**	**R^2**	**SEE**
S = 3.744*HL+ 99.278	0.239	7.157	S = 2.886*HL+106.648	0.189	6.488
S = 4.180*HB+ 134.050	0.073	7.899	S = 2.739*HB+135.545	0.031	7.093
S = 1.385*FL+ 134.401	0.124	7.679	S = 0.852*FL+136.725	0.027	7.108
S = 2.199*FB+ 147.723	0.046	8.013	S = 0.574*FB+151.110	0.002	7.198

Note: S (Stature), HL (Hand length), HB (Hand breadth), FL (Foot length), FB (Foot breadth).

SEE- Standard Error of Estimate; *Significant ($p < 0.001$)

Multiple Regression Analysis

Different combinations of multiple regression equations were derived for both the gender are presented in Table 5. These equations are formulated for better or accurate stature prediction using hand and foot measurements. Regression coefficients were found to be positively significant (P-value < 0.001) with stature for all measurements. Correlation coefficient varied from +0.353 to +0.492 in males and from +0.175 to +0.436 in females. The larger value of R was found between stature and male hand length-foot breadth dimensions and the lower value of R was found between stature and female foot length and foot breadth dimensions. The value of the coefficient of determination was varied from +0.125 to +0.261 for males and +0.031 to 0.197 for females. In males, standard error of estimate varied from ± 7.151 cm to ± 7.685 cm whereas in female, varied from ± 6.494 cm to ± 7.106 cm. Using linear regression equations, the comparison between actual stature and estimated stature from hand-foot measurements are calculated as shown in in Table 6. It was observed that minimum and maximum values of estimated stature in male and female showed greater variations than the actual minimum and maximum stature values. However, the mean values of both actual and estimated stature were close to each other. This is due to the fact that regression equations are calculated from measures of central tendency.

Table 5: Multiple linear regression equation for estimation stature from hand and foot dimension.

Gender	Multiple Regressionequation	R	R^2	SEE
Males	S =3.527*HL. + 974* HB+ 95.286	.492	.242	7.151
	S = 1.386*FL-.006* FB+ 134.467	.353	.125	7.685
Females	S = 2.944*HL- 0.301*HB+ 107.915	.436	.190	6.494
	S = 1.047*FL- 0.720*FB+ 138.444	.175	.031	7.106

Note: S (Stature), HL (Hand length), HB (Hand breadth), FL (Foot length), FB (Foot breadth)

*Significant ($p < 0.001$)

Table 6: Comparison of actual stature and estimated stature (in cm) from hand and foot measurements

Variable	Males			Females		
	Estimated Stature			Estimated Stature		
	Minimum	Maximum	Mean	Minimum	Maximum	Mean
HL	156.18	182.02	168.39	148.495	165.233	156.05
HB	159.96	174.17	168.40	152.25	159.64	155.97
FL	159.46	174.01	168.40	151.54	159.30	155.99
FB	162.89	173.01	168.41	154.61	157.30	155.99
Actual Stature	145.00	193.80	168.43	135.10	181.00	156.00

Note: S (Stature), HL (Hand length), HB (Hand breadth), FL (Foot length), FB (Foot breadth)

DISCUSSION & CONCLUSION

In this study of North Indian Population, the stature and hand-foot anthropometric measurements were larger for males than females. The similar findings were also reported by other researchers.[8,9,13,24] Sanli et al.[25] in Turkey population, Mohamadon et al.[20] in Malaysian population, Geetha and Swathi[26] in Indian population have reported larger stature, hand length, hand breadth, foot length and foot breadth in males than females. Another study by Kim et al.[9] in Korean population revealed that stature, hand length, hand breadth, foot length and foot breadth were higher in males and lower in females. Both male and female have different body measurements/ sizes as their growth are affected by various factors such as biological, genetic etc. This recommends that it is imperative to derived/formulate regression equations by categorizing genders when estimating statures through different anthropometric body measurements.

In the current study, the average hand length for men was 18.46 cm and for women it was 17.12 cm. In a research on the Korean population, Kim et al.[9] found that the average hand length was 18.42 cm for men and 17.05 cm for women. A research on the Kori community in North India[12] found that the average hand length was 17.63 cm for women and 18.43 cm for men. In this study, the average hand breadth was 7.46 cm for women and 8.22 cm for men.[27] Adults in Turkey were the subject of a research by Ozaslan et al.[27] who found that the average hand width was 7.57 cm for women and 8.29 cm for men. In the population of Uttar Pradesh[28], the mean hand breadth was 8.31 cm for men and 7.24 cm for women. Men's average foot length in this research was 24.55 cm, while women's average foot length was 22.62 cm. According to a research by Ahmed[29], men's average foot length is 26.43 cm, while women's average foot length is 24.06 cm. Males' average foot width is 9.41 cm, while girls' average foot width is 8.51 cm. Males had a mean foot breadth of 9.79 cm in the Korean population[9], whereas females had a mean foot breadth of 8.79 cm. In this study of North Indians population, significant differences were found in both sexes. These findings are consistent with previous studies.[9,29]

Previously, several studies have been conducted on hand and foot anthropometric measurements that showed positive correlation with the stature.[24,25,30] In the present study, Female and male hand lengths had the most positive correlation with height, whereas foot breadth had the weakest. These results are well supported by earlier research, which also showed a greater association between hand size and height than between foot size.[31,32]

In present study, regression equations have been deduced which can be used to determine unknown stature values for known body measurements such as hand length, hand breadth, foot length and foot breadth. In linear regression analysis (Table 4), the lowest SEE with the highest coefficient of determination values were observed in hand

length in both gender (R^2 = 0.239 in males and 0.189 in females; SEE ±7.157 cm in males and ±6.488 cm in females). Therefore, when utilising the regression equations obtained from our sample, employing foot length will produce the most accurate stature prediction. Therefore, using the regression equations obtained from our sample, hand length is thought to be the most accurate measurement for estimating height.

Hand length and hand breadth in both genders were the lowest SEE with the greatest coefficient of determination and coefficient of association in the multiple regression analysis (Table 2) (R^2 = 0.242 in males and 0.190 in females; SEE ±7.151 cm in males and ±6.494; R = 0.492 cm in males and 0.436 cm in females). The output of the multiple linear regressions displays the lowest SEE for hand length and hand breadth dimensions. In comparison to the simple linear regression models, multiple regression models have higher coefficient of determination, higher coefficient of correlation and lower SEE, therefore the more reliable stature are to be found with multiple regression equations. These findings were similar with the findings of other researchers.[13,20] Therefore, in case of mutilated body or amputated body where both hands and foot are found, the stature could be determined with these equations. However, using multivariate regression stature may be estimated from the different dimensions in situations of dismembered body parts when just a foot or hand are present.

The results of this study led to the conclusion that height assessment in forensics and criminal investigations might be done using hand and foot anthropometric measurements. However, it is important to remember that the population from which the data were gathered should be used when using the regression equations in particular. This study's age range of participants is a drawback; hence, comparable research in various age groups is required. The left hand and left foot were not measured for this study. Consequently, it is hard to confirm bilateral differences between both hands and both feet.

Conflict of Interest: *Nil*

Source of Funding: *Nil*

Acknowledgement: *Nil*

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E-mail: author@rfppl.co.in

Indian Journal of Forensic Medicine and Pathology
Volume 16, Number 1, January-March 2023.
DOI: https://dx.doi.org/10.21088/ijfmp.0974.3383.16123.5

ORIGINAL ARTICLE

Cone Beam Computed Tomographic Evaluation of Shape, Linear Dimensions and Volume of Sella Turcica: A Retrospective Observational Study

Manjushri Waingade[1], Raghavendra S. Medikeri[2]

ABSTRACT

Background: Sella turcica is an important saddle shaped structure that houses the pituitary gland. Any deviation in the development of the pituitary gland may affect the size and shape of the sella turcica as well. So, the morphology of the sella turcica gains special importance in certain clinical conditions. The aim of this study was to assess the shape, linear dimensions and volume of sella turcica in healthy adults using cone beam computed tomography (CBCT).

Material and Methods: This retrospective study involved CBCT images of 108 healthy adults. The sagittal, axial, and coronal slices of CBCT images were used to evaluate the shape, volume and linear dimensions.

Results: The overall linear dimensions of sella turcica were length 8.59 ±1.49 mm, depth 7.27 ±1.16 mm, diameter 10.24 ±1.75 mm and volume 1499.69 ± 395.5 mm3 respectively. The length of sella turcica was higher in males than females which was statistically significant ($p = 0.015$) while the depth, diameter and volume reported non-significant results. The most frequent shape of sella turcica was normal and the least frequent was sella turcica bridging. The Pearson correlation co-efficient was statistically significant for the length vs diameter and volume alongwith diameter vs volume in both genders ($p < 0.01$). The depth was statistically correlated with length, diameter and volume in males ($p < 0.01$).

Conclusion: The sella turcica shape and dimensions can be used in forensic and medicolegal purposes. So, a thorough of knowledge about this important structure is necessary.

keywords | Sella Turcica; cone-beam computed tomography; morphology; shape.

Author's Credentials:
[1]*Professor, Department of Oral Medicine and Radiology,* [2]*Professor, Department of Periodontics, Sinhgad Dental College and Hospital, Sinhgadroad, Pune 411041, Maharashtra, India.*

Corresponding Author:
Manjushri Waingade, *Professor, Department of Oral Medicine and Radiology, Sinhgad Dental College and Hospital, Sinhgadroad, Pune 411041, Maharashtra, India.*

Email: *manju.waingade@gmail.com*

Received on: *29.06.2022*

Accepted on: *25.12.2022*

How to cite this article:
Manjushri Waingade, Raghavendra S. Medikeri/Cone Beam Computed Tomographic Evaluation of Shape, Linear Dimensions and Volume of Sella Turcica: A Retrospective Observational Study. Indian J Forensic Med Pathol.2023;16(1):45-54.

INTRODUCTION

An important saddle shaped structure that houses the pituitary gland is the "sella turcica" that is located in the middle cranial fossa.[1-4] Due to its position as the central reference point in the assessment of cranial morphology and intermaxillary relations,

the sella turcica is considered to be of special significance.[2,5-7]

Accumulating evidence suggests that the radiological diagnosis of sella turcica is important in the field of orthodontics during cephalometric analysis. Investigations concerning the sella turcica have not only focused on size but also on morphology as they assist for diagnosis and evaluating the treatment results.[3,8-10] Various attempts to classify the sella turcica size have been made in pre-pubertal groups (till age 14 years) revealing that its size increases with age until skeletal maturation.[8,10,11] Also, conflicting results have been reported in the literature regarding the difference in size of sella turcica in males and females.[3,11-13]

Since the size of sella turcica influences the size of pituitary gland, any deviation in the development of the pituitary gland may affect the size and shape of the sella turcica as well. In this context, the morphology size and shape of the sella turcica gains importance under some clinical conditions such as Type I diabetes, Acromegaly, Turner syndrome, Sheehan's syndrome (SS), Trisomy 21, Neurofibromatosis type 1, Velocardiofacial syndrome, Meckel–Gruber syndrome and cleft lip and palate.[1,6,7,14,15] This necessitates the role of radiologist to carefully interpret such malformations and deviations that would provide significant insights in appropriate and timely diagnosis.

