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Determination of Sex Using Mastoid Process among South Indian Population - A Review

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Abstract

Identification of an individual is of utmost importance in conditions of natural calamities or in case of man made disaster. Determination of sex becomes the primary priority in the process of identification of a person by a forensic investigator during the time of crime investigations, natural disasters and the ethnic studies. Determination of sex is one of the vital for the identification of an individual. Often the fragmentary remains are available for forensic identification of an individual making sex determination difficult. When the pelvic bone is unavailable, the skull is also widely considered the best indicator of sex. Skull is important in this regard as it resists adverse environmental conditions over time. The first indicator for the sex determination is the pelvic bones and pelvis which is more accurate than the skull bones. The skull is the most dimorphic and easily sexed portion of the skeleton after pelvis, providing up to 92% reliability. The mastoid process can thus be used as a best indicator of sex as well as ancestry of populations and individuals. Mastoid process is a dimorphic bone situated at the basolateral region of the skull. This mastoid process is placed in the posterior aspect of the temporal bone. Mastoid process is one of the two projections situated behind the ear. The mastoid process provides an attachment for certain muscles of the neck. This mastoid process is a fragmentary piece of skull, is ideal for sexual dimorphism as it is resistant to damage due to its anatomical position at the base of the skull. The mastoid process of the skull plays a vital role in determination of the sex as it is the most di-morphic bone present at the baso-lateral region of the skull. Detailed morphometric analysis of mastoid process, mastoid triangle will help in the planning of surgical intervention involving the skull base. This review will be useful for the anatomist, neurosurgeon, radiologist and morphologists clinical anatomists to carry out further research work. The aim of the present review is the determination of sex using mastoid process and mastoid triangle among south Indian population

Keywords: *Morphometry; sex determination; mastoid process; mastoid triangle; forensic investigation.*

Introduction

Historically, identification of individuals is one of the most challenging and difficult subjects that man has confronted. The concept of identity, with few significant variations, is the same as the assertion of that identity is a set of physical characteristics, functional or psychic, normal or pathological, that define an individual [1–3]. Nowadays, human identification is a universal process based on scientific principles, mainly involving fingerprinting, the objective of which is to identify and register individuals for both civil and criminal identification purposes [4–6] the application of the knowledge of physical anthropology for the purpose of forensic medicine constitutes forensic anthropology [7–9]. Anthropology is the study of measurements or proportions of human body such as bones, muscle and adipose tissue according to sex and age for identification purposes. Forensic anthropology is the application of the

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science of physical anthropology and human osteology in other words the study of human skeleton Achievement of sex determination depends upon the completeness of the skeleton.

Sex classification is more precise in pelvic remains than the skull but whole and complete pelvic bone is not always available for analysis[10–12]. Skull is probably the second best region of the skeleton to determine sex often fragmentary remains are available, instead of complete skeletons for forensic evaluation. Furthermore, the petrous part of temporal bone is resistant to destruction and damage such as burning [13–15]. The mastoid region is favorable for sex determination as it is one of the most protected region and resistant to damage[16,17]. The mastoid process is a pyramidal bony projection from the posterior section of the temporal bone. It is located just behind the external acoustic meatus and lateral to the styloid process in the skull. The mastoid process characteristics are of great utility in the determination of sex. The mastoid Triangle (MT) is a triangle constructed between the landmark pterion, mastoidale and asterion. Parameters like mastoid process length can be used as predictors to determine gender [18,19]

Materials and Methods

Articles were collected from PMC database, Medline database. Using keywords, mastoid triangle, mastoid process, sex determination using bones, morphometry of the skull. The total number of articles collected were 34. All the collected articles were systematically analysed for review of its content based on determination of sex using mastoid process among south Indian population .

Results and Discussion

Morphology and Morphometry of Skull

Skull is the most dimorphic and easily sexed portion of the skeleton after the pelvic bone, providing upto 92% reliability. Determination of sex from skeletons is a vital work for a forensic anthropological analysis [20–22] skull is the most ordinarily used skeleton part in forensic anthropological analysis. Studies indicate that pelvis is that the most reliable indicator of sex assessment, and skull is that the other sexual dimorphism is extremely important in studies of morphologically, skeletal biology and human evolution. Skull is important in the determination of sex as it resists adverse environmental conditions over time. Dimorphic characteristics of sex are often studied metrically and morphologically, although morphologic studies pose several problems like difficulties with quantification and interobserver error[23]. Investigation into the usability of geometric morphometric analysis in assessment of sexual dimorphism [24,25]. The posterior part of the inferior surface of the skull is formed by the occipital bone.