The analysis of the sella turcica has been emphasized in the literature by 2D cephalometric and cadaveric analysis. [12,13,16-20] However, with the introduction of 3D imaging i.e. Cone beam computed tomography (CBCT), the radiographic analysis of 3D structures has improved, with the added benefits of a lower effective radiation dose and reduced time.[2,5,14,21] The morphology of the sella turcica appears to be more precise and accurate, with no superimposition or distortion, and measurements can be taken using 3-D images.[2,21]

As a result, a detailed understanding of sella turcica morphology in various populations has been thought to be beneficial in defining normal standards that differentiate abnormal morphology in various craniofacial syndromes and aberrations. There appears to be a paucity of literature on evaluating sella morphology using CBCT imaging. This research employed CBCT images to determine the dimensions and volume of the sella turcica in a population of healthy adults in order to establish a range of normal values.

MATERIAL AND METHODS

The present retrospective CBCT based analysis of sella turcica morphology was approved by the Institutional Ethics Committee (Ref no: SDCH/SAC/2017-18/90). Full Field of view (FOV) CBCT images of 108 healthy individuals aged 18 years and above were analyzed randomly which had been collected previously for several reasons (orthodontic treatment, prior to planning of implant angulations and/or occlusal plane constructions, evaluation of stabilization occlusal splint or periodontal problems, etc.). The patients having cleft lip and palate, impacted canines, dental transposition, and dental anomalies and patients with previous history of orthognathic treatment were excluded from the study.

CBCT images were obtained from the archives of Department of Oral Medicine and Radiology. All CBCT images were obtained using a Promax 3D Mid Proface CBCT unit (Planmeca, Helsinki, Finland), operating at voltage of 60-120 kVp, current of 1-12 mAs, Time 9-33 seconds and voxel size of 200-600 micrometer. The CBCT images were evaluated with in-built software Romexis version 4.2.0 R 10/13/15 software viewer and was analyzed by two investigators. To improve the reliability of data measurements, investigators were tested for intra and inter examiner variability. All measurements were analyzed twice by both examiners with an interval of one week before the study analysis and in between each measurement. If the variability between the two examiners was found to be upto 10%

then the average was considered. However, the variability more than 10% was reassessed by another investigator. The measurements were made to the nearest of 0.6 mm with a caliper. The sagittal, axial, and coronal slices of CBCT images were used to evaluate the volume and linear dimensions. The linear dimensions (length, depth and diameter) were evaluated according to Silverman and Kisling method.[22,23] The measurements were as follows:

1. ***Length:*** From the tip of the dorsum sella to the tuberculum sella;
2. ***Depth:*** As a perpendicular from the line extending to the deepest point of the sellar floor;
3. ***Diameter:*** As the furthest point on the postero-inferior aspect of the pituitary fossa to the most superior point on the tuberculum sella. (Fig. 1 and 2)

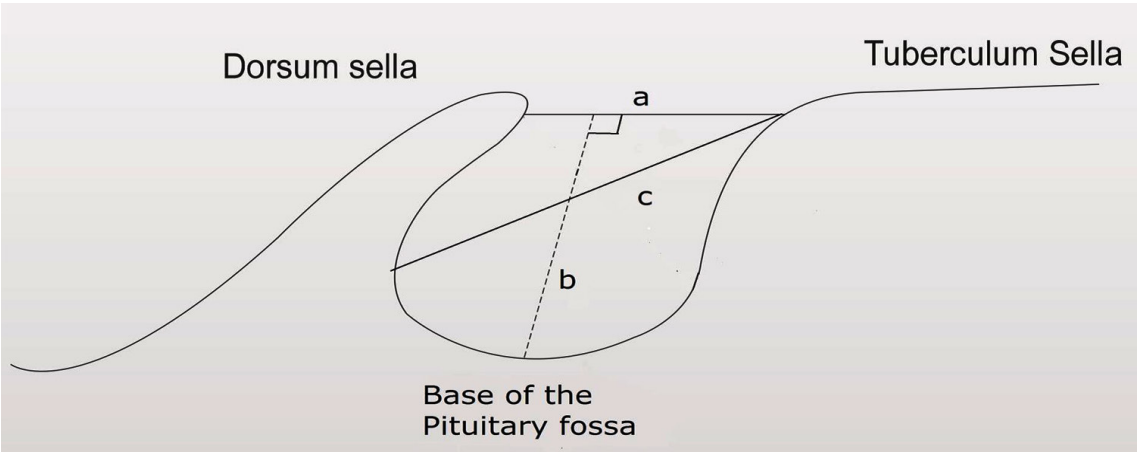

Fig. 1: Measurements of linear dimensions of sella turcica (according to Silverman). (length - a, depth - b and diameter - c).

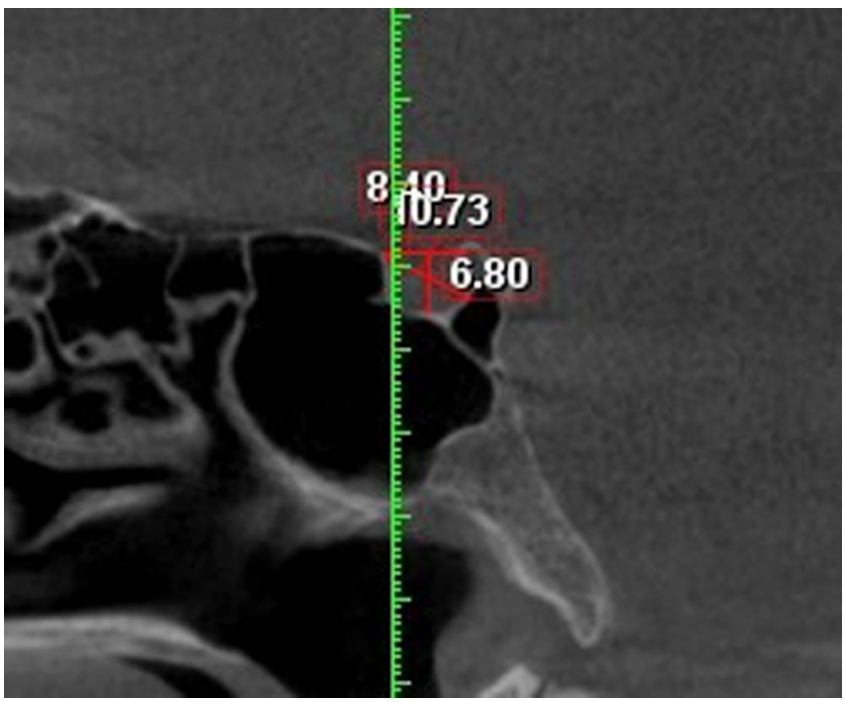

Fig. 2: Linear Diamensions of sella turcica.

4. ***Shape:*** The sella turcica was described according to the sella turcica shape classification given by Axelsson et al. (Fig. 3)

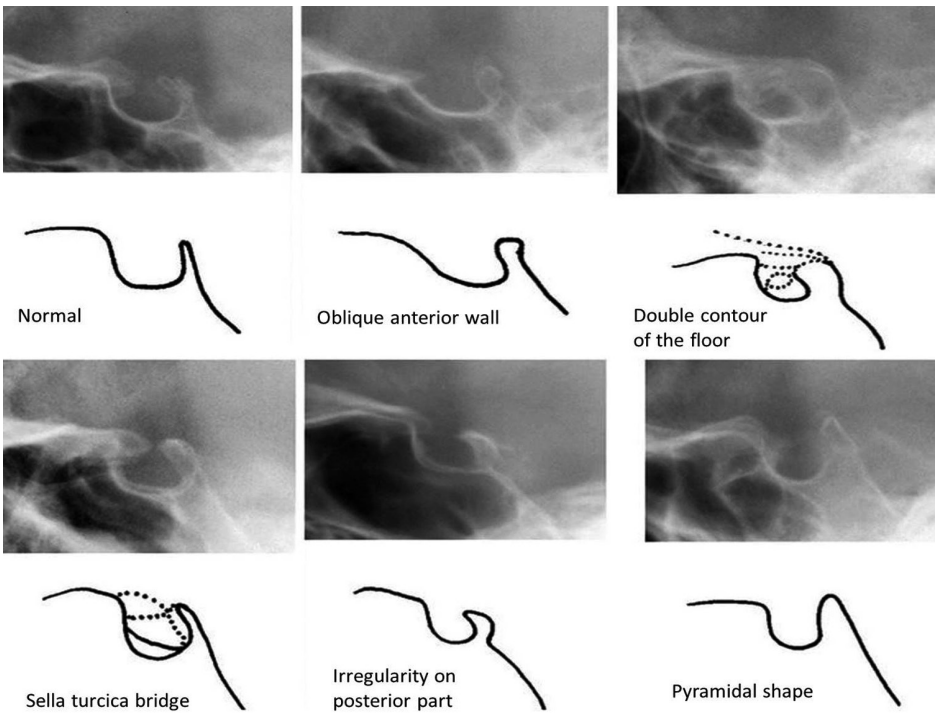

Fig. 3: Shapes of sella turcica.

5. Volume of sella turcica: In the sagittal slice, a circle most fitting the outer contours of the sella turcica was constructed on the image. Simultaneously, this circle was formed multiplanarly in the axial and coronal slices and the volume was calculated by the romexis software programme. (Fig. 4) (TanerL et al.)[14]

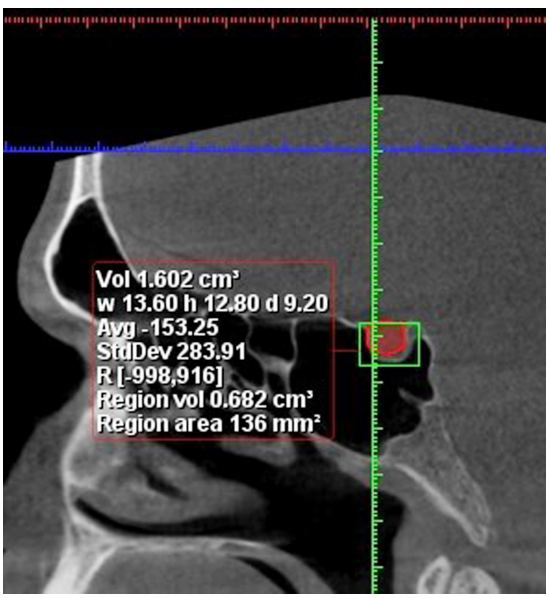

Fig. 4: CBCT image of volume of sella turcica.

Statistical analysis

Data was analyzed using SPSS software (v.21). Normality of data was checked using Shapiro -Wilk test or Kolmogorov-Smirnov test. Descriptive measures were assessed in both genders. Frequency analysis was performed for the prevalence of shape of sella turcica. Unpaired 't' test was used for gender wise comparison. Correlation between variables was assessed by Pearson correlation test. The $p<0.05$ was considered statistically significant.

RESULTS

The overall dimensions of sella turcica were length – 8.59 ±1.49 mm, depth – 7.27 ±1.16 mm, diameter – 10.24 ±1.75 mm and volume – 1499.69 ± 395.5 mm^3 (Table 1). In females the mean dimensions were length 8.25±1.24 mm (range 5.6 – 10.81 mm), depth – 7.26±1.09 mm (range 5.2 – 9.60 mm), diameter – 10.24±1.51 mm (range 4.8 – 13.97 mm) and volume -1461.52 ± 337.57 mm^3 (range 430 – 2209 mm). In males the mean dimensions were length 8.94 ± 1.64 mm (range 6.00–13.20 mm), depth – 7.28 ± 1.24 mm (range 5.6–10.41 mm), diameter – 10.25 ± 1.98 (range 1.63–13.96 mm) and volume 1537.87 ± 445.95 mm^3 (range 810–2959mm^3) (Table 2).

The comparison of length of sella turcica in males and females were statistically significant (p=0.015) with males showing higher dimensions compared to females. All other dimensions reported were statistically non-significant (Table 2).

The most frequent shape of sella turcica was normal and the least frequent was sella turcica bridging (Table 3). In females, the most common shape of sella turcica was normal (70.4%) and in males, normal (64.8%) was most frequently found. (Table 3).

The Pearson correlation co-efficient was statistically significant for the length vs diameter and volume and diameter vs volume in both genders ($p < 0.01$). The depth was statistically correlated with length, diameter and volume in males ($p < 0.01$) (Table 4).

Table 1: Descriptive Statistics in all samples

	Length mm	Depth mm	Diameter mm	Volume mm
Mean ± Std. Deviation	8.59 ±1.49	7.27 ±1.16	10.24 ±1.75	1499.69 ± 395.5
Median	8.49	7.2	10.07	1419.5
Minimum	5.6	5.2	1.63	430
Maximum	13.2	10.41	13.97	2959

Table 2: Gender wise descriptive statistics

	Length mm		Depth mm		Diameter mm		Volume mm	
	Females	Males	Females	Males	Females	Males	Females	Males
Mean ± Std. Deviation	8.25 ±1.24	8.94 ±1.64	7.26 ±1.09	7.28 ±1.24	10.24 ±1.51	10.25 ±1.98	1416.52 ±337.57	1537.87 ± 445.95
Median	8.4	8.81	7.21	7	10.24	10.03	1466	1419
Minimum	5.6	6	5.2	5.6	4.8	1.63	430	810
Maximum	10.81	13.2	9.6	10.41	13.97	13.96	2209	2959
t value	2.475	–	0.126	–	0.025	–	1.003	–
P value	0.015 *	–	0.9	–	0.98	–	0.318	–

* significant at $p < 0.05$

Table 3: Shape of sella turcica in all study samples.

Shape	Total number	Frequency
	(Females / Males)	(Females / Males) in %
Normal	73 (38 / 35)	67.6 (70.4 / 64.8)
Oblique anterior wall	9 (5/4)	8.3 (9.3 / 7.4)
Double contour of the floor	10 (8/2)	9.3 (14.8 / 3.7)
Sella turcica bridge	1 (0/1)	0.9 (0 / 1.9)
Irregularity on posterior part of sella turcica	7 (0/7)	6.5 (0 / 13)
Pyramidal shape of dorsum sella	8 (3/5)	7.4 (5.6 / 9.3)
Total	**108**	**100**

Table 4: Correlations of dimensions of sella turcica with age in females and males.

Correlation	Gender	'r' value	p value
Age v/s Length	Females	-0.011	0.935
	Males	0.152	0.273
Age v/s Depth	Females	0.13	0.35
	Males	-0.034	0.808
Age v/s Diameter	Females	-0.078	0.576
	Males	0.11	0.428
Age v/s Volume	Females	0.149	0.281
	Males	0.119	0.391
Length v/s Depth	Females	-0.178	0.197
	Males	0.491**	0
Length v/s Diameter	Females	0.574**	0
	Males	0.649**	0
Length v/s Volume	Females	0.378**	0.005
	Males	0.563**	0
Depth v/s Diameter	Females	0.255	0.063
	Males	0.486**	0
Depth v/s Volume	Females	0.235	0.087
	Males	0.683**	0
Diameter v/s Volume	Females	0.450**	0.001
	Males	0.533**	0

** Correlation is significant at the 0.01 level (2-tailed).

DISCUSSION

Sella turcica is an important landmark in the skull base and the changesin its size correlate with pathologies of pituitary gland.[2,3,21] The size of sella turcica also varies with race and geographical location.[5] Studies have been done in cadavers, 2D and 3D imaging to find the length, depth and diameter in various populations.[4,7,12,14,17,18,19,24,25] The Silverman and Kisling's method for calculating the dimensions of sella turcica, has been adopted by most authors.[2-4,6,8,11,14,16,26,27] The same method was followed in the present study. Few authors have used additional measurements to more accurately quantify the sella turcica, such as anterior and posterior sella height, tranverse width, and so on.[4,5,10]

The length of the sella turcica is the most commonly studied parameter in the literature.[2-6] Various studies reported that the length of the sella turcica ranged from 7 ± 1.7 mm to 10.41±2.25 mm.[2,5,6,10,11] The length of the sella turcica found in this study is consistent with previous findings.

A few authors have categorized the linear dimensions of sella turcica according to skeletal classes, but the findings have been conflicting.[6,7,12] Sathyanarayan et al.[12] noted significant differences in linear dimensions between skeletal class, while most authors reported no difference.[3,4,6,7,8,13,27]

In determining if gender played a difference in terms of linear dimension i.e. length of sella turcica, contradictory findings were reported.[3,11-13] Males were found to have higher length than females in previous research which is consistent with findings of present research.[4,11,12,16,26] However, few others reported no gender difference.[3,7,8,13,14,16,27]

In the literature, various authors have analyzed the relationship between age and the length of the sella turcica, with contradictory results.[5,10,11,12,13] A few authors found no correlation between age and sella turcica length[11,13] whereas others found a positive correlation.[5,10,12,24]

Many authors conclude that the length of sella turcica showed higher values in males from 1 month to 18 years of age; while females experience a significant increase in the size from 11 to 15 years of age as a result of the pubertal growth spurt, which occurs two years earlier in females compared to males. Following that, both genders show a more roundening-out of the sella region.[8,22,25,27,28] Also, until the age of 25 years, the dimensional changes in the sella turcica show a strong positive trend in length, depth, and diameter. After that, the growth ceases.[8,11,20,25,27]

The mean depth in various studies ranged from 7.3±1.1 to 9.87±2.42 mm.[4,5,6,8,11,26,29] The least dimension was reported by Axelsson et al.[11] (7.3±1.1 mm in males and 7.2±1.2 mm in females) and the highest dimension was reported by Chaurasia et al.[5] (9.87±2.42 mm in males and 9.47±1.98 mm in females). In the present study, the mean depth reported is in accordance to Axelson et al.[11] Differences in imaging methods and the degree of radiographic enlargement may explain the variance in depth dimension. This may also be due to the different population sample and diversity in distribution of sample.

Analysis of gender related difference in depth and diameter was found to be non-contributory in most of the studies.[4,6,7,8,11,12,13,14,16,27] In the present investigation, similar findings were obtained. However, Kumar M et al.[16] found that depth of sella turcica was more in females. Similarly, Magat et al.[6] reported females had more diameter of sella turcica than males.

Regarding the correlation of age with the depth of sella turcica, there was a positive correlation of depth and age in most of the studies.[2,6,11,12,16,24] But, Chaitanya et al.[13] found no correlation of depth with age. Also, the conclusions of a positive correlation between diameter and age werereported in most of the studies.[2,7,11,12,16,24] In the present study correlation of age with linear dimensions of sella turcica was not done.

There is a paucity of literature on the measurement of sella turcica volume with authors reporting different methods and formulae for calculating volume.[24,25,26,30] However, no standard protocol has yet been

stated in any imaging modalities. In the present study, the method of assessing the volume of sella turcica is followed according to that given by Taner L et al.[14] Though we reported that males showed slightly higher volume than females, it was statistically non-significant, while Taner L. et al.[14] reported a higher volume in males (1102±285.3 mm^3) as compared to females (951.3±278.5 mm^3). However, Taner L et al.[14] reported a lower volume of sella turcica as compared to the present study.

The sella turcica has been classified by several authors.[11,29,31,32,33,34] The Axelsson classification was used in this study because it is elaborate and simple to understand. Various authors have used this classification and stated that the normal sella turcica ranges from 39-76%.[3,6-9,12,13,16,25,27,35] The normal shape of sella was found to be 67.6% in the current analysis.

Other forms of sella turcica shapes include oblique anterior wall, which ranged from 5-20%; while we reported 8.3% in the current study.[7,12]

Sellat urcica bridging is more often seen in patients with craniofacial disorders, but it can also occur in healthy individuals.[36,37] In the literature, the sella turcica bridging rangedfrom 1.1%-17%.[8,9] It was revealed to be 9.3% in the current research.

Double contour (0.9%) was the least commonly recorded form in the present study, while in the literature it ranges from 5 to 22.8 %.[12,35] Thus, being much lower than previously published.

Other forms include irregular ranging from 3 to 16% and we reported 6.5%[25,35] The pyramidal form ranges from 2.8-15.5% in the literature[6,8] while we found 7.4% in the current analysis.

In the present study, the length of sella turcica was higher in males than females. Also, the depth of sella turcica correlated with length, diameter and volume in males. Thus, from forensic perspective, this study highlights that sella turcica could be useful landmark in gender determination.

The study's limitations include a limited sample size and an unequal distribution of age groups. To increase the reliability of the data, future studies should provide a larger sample population with comparable samples in all age groups.

The results of this study emphasize the role of CBCT in the 3-dimensional evaluation of sella turcica. Since this an important landmark is seen in the CBCT images, it is the responsibility of the maxillofacial radiologist to have a thorough knowledge that will differentiate a normal morphologyof sella from an abnormal one while correlating the radiological findings with the clinical parameters if any. This could be helpful for an appropriate and complete diagnosis of the CBCT image in question and would help in forensic, medico legal and orthodontic diagnosis and treatment evaluation.

Conflict of Interest: *Nil*

Source of Funding: *Nil*

Acknowledgement: *Nil*

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Indian Journal of Forensic Medicine and Pathology
Volume 16, Number 1, January-March 2023.
DOI: https://dx.doi.org/10.21088/ijfmp.0974.3383.16123.6

REVIEW ARTICLE

Oral Microbial Identity: A Potential Tool for Forensic Science

Paromita Banerjee[1], Neelam Ahirwar[2], Moumita Sinha[3]

ABSTRACT

Microbial forensics is a field that uses scientific methods to analyze the evidence of bioterrorism, bio crimes, hoaxes, or the unintentional release of a biological agent or microbial toxin to determine who is to blame. It is now possible to characterize microorganisms for various human forensic applications, including human identification, body fluid characterization, postmortem interval estimation, and bio crimes involving the tracking of infectious agents. Big applause to technological advancements, remarkably massively parallel sequencing and bioinformatics. The oral microbiome contains microbiota markers that vary between individuals, emphasizing the possibility that it is highly individualized and perhaps even particular to each person. As a result, the oral microbial evidence found at crime scenes may lead to new information. This comprehensive review will discuss the state of the art of using the oral microbiome as a signature to conclude in the forensics sector.

Author's Credentials:

[1]*Assistant Professor, Department of Microbiology,* [2,3]*Assistant Professor, Department of Forensic Science, Kalinga University, Raipur 492101, Chattisgarh, India.*

Corresponding Author:

Moumita Sinha, *Assistant Professor, Department of Forensic Science, Kalinga University, Raipur 492101, Chattisgarh, India.*

Email: *moumita.sinha@kalingauniversity.ac.in*

Received on: *22.12.2022*

Accepted on: *12.02.2023*

How to cite this article:
Paromita Banerjee, Neelam Ahirwar, Moumita Sinha/Oral Microbial Identity: A Potential Tool for Forensic Science. Indian J Forensic Med Pathol.2023;16(1):55-62.

KEYWORDS | MICROBES; ORAL; FORENSIC; PERSONAL; IDENTIFICATION; DEATH.

INTRODUCTION

The mouth cavity is one of the main entryways into the body and is home to hundreds of different bacterial species, fungi, andviruses. The oral cavity provides homes to various microbes, including solid surfaces and mucosal shedding (mucosa) (teeth or dentures). The habitat includes dental surfaces, the gingival crevice or sulcus, the tongue's papillae, crypts, and various keratinized (gingival and hard palate) and non-keratinized (cheeks, lips, soft palate) mucosal surfaces, contain unique ecological niches that favor particular microbes.[1] One milliliter of healthy adult human saliva is thought to have about 100 million microbial cells. Every 24 hours, approximately 8x1010 germs are shed from the oral surfaces at the 750 mL/day normal salivary flow rate.[2] The human oral microbiome is made up of these microbes and more than 2000 different bacterial taxa, including a significant number of opportunistic diseases. Compared to the gut microbiome, the oral microbiome has received less research even though it is the second most varied microbial community

after stools and is critical in defining human health and disorders. Understanding the intricacy of oral microbiota has significantly advanced with DNA sequencing innovations.[3] The most significant efforts are concentrated on identifying the potential associations between oral microbiota and a broad range of systemic and oral pathological conditions, such as type 2 diabetes, cardiovascular disease, sepsis/endocarditis, as well as their known risk factors, such as obesity, chronic kidney disease, rheumatoid arthritis, Alzheimer's disease, and cancer of head and neck.[4-7]

Remarkably, the oral microbiome has distinctive microbial community signatures that vary from person to person, highlighting the possibility that it is highly individualizing and may be exclusive to each person.[8] An expert's most important task is determining the probable time since death. In both criminal and civil situations, the oral microbial remains found at crime scenes may provide insights for further investigation. The conventional manners encountered by experts are rigor mortis, algor mortis, biochemical assessments, livor mortis, supra strong reactions, etc. In this new vogue, the oral microbial signatures can be a boon for the cause of death investigation.

Thus, oral microbiomes serve as a unique signature to infer the postmortem interval in the cause of death investigations, according to the state of the art described in this comprehensive review.

ORAL MICROBES

The bacteria in the human oral cavity are the oral microbiome, oral microbiota, or oral microflora.[9] The Dutchman Antony van Leeuwenhoek initially discovered it using a microscope he had built to do so.[10] Known as the "father of microbiology," he was a trailblazer who found protists and bacteria.[11] In 1674, he noticed the dental plaque on his teeth and described seeing "small living animalcules prettily moving."[12]

An organism's genetic makeup is defined as a genome. It is the encyclopedia of DNA, including every gene in that particular body. Oral microbiome is the collective genome of the bacteria that live in the oral cavity. It is the second largest microbial colony in humans, behind the gut. They have an incredible range of anticipated protein activities when compared to other body locations.

The human microbiome is made up of a core microbiome and a variable microbiome. All people share the same core microbiome, yet each has a different variable microbiome based on their lifestyle and physiological makeup. The complex and soft tissues of teeth and the oral mucosa are two surfaces where bacteria invade the oral cavity. The tough and soft palates, tonsils, gingival sulcus, teeth, tongue, and cheeks offer a hospitable environment for microbes to thrive. The so called bacterial biofilm is a thick layer of bacteria covering the mouth cavity's surface covers the surfaces of the mouth cavity.

The mouth cavity and related nasopharyngeal areas are among the most favorable environments for microorganisms to grow. Without significant changes, the average temperature of the mouth cavity is 37°C, which gives bacteria a stable habitat to survive. Additionally, saliva maintains a steady pH of 6.5-7, which is ideal for most bacterial species. In addition to keeping the bacteria nourished, it acts as a conduit for delivering nutrients to microorganisms.

The Oral Microbiome's Makeup

The bacterial predominance in a varied version is offered in the mouth cavity. It constantly interacts with the environment, and even research has revealed that it is susceptible to its impacts. Most of the microbiome's species are found at various locations throughout the body in a healthy state. Individuals' specific varied microbiome has developed in response to their particular lifestyle and genetic makeup.

The oral cavity's complex and diverse microbial ecology is a rich biological habitat with specific niches that offer a unique setting for the colonization of bacteria. The gingival sulcus, the tongue, the cheek, the hard and soft palates, the mouth's floor, the throat, the saliva, and the teeth are some of these niches. Due to

particular adhesins on their surface that adhere to complementary receptors on an oral surface, oral bacteria selectively colonize different textures in the mouth.

Archaea, protozoa, fungi, bacteria, and viruses make up the typical microbiome. There are limited reports on the mycobiome-fungal microbiome, while the information on a distinct microbiome is only focused on the bacteriome.

Three hundred ninety-two taxa have at least one reference genome, making the oral cavity one of the most thoroughly investigated microbiomes. The total number of genomes in the oral cavity is close to 1500. It contains over 700 different prokaryote species that have been identified. Approximately 54% of these species have official names, 14% are nameless but farmed, and 32% are only known as uncultivated phylotypes. These species are members of 185 genera and 12 phyla. Firmicutes, Fusobacteria, Proteobacteria, Actinobacteria, Bacteroidetes, Chlamydiae, Chloroflexi, Spirochaetes, SR1, Synergistetes, Saccharibacteria (TM7), and Gracilibacteria make up the 12 phyla (GN02). In healthy mouths, the oral microbial ecology is retained down to the genus level. The tongue contains a diversified microbiota that includes anaerobes due to its many papillae and sparse anaerobic locations. Despite the commonalities, the microbiome's diversity depends on the individual and the location.

The oral microbiome can vary dramatically and quickly over time, both in terms of composition and activity, and it is dynamic as the host develops. Numerous factors, including the temporal frequency of the host and diet, the response to pH changes, interactions between the bacteria, and, over a longer time horizon, gene mutations and horizontal gene transfer that confer new properties on the strain, contribute to these theaters, non - equilibrium dynamics.

The following are the main bacterial genera that can be found in a healthy oral cavity:

Gram-positive

1. **Cocci:** Abiotrophia, Peptostreptococcus, Streptococcus, and Stomatococcus.
2. **Rods:** Rothia, Actinomyces, Bifidobacterium, Corynebacterium, Eubacterium, Lactobacillus, Propioni-bacterium, and Pseudoramibacter.

Gram-negative

1. **Cocci**-Moraxella, Neisseria, and Veillonella
2. **Rods:** Leptotrichia, Prevotella, Selemonas, Simonsiella, Treponema, Wolinella, Campylobacter, Capnocytophaga, Desulfobacter, Desulfovibrio, Eikenella, Fusobacterium, Hemophilus.

Nonbacterial Oral Cavity Members

Numerous bacteria, including viruses, fungi, and protozoa, can be found in the oral cavity. The two most prevalent protozoa, Entamoeba gingivalis, and Trichomonas tenax, are primarily saprophytic. The most frequent fungus found in connection with the oral cavity is a member of the Candida species.

Ghannoum et al. reported 85 fungal taxa after conducting culture independent research on 20 healthy hosts. Candida, Cladosporium, Aureobasidium, Saccharomycetales, Aspergillus, Fusarium, and Cryptococcus species were the most often seen. After stool samples, the oral habitats contain the highest operational taxonomic unit-level richness in the body regarding alpha diversity. There is less alpha diversity in the cutaneous and vaginal microbiome. When samples from the same sites from different people are analyzed, the mouth sites have the lowest beta diversities. This indicates that population members share relatively comparable organisms in oral places than in other areas of the body.[13] Alpha diversity in taxonomy refers to variability inside the sample, while beta diversity is diversity between samples.

Functions of Oral Microflora

At both the micron and host scales, the physiology and ecology of the microbiota become intricately entwined with those of the host. The microbiome significantly impacts whether health is promoted or disease develops.[14] Typically, the oral microbiota exists as a biofilm. It is essential to preserve oral homeostasis, safeguard the oral cavity, and haltdisease progression. For a mechanical knowledge of the significant participants, it is vital to be aware of the identity of the microbiome and the nearby neighbors with whom they frequently interact.

Critical physiological, metabolic, and immunological processes carried out by the microbial communities present in the human body include food and nutrition digestion, energy production, differentiation and maturation of the host mucosa and its immune system, regulation of fat storage and metabolism, processing and detoxification of environmental chemicals, maintenance of the immune system, and the balance between these processes.

On Microbial collaboration, an essential line of protection against invading bodies originates from oral bacteria. On the other hand, if there is an imbalance, this can have several negative repercussions on the host's health. The term "dysbiosis" is used to describe this microbial imbalance. When it happens, it may play a role in developingseveral diseases. This includes cirrhosis of the liver, Alzheimer's, diabetes, pancreatic cancer, and inflammatory bowel disease.

Due to the intimate relationship between the human microbiome and the immune system, dysbiosis may impact the immune system and contribute to diseases, including rheumatoid arthritis and HIV infection. Oral microbiome dysbiosis is also linked to the cardiovascular system and the emergence of atherosclerosis.

The uniqueness of Oral Microbial Flora

For the first two or three years of its existence, a human kid maintains a relatively unstable microbial environment 15, which is an exceptionally long-time frame based on what we know about microbial ecology. For instance, a recent study on bathroom surfaces showed that the microbiome had stabilized 8 to 24 hours after initial colonization.[16] So why does the stability of the human microbiome take so long to develop? The ecosystem, or island in biological terms, where new bacteria are settling, is continually changing, which is the most likely explanation. During the first few years of life, the human body experiences significant immunological, physiological, and endocrinological changes; as a result, of the microorganisms that live on and in it, the human body is like shifting sands.

The dynamic interaction between the human body and its microbiome during these challenging years likely influenced the evolution of features that tend to stabilize the sources of bacteria that a baby is exposed to. In this interaction, immunoglobulin A synthesis is crucial because it prevents bacteria from getting to the cellular tissue in the stomach while binding bacteria that are beneficial to the mucosal layer of the gut. This could be regarded as managing the microbial environment that interacts with the body or bacterial husbandry. Unlike plants and animals, the human body has developed mechanisms of developing a cooperative atmosphere for the bacteria that have a beneficial impact on themselves. These microorganisms aid food digestion, produce specific products like vitamin K, and defend the body from diseases. Vertical transmission from parent to offspring is one of the strategies for preserving beneficial bacteria. It offers the most plausible explanation for the earliest occurrences of individuality in the microbiome.[17]

Understanding how human lifestyle and habitat affect our microbial ecology is impacted specifically by the individuality of microbial metabolism discovered by Bork and colleagues using metagenomic data. Metagenomic datasets from human microbiomes showed much more variance in gene content when compared to genomes of isolated species. Therefore, compared to the genome repertoires in the public libraries, these metagenomic data caught a higher level of metabolic variety. This shows that analyzing

raw metagenomic data rather than mapping it to the known pangenome diversity can help us find greater diversity and individuality in the human microbiome.[17]

Significance of Oral Microflora in Forensic Science

A. For Time Since Death:

A crucial component of forensic sciences and casework is accurately estimating the time since death. According to a recent study, this might be accomplished by observing changes in the mouth's bacterial communities after death.

Finding the PMI (the amount of time since a person died) is frequently essential to a criminal investigation. Researchers have started analyzing the thanatomicrobiome to increase PMI forecast accuracy.[18-19] These colonies overpower the immune system after death, enabling future colonization.[20] According to preliminary investigations, these microbial communities may experience significant successional changes in organs that may help determine the PMI.[21]

Oral swab samples from each of the three donated subjects: a male and two females were collected daily throughout the various stages of decomposition. The literature review suggested that the successional alterations in bacterial taxa among the three corpses were comparable[22] interaction with humans and are crucial to health and disease. Bacterial populations alter after death and as the decomposition process progresses in response to the newly established environmental conditions."

Exterior locations make it possible to sample the epinecrotic microbial community in an accessible, non-invasive way. In this sense, the oral cavity is the most important place in forensic applications, along with the skin. The skin provides information about 0 body parts with their niche of bacteria. This data thoroughly leads to the microbial population of a specific area, such as the oral cavity, which is comparable to that of other body parts and distinct from other areas simultaneously.

In a study conducted at the Southeast Texas Applied Forensic Science lab, two dead human bodies were allowed to rot in the spring and winter seasons. The results showed that various bacterial and fungal groups form a reproducible network that emerges on a predictable time scale and can therefore be used as estimators of PMI.[23] The internal left buccal region, external left/right cheeks, external left/right biceps, chest, and rectum of two additional human participants were also sampled.[24] The microbial diversity and richness for both bodies' skin, mouth, and rectal samples were comparable as the decomposition process advanced. Microbial analysis showed that the Acinetobacter of the class Proteobacteria was also prevalent in both bodies during the final stages of decomposition. Researchers confirmed that communities from the mouth and oral cavity differ in the pre-bloat and end-bloat locations of decay, according to a different study by the same group.[25] Oral microbial specimens from three donated dead bodies demonstrated variations in bacterial composition as the decomposition process continued through fresh, bloat, active and advanced decay, and dried remains stages and had similar overall successional alterations. In the fresh stage, Firmicutes and Actinobacteria predominated, but from bloat to advanced decay, Clostridiales and Bacillaceae were the main representatives of Firmicutes.[22]

The similarity in the microbial progression withinthe various stages of breakdown is a crucial discovery, even though the sample numbers for the research listed above are smaller and more varied, as it demonstrates the feasibility of using the oral microbiome in PMI calculation. The surface communities in the ear and nasal canals of 17 cadavers were analyzed, and a k-nearest neighbor regression model was successfully developed. This model successfully predicted the true PMI to be within 55 ADD.[26]

Research continues by taking samples from the eyes, ears, nose, mouth, and rectum in a larger study involving 188 participants. The samples were then analyzed to demonstrate that predictive models from composition and functional profiles, in the context of each sample location, could be used to estimate PMI within the time frame of less than as well as greater than 2 days.[27] To predict PMI,[28] used

the datasets from the study stated above and machine learning methods. They discovered that the computer algorithm technique produced the highest accuracy when combining all anatomical areas. Reports suggested that the skin and the mouth cavity may be viable areas to use as the foundation for a precise microbial clock.

B. For Personal Identification

In a manner analogous to how human DNA is routinely deposited and transferred, human microbes with their nucleic acids can be utilized to identify criminal defendants.[29] Furthermore, bacterial DNA is more resistant to degradation than human DNA because it is circular and well protected by peptidoglycan.[8,30] One advantage of using the human microbiome for personal forensic identification is that it is very individualized. This is especially true when there is little or no human DNA present. However, because every bodily habitat has a unique microbiome[31] the human microbiome can be used forensically to determine the source of biological traces.

In forensic practice, oral biological samples are an essential form of evidence. Police officers can identify suspects by identifying saliva and mucosa that may have been left at the crime scene in bite marks, hickeys, and stains. In forensic practice, it is necessary to determine what activity created the biological trace.[32-33] Because saliva and oral mucosa both include oral epithelial cells, the conventional forensic analysis based on the human cell does not concentrate on the distinctions between the two. The oral cavity, however, exhibits a variety of microbial habitats, each of which has a unique microenvironment that is inhabited by a variety of microbial communities.[34] In some situations of specific sexual assault, including kissing and other actions with mouth contact, the variations in the bacterial communities in saliva and buccal mucosa may be helpful in determining the source of oral biological traces. Therefore, it is essential to ascertain how the microbial communities in buccal mucosa and saliva differ. Since the human oral microbiota is just as unique as the skin microbiota, it can be used to help identify an individual, especially in cases where there is little or no human DNA, like in bite marks and hickeys. This can help law enforcement identify potential donors by connecting oral biological traces to them.

According to numerous studies[35], the human skin microbiome has the potential for forensic personal identification, but there aren't as many studies on the oral microbiome, and more need to be done in this area.

CONCLUSION

Microbiomics, the study of the variety of microorganisms found in our bodies and surroundings, was created over the past ten years due to developments in genomic sequencing and bioinformatics. The evidence analyzed in this review suggests that microbiomics may be a forensically relevant and promising field with many applications, including tracing the provenance of substrates, collecting trace evidence, identifying people, and calculating PMI. These developments may enable forensic scientists to employ various microbiome data, such as those produced via thanatomicrobiome analysis, to address issues linked to criminal investigations or at least be used in conjunction with other forensic techniques.

Humans and their microbiomes engage in intricate interactions and co-adaptation processes that involve nutrition intake and result in the formation of breakdown products like metabolites during their lives. These interactions alter significantly after death, and the microbiome's dynamics and composition shift along. Understanding these colonizations, fluctuations, and antemortem microbial dynamics provides significant philosophical, methodological, and computational hurdles. Future advancements in the microbial and forensic toolset may also result from related microbiome based research in forensics and a more profound investigation of fungal and virus communities.

Conflict of Interest: *The authors declare no conflicts of interest.*

Source of Funding: *This review article received no external funding.*

Ethical Approval: *The present study is a review-based article therefore, no ethical approvals or informed consent was required.*

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Indian Journal of Forensic Medicine and Pathology
Volume 16, Number 1, January-March 2023.
DOI: https://dx.doi.org/10.21088/ijfmp.0974.3383.16123.7

REVIEW ARTICLE

Medical Evidence: Corroborative or Decisive Factor Based on a Case Series

K. S. Arun Prakash[1], K. Thangarj[2], O. Gambhir Singh[3]

ABSTRACT

In all Medico-legal cases and sudden suspicious deaths, an Autopsy is done to establish the cause of death. An Autopsy examination is compulsory in all cases of homicides to fix the probable cause of death, time since death, nature of injuries, and the probable weapon used. Sometimes, problems may arise when there is a conflict between the Doctor's opinion and the eyewitness testimony. In such cases, there arises the question of whether the court will admit the doctors' evidence or the eye witness testimony. In the present case series, we have examined five cases of homicide with the court verdict and found that in some cases the verdict was delivered based on the post-mortem report and in some casesit was based on both the post-mortem report and the eyewitness testimony. In a few cases, it was based only on the eyewitness testimony. In cases of where there was a conflict of opinion, the testimony of eyewitnesses was considered superior.

KEYWORDS | MEDICAL EVIDENCE, POST-MORTEM REPORT, MURDER, LEGAL PROCEDURE, SESSIONS COURT.

Author's Credentials:

[1]Associate Professor, Department of Forensic Medicine & Toxicology, [2]Medical Superintendent, [3]Professor & Head, Department of Forensic Medicine & Toxicology, SRM Medical College Hospital & Research Centre, Kattankulathur 603203, Tamil Nadu, India.

Corresponding Author:

K. S. Arun Prakash, *Associate Professor, Department of Forensic Medicine & Toxicology, SRM Medical College Hospital & Research Centre, Kattankulathur 603203, Tamil Nadu, India.*

Email: *drarunksprakash@gmail.com*

Received on: *15.09.2022*

Accepted on: *28.01.2023*

How to cite this article:
K. S. Arun Prakash, K. Thangarj, O. Gambhir Singh/Medical Evidence: Corroborative or Decisive Factor Based on a Case Series. Indian J Forensic Med Pathol.2023;16(1):63-68.

INTRODUCTION

Homicide may be defined as the killing of one human being by another.[1] As per the Indian Legal System, homicide may be of two types: Lawful Homicide & Unlawful Homicide. The Unlawful Homicide may be again sub-classified into 1. Culpable Homicide Amounting to Murder, under Sec. 300, Indian Penal Code (IPC); and 2. Culpable Homicide Not Amounting to Murder, under Sec. 299, IPC. Sec. 302, IPC prescribes punishment for murder as life imprisonment or death sentence with or without a fine. Sec. 303, IPC is about the punishment of murder by a life convict person and it is in the form of a death sentence. Sec. 304, IPC prescribes punishment for culpable homicide not amounting to murder in the form of life imprisonment or fine, or both. Sec. 304-A, IPC is about death caused by gross negligence and punishment is in the form of imprisonment for 2 years or fine, or both. Sec. 304-B, IPC is punishment for the death of a woman in relation to dowry demand and punishment

is minimum imprisonment of 7 years which may be extended to life imprisonment. In such cases of culpable homicides, post-mortem examination is required as per law.[1-3] Post-mortem examination plays a vital role in establishing the cause of death, time since death, determining the manner of death, etc. In case of deaths due to injuries, the nature of the injury, age of the injury, and probable weapon used may also be established during the post-mortem examination.[4] Though the evidence of an eyewitness is considered positive and bears more value than the evidence of a Forensic expert as per Indian Law, a Post-mortem report will definitely help the legal system not only to identify a criminal but also to exempt a suspect or an innocent person from the involvement of crime by corroborating these facts with the ocular evidence.

However, in some cases, this post-mortem report may be poorly documented due to a lack of knowledge or negligence of the Doctor who has conducted the Autopsy. Such things are often seen where there are multiple injuries on the body. Sometimes, the victim might have been examined by different doctors and accordingly, there might have been different conflicting reports of body injuries. Occasionally, such differences in the injury report may be seen in reports prepared by the police investigating officer and autopsy doctors. The non-concordance may also be in the statements deposited by eyewitnesses. In case of any doubt or conflict in autopsy findings or police findings or eyewitness statements, the benefit of the doubt ultimately goes in favor of the accused. This will reduce or alter the quantum of punishment of the accused. The present case series study was conducted as a part of the Ph.D. thesis work of one of the three authors. Here we have examined the relevance and futility of autopsy findings in five cases of Homicide and their Judgement.

CASE NO. 1

Around 5 am, a lady found her husband's dead body lyingin a pool of blood in a nearby field with a cut injury over his head. As per the informant's statement, the victim left home by 10 pm the previous night to irrigate of his field. There was a history of enmity due to a land dispute between the victim and the family of the suspected women. The accused was seen running out of the field with an aruval (a type of billhook machete type of weapon traditionally used in Kerala & Tamil Nadu states of India) by three witnesses who were also working in the nearby fields.

An autopsy was done in a nearby civil hospital & autopsy findings were as given below:

There was a cut injury over the scalp exposing bone & brain matter. Both occipital and temporo-parietal bones were fractured with the laceration of the overlying scalp, size being 10x5x2 cm. There was an intracerebral clot of about 7x5x3 cm in size. Other findings were insignificant and chemical analysis reports of viscera were also non-informative. According to the Autopsy report the individual died due to Intracranial Hemorrhage and Shock. The District Session Court (highest criminal court in a district) convicted the accused under Sec. 302, IPC with an imprisonment for life and a fine of Rs. 2000.

CASE NO. 2

A Middle aged male complained that his daughter was found dead on the banks of a lake near the village school. The offence was said to be committed by seven accused who were his brothers-in-law and his sister-in-law. The motive of the murder was a land dispute between the man and the accused. The incident was witnessed by two villagers who later on deposited their statements in the Court of Law.

The post-mortem was conducted in the nearby Civil Hospital and thefindings were:

About 12x10x5 cm laceration seen on the temporo-parietal region of the head extending on both sides exposing the underlying brain matter. Another 20x10x10 cm laceration, placed horizontally, was seen from the left pinna to 4cm behind the right pinna exposing the brain matter. There was a crush injury of the left thumb with about 8x5x10 cm laceration over the left wrist. About 15x10x6

cm laceration was seen on the back of the left elbow exposing the muscles, tendons & bones. Another 4x3x2 cm laceration was seen on the left side of the back of the chest. The abdomen was slightly distended due to the accumulation of gas from decomposition, the stomach was empty and the liver, kidney, spleen & other internal viscera were found to be normal. As per the autopsy report the death was due to injury to the brain and hemorrhagic shock. The District Sessions Court convicted the accused under section 302, IPC for life imprisonment with Rs. 1000 fine, under section 498-A, IPC for three years of rigorous imprisonment with afine of Rs. 1000.

CASE NO. 3

When both the husband and wife were returning home after their work in the evening, they were run over by a TATA Sumo car. It was not a case of a simple road traffic accident but turned out to be a case of planned homicide. The reason behind the homicide was that she was forced to have an illicit relationship with the accused. When the relatives came to know about the illegal affair between them, the families gathered and warned them. Both the victim and accused were neighbors.

The post-mortem was done in a nearby Government Hospital. There was a lacerated wound 5x0.25 cm in size over the right parieto -temporal region of the head, multiple linear abrasions over the lower abdomen, fractures of both the thigh bones, and a laceration over the dorsum of the right foot (dimensions of some injuries were not mentioned in the original autopsy report). Internally anextradural hematoma of 5x0.5cm size (dimension as per original autopsy report) was found over the right parieto-temporal area. Other findings were normal. The Intracranial hemorrhage and the hemorrhagic shock due to road traffic accident was found to be cause of Death.

The case was fought in the District Sessions Court. The Autopsy report given by the doctor during his deposition was used asa corroborative evidence only in this case. The accused was convicted under Sec. 302, IPC based on the statements given by six eye witnesses.

CASE NO. 4

On the day of their 12th wedding anniversary, the daughter of the couple who was about two anda half years old, was playing around and she was wearing a gold chain of about 5 sovereign gold (1 sovereign is equal to 7.98 g). On seeing this, two people who were also attending the function hatched a plan to abduct and rob her of her gold chain.

With the intention to rob the ornaments the accused abducted the child and took her to a nearby house. They were removing the ornaments and as the child cried out loudly, in an intention to stop the cry they laid the child on the floor and tightly closed the mouth and the airway leading to her death. In order to hide the murder both the accused put the child into a nylon sack and tied it with the nylon rope and threw it on the seashore.

The dead body was recovered and a post -mortem was done in a nearby government hospital. The post-mortem findings were 4x4 cm dried abrasion over the right knee, 3x3 cm dried abrasion over the left side face below the ear, 3x3 cm contusion over the left side of the neck below the ear, 1x1 cm dried abrasion below the left eye and a 1x1 cm dried abrasion over the left forehead. Internal findings were insignificant. The post-mortem report concluded thatthe deceased would appear to have died due to smothering.

Later on, the nylon rope, which was used to tie the sack in which the child was kept before the disposal, was recovered with the help of a police sniff dog. Based on the chain of circumstantial evidence the two accused were arrested and convicted by the court under sec. 302, IPC.

CASE NO. 5

A married woman was frequently abused and harassed by her husband on the mere ground that she was older than him. There were frequent fights between them and many times she was asked to leave him so that he can

marry another girl of a younger age group.

One day, in a fit of rage, her husband hit her in the abdomen multiple times and she died on the spot. To disguise the crime as a suicidal hanging her husband tied a saree around her neck and hung her from a ceiling fan.

A police case was registered and the dead body was sent to a nearby Government Hospital for autopsy. During the autopsy, one faint ligature mark was seen around the neck (details about the ligature were not mentioned in the original autopsy report). Internal examination revealed a 10x6x4 cm size laceration of the liver, laceration of the large bowel, and rupture of theomentum with multiple small bowel contusions. There was a collection of about 3 liters of fluid and clotted blood in the peritonealcavity. The cause of death was found to be hypovolemic shock, cardiorespiratory arrest (blunt injury to the abdomen).

After considering all the evidences, the Honorable Court convicted the accused (the husband of the deceased) under Sec. 302 and Sec. 201, IPC.

DISCUSSION

In our study, we have included five cases of homicide. The cases include one sharp and blunt weapon injury, one case of homicide by vehicle runover, one case of murder by smothering, and one by blunt abdominal injuries disguising as a suicidal hanging.

In Case Report No.1, the opinion given regarding the cause of death was found to be consistent with the injuries present in the body but the alleged weapon used and the nature of the injuries described in the post-mortem report was not consistent. How an aruval, a sharp cutting heavy weapon, can cause the mentioned lacerated injury on the head? If the weapon used was an aruval then the injury must be an incised or chop wound. If it was a hard, blunt, and heavy weapon then the injury described in the autopsy report might be possible. Thus, injuries described in the autopsy report were not consistent with the weapon used as per history. In his retrospective studies of 10 years, OngBB[5] observed different cases of homicides where there were chop wounds over the head region. A similar observation was also reported by S Bhupinder et al.[6] Most interestingly, there was no direct eyewitness in this case and the autopsy report was also not so informative. The judgment was delivered considering the circumstantial evidence.

In Case Report No.2, the victim was initially attacked with a heavy wooden club, and later on, a moderately large stone was used to smash the victim. The injuries described in the autopsy report such as lacerated wound with underlying fracture of bones in the temporo-parietal region of the head, crush amputation of the left thumb, and laceration of 20x10x10 cms in size starting from left pinna to 4 cm behind the right pinna exposing brain were consistent with the history of use of moderately large stone as a weapon. Other injuries were consistent with the use of moderately heavy wooden clubs as a weapon. In this case, there were twoeyewitnesses, and finally,the accused was convicted based on the autopsy report, eyewitness statements, and other circumstantial evidence. In cases of murder, blunt force injuries are commonly seen in the head region. A similar observation was reported by other authors also.[7-9]

In Case Report No. 3, we found some lacunae in the post-mortem report. There was a history of knockdown by a TATA Sumo car while the victim was returning home with her husband. Many of the injuries mentioned in the post-mortem reports were not consistent with the available history. Generally, in the case of RTA, if the person is a pedestrian, there will be a primary impact injury commonly in the form of a fracture of the upper end of the tibia, sometimes in the form of a contusion or a laceration.[10-12] In the present case, there was no such injury. However, the accused was convicted based on the statements deposited by six eyewitnesses.

Case Report No. 4 was that of a smothering. Homicidal smothering is very difficult to detect during autopsy.[13-15] As the victim was a child there might not be a strong resistance and struggle. Abrasions present over the face and a contusion in the neck might goes in favour of death due to smothering. However,

post mortem report did not mention the presence of features of asphyxial death such as cyanosis, petechial hemorrhages, and organ congestion, etc. In such difficult cases, it is necessary to interpret the autopsy findings with the available history, crime scene visit, and other circumstantial evidence. Abhishek Y et al[15] expressed a similar opinion during their case report "An Interesting Case of Accidental Smothering in an Unusual Place." However, in the present case, the accused were convicted considering the autopsy report, circumstances evidence, and confessional statements of the accused.

Case Report No. 5 was that of an assault disguised as a suicidal hanging. As it was a post-mortem hanging and a saree was being used, the ligature mark around the neck was very faint and didn't show features of an ante mortem wound. Except for a faint ligature mark, there was no external injury on the body. But internally there were visceral injuries with the collection of fluid and clotted blood inside the peritoneum. It is quite possible that as the abdomen is a soft and yielding area there may not be external injuries especially when blunt and soft weapons like fists or legs are used. Ananda Rao B V S et al[16] observed the liver to be the most frequently involved organ in blunt abdominal injury cases. Spleen, small intestine, mesentery, etc. are also vulnerable organs in blunt abdominal injury cases. So, it was established a case of death from blunt abdominal trauma and the hanging was post-mortem in nature and accordingly, her husband was convicted under Sec. 302, IPC.

The value of medical evidence is only corroborative. The evidence given by an eye witness will be considered positive and will bear a greater value. In the case of Mani Ram Vs. the State of Uttar Pradesh,[17] the Honourable Court reiterated the secondary nature of medical evidence, the oral evidence of an eyewitness has to get primacy as medical evidence is basically opinionative. This is applicable whenever there are gross opinion differences between statements of eyewitness and expert opinion. In S. Gopal Reddy vs The state of Andhra Pradesh,[18] the court explained that expert evidence is opinion evidence and it can't take the place of substantive evidence. It is a rule of procedure that expert evidence must be corroborated either by clear direct evidence or by circumstantial evidence. It is not safe to rely upon this type of evidence without seeking independent and reliable corroboration.

In another landmark judgment, in Abdul Rahman Sheikh Vs the State of Madhya Pradesh,[19] the court has observed that "the post-mortem report is the findings of an expert on the basis of which the opinion is given about the cause of death, nature of the injury and its effect or connection with the death. Such opinion evidence is admissible under section 45 of the Evidence Act and it could not be disputed that an opinion could not be admitted in evidence without the evidence of the expert. The genuineness of the post-mortem report may not be disputed, but the contents thereof i.e. facts observed by the doctor and the opinion as to the cause of death, nature of the injury, and the effect of injury are matters which could only be admitted in evidence under section 45 of the Evidence Act. And under section 45 the opinion could only be admitted in evidence if the expert is examined in Court as the mere certificate is not evidence."

CONCLUSION

A Post-mortem Report is a Medico-legal document and the doctor must prepare it meticulously. Though the law considers it as a corroborative evidence and inferior to eyewitness testimony, it is helpful in the Court to deliver its verdict. Even if it is not a sustentative evidence, the post-mortem report will remain as a crucial evidence in all Homicidal cases.

Conflict of Interest: *Nil*

Source of Funding: *Nil*

Acknowledgement: *Nil*

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Indian Journal of Forensic Medicine and Pathology
Volume 16, Number 1, January-March 2023.
DOI: https://dx.doi.org/10.21088/ijfmp.0974.3383.16123.8

CASE REPORT

Sudden Death due to Ascariasis Infestation: An Unrecognized Danger

Abhishek Yadav[1], Varun Chandran[2], Karthi Vignesh Raj K[3], Pooja Gupta[4]

ABSTRACT

Ascaris Lumbricoides or common round worm is the most common of human helminths and is distributed worldwide. Infection is more prevalent in the low socioeconomic areas locations with poor hygienic habits like lack of regular hand washing and proper disposal of human excretions. *Ascariasis* causes both intestinal and extra intestinal problems but very rarely leads to death. Most patients infected with *Ascaris* have a chronic disease course and remain asymptomatic for years or present with only mild symptoms.We report a case of an adolescent boy who was admitted with abdominal pain and passed away next day. The autopsy was conducted and it was found that boy died due to intestinal obstruction due to the *ascaris* infestation. The authors aim to highlight the risk of mortality due to ascaris infestation. The susceptible population should be educated and screened so as to prevent any further complications and avoidable fatality. The authors also aid to increase the awareness amongst autopsy surgeons about the presence of this hidden pathological finding in sudden undiagnosed death.

KEYWORDS | Ascaris Lumbricoides, Ascariasis, Round worm, Intestinal Obstruction, Sudden Death.

Author's Credentials:
[1]*Additional Professor,* [2]*Assistant Professor,* [3]*Senior Resident,* [4]*Junior Resident, Department of Forensic Medicine and Toxicology, All India Institute of Medical Sciences, New Delhi 110029, India.*

Corresponding Author:
Abhishek Yadav, *Additional Professor, Department of Forensic Medicine and Toxicology, All India Institute of Medical Sciences, New Delhi 110029, India.*

Email: *drayad_in@yahoo.com*

Received on: *27.12.2022*

Accepted on: *15.02.2023*

How to cite this article:
Abhishek Yadav, Varun Chandran, Karthi Vignesh Raj K, et al./Sudden Death due to Ascariasis Infestation: An Unrecognized Danger. Indian J Forensic Med Pathol.2023;16(1):69-72.

INTRODUCTION

Ascaris Lumbricoides or common round worm is the most common of human helminths and is distributed worldwide especially in developing countries.[1,2] Ascaris is the largest nematode living in the small intestine. Infection is more prevalent in the low socio-economic areas locations with poor hygienic habits like lack of regular hand washing and proper disposal of human excretions. The incidence may be as high as 80–100% in rural areas with poor sanitation.[1,2] Ascarisparasitic infects about more than 1 billion people worldwide, with annual addition of 10.5 million new cases.[3-5] Ascariasis is common in the age group of 5 to 15 years and cause approximately 60000 deaths per year worldwide, mainly in children.[2,4,6] Government of India too recognizes the magnitude of the soil transmitted helminthes infection and observes a National Deworming Day on 10th Feb every year to make every child wormfree.[7] Ascariasis causes both intestinal and extra intestinal problems but very rarely leads to death. Most patients infected with

Ascarishave a chronic disease course and remain asymptomatic for years or present with only mild symptoms.[6] We report a case of an adolescent boy who was admitted with abdominal pain and passed away next day. The autopsy was conducted and it was found that boy died due to intestinal obstruction due to the ascaris infestation. The authors aim to highlight the risk of mortality due to ascaris infestation. The susceptible population should be educated and screened so as to prevent any further complications and avoidable fatality. The authors also aid to increase the awareness amongst autopsy surgeons about the presence of this hidden pathological finding in sudden undiagnosed death.

Case Details

The deceased was a 13 years old male child who presented to a hospital with the complaint of abdominal pain. But when the symptoms didn't subside he was brought to All India Institute of Medical Sciences, New Delhi next day where he was declared brought dead. The case was labeled as a Medicolegal case and subjected to medico-legal postmortem examination.

The deceased was average built teenaged male. The clothes were intact. Fungal infection was present over abdomen and inguinal region. Oral hygiene was poor. The other natural orifices were normal. No external injury was present over the body. Brain was edematous and congested, weighing 1360 gms. Thyrohyoid complex and other neck structures were intact. Pleural cavity contained about 200ml of pleural fluid. Right lung was adherent to chest wall with consolidation changes. Heart was normal, weighing 290 gms. Peritoneal cavity contained about 500 ml of hemorrhagic fluid. Stomach mucosa was hemorrhagic and congested. In proximal part of duodenum about 10 Ascaris worms were present at the pyloric duodenum junction obstructing the outlet of stomach (Fig. 1).

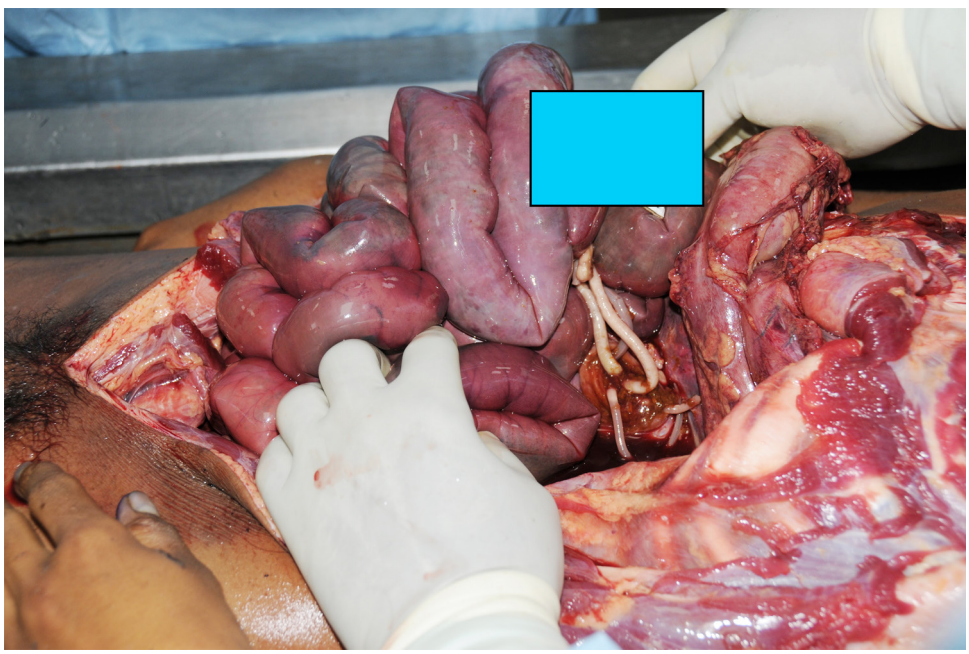

Fig. 1: Ascaris worms at Pyloric Duodenal Junction

On further dissection more worms were found blocking the jejunum region with the entire loop being dilated and inflamed. The other internal organs were congested. No other significant injury/pathology was present inside the body. The cause of death was concluded as shock due to complications on intestinal obstructions.

DISCUSSION

Most of the complications of ascariasis are in the digestive and airway tracts[6] due to life cycle of Ascaris lumbricoides. Ascaris infection occurs by ingestion of eggs in the fecal contaminated drinking water and raw or undercooked foods. Eggs containing infective larvae hatch in the duodenum. The larvae penetrate the intestinal mucosa and migrate to the portal vessel to the liver and lungs. The larvae molt twice in the lungs. Eventually rupture from the pulmonary capillaries to enter the alveoli. Subsequently they move up to the respiratory tree and trachea to the epiglottis to be coughed up, swallowed, and passed again to the small intestine and mature into adults.[2,8,9]

Clinical manifestations may vary from asymptomatic to fatal cases. The mechanical effects are caused due to masses of worms causing luminal occlusion or even a single worm infiltrating into a vital area. The adult worms live in the upper part of the small intestine, causing recurrent and often severe colicky pain in the abdomen. The worms may be clumped together into a mass leading to volvulus, intussusception, or intestinal obstruction and intestinal perforation.[2,8,9] The deceased in the present case had abdominal pain prior to his death. The worms were found in the duodenal and jejunal region. The death was attributed to intestinal obstruction due to mechanical effects of the worms.

The presence and significance of Ascaris infection in trauma patients has also been reported with life-threatening complications such as obstruction of larynx[10,11], trachea[6] and tracheal passage.[12,13] Presence of even a single ascaris worm in the airways can cause acute respiratory failure and death.[12] Fatal case has been reported due to diffuse peritonitis, due to perforation of duodenal wall.[14] Severe intestinal infestation may cause malabsorption[15] and undernutrition leading to fatality.[16]

The prognosis of intestinal infestation is usually good, but if undiagnosed may prove fatal like in the present case.[14] Definitive Diagnosis is usually established by detection of eggs ova in feces. Radiological imaging such as ultrasoung, CT, MRI can easily detect adult worms in intestinal or respiratory tract. Serological tests can detect Ascaris antibodies particularly in extra intestinal Ascriasis.[2] Ascariasis is easily treatable with medications like pyrantelpamoate, albendazole, mebendazole, or ivermectin.[2]

Ministry of Health & Family Welfare, Government of India in coordination with other ministries and all States/Union Territories observes National Deworming Day (NDD. The objective is to deworm all preschool and school age children (enrolled and non-enrolled) between the ages of 1-19 years through the platform of schools and Anganwadi Centers in order to improve their overall health, nutritional status, access to education and quality of life.[7]

CONCLUSION

Ascariasis is a prevalent, potentially lethal but preventable disease. Awareness activities towards maintaining the hand hygiene and sanitation, particularly in children, can restrict the spread of infection. Mass deworming programs will significantly reduce the morbidity and mortality. The sudden deaths with history of symptoms of abdominal pain etc should be meticulously investigated at Autopsy to diagnose unknown/hidden Ascaris infestations.

Conflict of Interest: *Nil*

Source of Funding: *Nil*

Acknowledgement: *Nil*

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Indian Journal of Forensic Medicine and Pathology
Volume 16, Number 1, January-March 2023.
DOI: https://dx.doi.org/10.21088/ijfmp.0974.3383.16123.9

CASE REPORT

Leiomyoma of Broad Ligament a Location with Rare Incidence: A Case Report

Bhavinee Pathak[1], Sabiha Maimoon[2], Kalpana A. Bothale[3]

ABSTRACT

Leiomyoma are most common benign tumors of the uterus, mostly situated in the body of the uterus. Rarely, they arise from extrauterine sites with broad ligament leiomyoma being uncommon.[1]

A 49-year-old female, multipara presented in outpatient department with complaints of lower abdominal pain and abdominal distension. Abdominal examination revealed a firm mass arising from the pelvis corresponding to 18 week size. On per vaginal examination, huge mass was palpable occupying whole abdomen; uterus was not felt separately. CECT abdomen and pelvis revealed lesion arising from right adnexa and occupying pelvic region most likely suggestive of neoplastic etiology of ovary? USG was suggestive of an abdominopelvic neoplastic lesion arising from right adnexa. Total abdominal hysterectomy with bilateral salpingo-oophorectomy was done. The specimen was sent for histopathological examination.

Histopathological examination revealed broad ligament leiomyoma.

This case is being reported for its rare incidence, diagnostic dilemma with ovarian malignancy and surgical challenge.[1]

KEYWORDS | Broad ligament, Leiomyoma, Ovarian malignancy, case report.

Author's Credentials:

[1]*Junior Resident,* [2]*Professor & HOD,* [3]*Associate Professor, Department of Pathology, NKP Salve Institute of Medical Sciences, Nagpur 440019, Maharashtra, India.*

Corresponding Author:

Bhavinee Pathak, *Junior Resident, Department of Pathology, NKP Salve Institute of Medical Sciences, Nagpur 440019, Maharashtra, India.*

Email: *bhavineepathak@gmail.com*

Received on: *17.10.2022*

Accepted on: *13.12.2022*

How to cite this article:
Bhavinee Pathak, Sabiha Maimoon, Kalpana A. Bothale/Leiomyoma of broad ligament (A location with rare incidence): A Case Report. Indian J Forensic Med Pathol.2023;16(1):73-76.

INTRODUCTION

Leiomyomas are benign tumors of female genital tract with uterine leiomyoma being the mostcommon. Leiomyomas of uterus are the most common myomas and account for 20-30% of cases in women aged less than 35 years.

Leiomyoma of broad ligament is extremely rare having incidence of less than 1%.[1] Further, cellular leiomyoma of broad ligament is the least common variant reported in literature.[2]

The diagnostic dilemma arises when leiomyomas undergo degenerative changes. Broad ligament leiomyomas are rare and therefore can cause specific diagnostic difficulties and may lead to mistaken diagnosis and management. This poses both clinical and radiological difficulty in differentiating with an ovarian tumour.[1] Even in forensic pathology, large pelvic masses are usually associated

with venous thrombosis which has clinical implications.[3]

PATIENT AND OBSERVATION

Patient Information

49-year-old female married for 30 years P2L2 with tubal ligation done with previous full term normal delivery came with chief complaints of pain in abdomen, premenstrual severe dysmenorrhea in the last 4-5 months. She also had complaints of distension of abdomen, hard stools, swelling of bilateral feet and generalized weakness. Her menstrual cycle was regular with average flow. The patient was a known case of hypertension since 2-3 years and was on medication.

Clinical Findings

Abdominal examination revealed a firm mass arising from the pelvis corresponding to 18 week size with solid cystic consistency and restricted mobility. On per speculum examination, the cervix and vagina were healthy. On per vaginal examination, hugemass was palpable occupying whole abdomen; uterus was not felt separately.

Timeline of the Current Episode

Patient was having complaints of pain in abdomen since 4 months and premenstrual severe dysmenorrhea since 4-5 months. Abdominal distension was present. Patient was having generalized weakness and lethargy. She also complained of constipation and hard stools. There was no history of menorrhagia, menstrual irregularity, bladder complaints, per vaginal white discharge or nausea and vomiting.

Diagnostic Assessment

CECT abdomen and pelvis revealed a large well defined peripherally enhancing cystic lesion with large enhancing solid component and enhancing septae within arising from right adnexa and occupying pelvic region with its relations as described most likely suggestive of neoplastic etiology of ovary. CA-125 serum levels were in normal range. USG guided FNAC was suggestive of mucinous epithelial neoplasm of ovary. Cytology PAP smear revealed inflammatory smear with Low Grade Squamous Intraepithelial lesion.

Therapeutic Intervention

Total abdominal hysterectomy with bilateral salpingo-oophorectomy was done.

Intra-Operative findings revealed two true broad ligament fibroids. One was 30x20 cm size extending in both hypochondrium more in right with cystic and red degeneration. The second one was 7x6 cm size present just lateral to cervix on right side.

The specimen was sent for histopathological examination.

Grossly, the mass was solid cystic arising from broad ligament; Total measurement: 15x 12x4 cm.

Fig. 1: Gross

Microscopically, sections from the broad ligament mass revealed intersecting and interlacing fascicles of closely packed spindle cells arranged in whorled pattern.

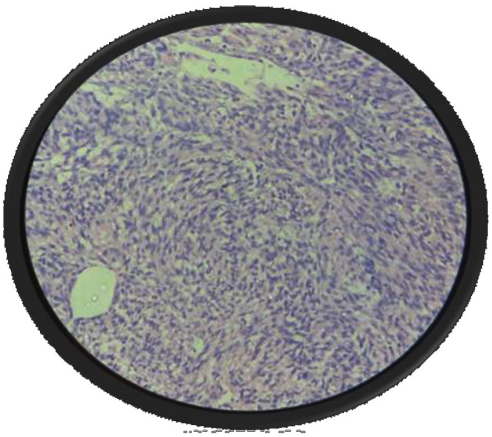

Fig. 2: Microscopy

DIAGNOSIS

A diagnosis of Cellular leiomyoma with extensive cystic change was made on histopathology.

Follow-up and Outcomes

The patient was relieved of acute symptoms of pain in abdomen and abdominal distension. Her menstrual cycle became regular and dysmenorrhea had subsided. Her bowel and bladder habits became normal. Overall, the patient was doing quite well after therapeutic intervention.

DISCUSSION

Leiomyoma is the most common tumour of female pelvis having a prevalence of 20-30%. Extra uterine locations of leiomyoma are rare. Smooth muscles of uterus give rise to leiomyoma. The clinical presentation is determined by the size, number and location. The number varies from one to multiple and size varies from small to huge. They can be intramural, submucosal, or subserosal in location.[4]

Broad ligament, ovary, urinary bladder, urethra, vulva and vagina are the extra-uterine location of leiomyoma. Broad ligament fibroids reach enormous size and present with bowel and bladder abnormalities.[5] Podduturi et al concluded that sudden death can be caused by deep venous thrombosis and pulmonary embolism due to stasis of venous blood caused by large pelvic masses.[3]

We report this case of true broad ligament fibroid measuring 20x18x12 cm due to its rare location and diagnostic dilemma in differentiating it from ovarian tumour and giant fibroid. These are asymptomatic benign tumours. The leiomyoma can push the uterus to contralateral side or it can compress the adjacent pelvis structure when it reaches a significant size; thus, causing various signs and symptoms.[6]

There is great surgical difficulty because it is relatively inaccessible and lies in close proximity to the bladder and uterus. Other severe symptoms include urinary retention and ureteric obstruction.[1]

Degenerations, haemorrhage, necrosis, infections and sarcomatous changes are the most common secondary changes in fibroids. A rare complication of benign fibroid is myxoid degeneration, which mimics metastatic malignant ovarian tumour due to presence of cystic changes.[6]

Diagnosis of parasitic and pedunculated leiomyoma is aided by ultrasonography. As the parasitic leiomyoma are separate from uterus, they are very often mistaken for adnexal tumours such as ovarian tumours.[7]

Broad ligament differential diagnosis includes

1. Masses from ovarian origin-benign or malignant
2. Broad ligament cyst
3. Lymphadenopathy
4. Tubo-ovarian masses

Fatal pulmonary thromboembolism can occur due to huge leiomyomas as they cause compression of pelvic veins which results in stasis and thrombosis in leg veins. Therefore, very large leiomyomas can lead to deep venous thrombosis causing pulmonary thromboembolism which can be a cause

of sudden death.[3] However, deep venous thrombosis associated with large pelvic masses is a rarely reported complication.[8]

Our case was suspicious of ovarian neoplasm on clinical and radiological investigation.

CA-125 serum levels were in normal range. Elevation of CA-125 levels usually directs towards metastatic ovarian neoplasms.For the diagnosis of such cases, histopathology plays an important role.[9] Therefore, properhistopathological evaluation is important for patient management.

Patient Perspective

I was having complaints of pain in abdomen since 4 months. My menstrual cycle was painful. My abdomen had distended. I was suffering with constipation and there was generalized weakness too when I visited Lata Mangeshkar Hospital's Gynecology Out Patient Department.

I underwent numerous pathological and radiological investigations, which suggested a tumour mass in my pelvis Finally, my doctor recommended surgical removal of the tumour.

I was operated. The tumour mass was removed. I was discharged after 3 days from the hospital.

I took the medications advised by the doctors at home. Gradually, I could notice relief of my symptoms. My menstrual cycle was regular, with little or no pain and average flow. My abdominal pain and other symptoms had also subsided.

Informed Consent

Informed consent was obtained by the patient in the study.

CONCLUSION

Broad ligament leiomyomas are rare and they mimic ovarian neoplasm on clinical and radiological examination. Therefore, it is necessary that we keep them as important differential diagnosis for such solid adnexal or ovarian mass. Broad ligament leiomyoma diagnosis is difficult clinically and radiologically due to its rarity and unusual presentation. It is therefore very important for the histopathologist to diagnose it.

Conflict of Interest: *Nil*

Source of Funding: *Nil*

Acknowledgement: *Nil*

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Preparation of the Manuscript

The text of observational and experimental articles should be divided into sections with the headings: Introduction, Methods, Results, Discussion, and Conclusion. References, tables, figures, legends, and Acknowledgment, Appendices and Abbreviations may be provided after the Abstract page.

Title Page

The title page should carry the following:

1. Type of manuscript (e.g. Original Article, Review Article, Case Report and so on).
2. The Title should be descriptive of the subject
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4. The name of each contributor is to be provided (Last name, First name and initials of middle name), with their academic degree and institutional affiliation
5. The name of the department(s) and institution(s) to which the work may be attributed;
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9. Acknowledgement, if any; and
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Abstract Page:

The second page should carry the full title of the manuscript and an Abstract (of no more than 150 words for case reports, brief reports and 250 words for original articles). The abstract should be structured and state the Context (Background), Aims, Settings and Design, Methods and Materials, Statistical analysis used, Results and Conclusions. A minimum of 4 keywords and a maximum of 8 keywords may be provided by the author for indexing.

Introduction

State the background and purpose of the study and summarize the rationale for it. Describe in a few short sentences in simple English, the background and significance of your article in the following format.

Materials and Methods

The Meterials and Methods section should include only information that was available at the time the plan or protocol for the study was written such as study approach, study design, type of sample, sample size, sampling technique, setting of the study, description of data collection tools and methods.

Reports of randomized clinical trials should be based on the CONSORT Statement. (www.consort-statement.org) When reporting experiments on human subjects, indicate whether the procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional or regional) and with the Helsinki Declaration of 1975, as revised in 2000 (available at http://www.wma.net/e/policy/17-c_e.html).

Supplementary materials and technical details can be placed in an appendix where it will be accessible but will not interrupt the flow of the text; alternatively, it can be

Result

Present your results in a logical sequence in the text, tables, and illustrations, describing the most important findings first. Do not repeat the data in the tables or illustrations; emphasize or summarize only important published only in the electronic version of the journal.

Discussions

Include a summary of key findings (primary outcome measures, secondary outcome measures, results as they relate to a prior hypothesis); strengths and limitations of the study (Study question, design, data collection, analysis and interpretation); interpretation and implications in the context of the totality of evidence (is there a systematic review to refer to, if not, could one be reasonably done here and now? What does this study add to the available evidence, effects on patient care and health policy, possible mechanisms). Controversies raised by this study; and future directions (for this particular research collaboration, underlying mechanisms, clinical research). Do not repeat in detail data or other material given in the Introduction or the Results section.

References

References should be listed in alphabetical order and numbered accordingly. Each listed reference should be cited in the text. Identify references in text, tables, and legends by Arabic numerals in square bracket (e.g. [10]). Please refer to ICMJE Guidelines (http://www.nlm.nih.gov/bsd/uniform_ requirements.html) for more examples.

Standard journal article

- 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.
- Twetman S, Axelsson S, Dahlgren H, Holm AK, Källestål C, Lagerlöf F, et al. Caries-preventive effect of fluoride toothpaste: A systematic review. Acta Odontol Scand 2003; 61: 347-55.

Article in supplement or special issue

- Fleischer W, Reimer K. Povidone iodine antisepsis. State of the art. Dermatology 1997; 195 Suppl 2: 3-9.

Corporate (collective) author

- American Academy of Periodontology. Sonic and ultrasonic scalers in periodontics. J Periodontol 2000; 71: 1792-801.

Unpublished article

- Garoushi S, Lassila LV, Tezvergil A, Vallittu PK. Static and fatigue compression test for particulate filler composite resin with fiber-reinforced composite substructure. Dent Mater 2006.

Personal author(s)

- Hosmer D, Lemeshow S. Applied logistic regression, 2nd edn. New York: Wiley-Interscience; 2000.

Chapter in book

- Nauntofte B, Tenovuo J, Lagerlöf F. Secretion and composition of saliva. In: Fejerskov O,

No author Listed

- World Health Organization. Oral health surveys - basic methods, 4th edn. Geneva: World Health Organization; 1997.

Reference from electronic media

- National Statistics Online—Trends in suicide by method in England and Wales, 1979-2001. www.statistics.gov.uk/downloads/theme_health/HSQ20.pdf (accessed Jan 24, 2005): 7-18. Only verified references against the original documents should be cited. Authors are responsible for the accuracy and completeness of their references and for correct text citation. The number of reference should be kept limited to 20 in case of major communications and 10 for short communications.
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- Tables should be self-explanatory and should not duplicate textual material.
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- Explain in footnotes all non-standard abbreviations that are used in each table.
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- Graphics files are welcome if supplied as Tiff, EPS, or PowerPoint files of minimum 1200x1600 pixel size. The minimum line weight for line art is 0.5 point for optimal printing.
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- Conflicts of interest disclosed

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- Middle name initials provided.
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- Headings in title case (not ALL CAPITALS). References cited in square brackets

References according to the journal's instructions

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- Numerals at the beginning of the sentence spelt out

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- Actual numbers from which graphs drawn, provided.
- Figures necessary and of good quality (color)
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