Prominent features of posterior part of inferior surface are the foramen magnum and associated occipital condyles, jugular foramen, mastoid notch and the squamous part of the occipital bone up to the external occipital protuberance and the superior nuchal lines, hypoglossal canals (anterior condylar canals) and condylar canals (posterior condylar canals) [26]. It may be a vital landmark for anthropology, anatomy, forensic pathology, surgeons and other medical fields for the skull base [24].

Determination of Sex Using Bones

The microscopic age changes that occur in human cortical bone were measured by counting the amount of osteons, osteon fragments and non-Haversian canals. The microscopic determination of age in human bone [27]. Sex determination is one of the first and basic steps of assessing the biological profile. Although the analysis of DNA is the most reliable method for sex determinationit is also the most expensive and time consuming method, which can also be hindered by local conditions [28,29].

During the reconstruction process, numerous issues may arise, including bone fragmentation and poor preservation of skeletal remains, coupled with the complexity of human skeleton [30]. Osteometric studies using individual bones exhibiting sexual dimorphism have been reported among different population

Mastoid Process

In the skull, the mastoid bone is robust and tough making it resistant to physical damage. The mastoid region is favourable for sex determination for two reasons it's compact structure of the petrous portion and it's protected position at the base of the skull. Hence, it is commonly found intact in skeletons of very old age. Even though the skull is fragmented, the mastoid stays intact. The mastoid process characteristics are of great

utility in determination of sex. Studies based on human skeletal remains for determination of sex have been the topic of interest among the researchers.

The mastoid region is considered as one of the slowest and later growing regions of the cranial cavity and this mastoid region shows a higher degree of sexual dimorphism in adulthood. The mastoid process is a conical prominence which projects from the undersurface of mastoid portion of temporal bone situated behind the and lateral to the tactic and external acoustic meatus and lateral to the styloid process. The mastoid process is larger in males than in females. Difference between the size of mastoid process in males and females could be due to the variation in growth of mastoid process in both males and females along with response of stronger muscle actions of the muscles attached to it. The important role of this bone is that, it is a point for attachment of several muscle the of the neck such as splenius capitis, longissimus capitis, posterior belly of digastric and sternocleidomastoid, because of these muscle attachments mastoid tend to be larger in males and smaller in females. Determination of sex through skeletal remains is an age old and time tested method.

In the understanding of humans the sex determination from skeletal remains has began ever since Hippocrates period, but thorough knowledge was acquired in post renaissance period. Such knowledge is applied in time of war, crimes, genocides, or mass disaster [11]. In the skull, the mastoid bone is robust and tough making it resistant to physical damage. The mastoid region is favorable for sex determination for two reasons – the compact structure of the petrous portion and its protected position at the base of the skull [31]. The mastoid process can be used as a marker of determination of sex in unidentified human skeletal remains. The articles reviewed for the determination of sex using mastoid process by morphometric parameters were subjected for quality analysis and the confidence level scoring was given as level 1, level 2, level 3 and graded accordingly as low, moderate and high (Table 1). The articles were subjected for scoring with a scale ranging from 1 to 10, represented in Table 2.

Mastoid Triangle

The mastoid triangle varies in different age groups. The perimeter, area, dimensions and the angles of the mastoid triangle were analysed for their utility in determination of sex [32]. The mastoid triangle is one of the poor indicator of sex . The sex difference has been observed to be statistically significant for all measurements except for the angles of the opisthion-Bimastoid triangle the highest value for determination of sex for Asterion- Mastoidale length of right side and next is the Bimastoid breadth. This is useful for determination of sex of unknown bones [33,34]. Heron's formula was used for calculating the area of the mastoid triangle in mm . It needs to be highlighted here that the mastoid triangle does not constitute a flat surface but a slightly curved one, and hence, the area calculated in the study cannot be considered as a true area but area for a two dimensional planar view.

Limitation of the Study

Less articles were reviewed and specific parameters were discussed and considered.

Future Scope

With this we can conclude that the results obtained from the present review may be of use to the forensic experts, neurosurgeons, anthropologists, morphologists clinical anatomists carrying out further research work

Conclusion

This review concluded that the morphometric values of the mastoid process are variable. The mastoid process is a good indicator of sex when all the parameters are considered length is the best parameter when individual parameters are considered. So the knowledge of these variations may guide neurosurgeons to approach in the management of neoplasms and other pathology related to this region. The area of mastoid triangle is considered as a poor indicator of sex. The mastoid triangle plays an important role as a landmark. It is of particular interest in the field of forensic medicine to identify fire victims and also used for intracranial surgical approaches. The result of this study offers a good opportunity to identify sex using the mastoid process apart from pelvimetric and craniometric analysis of sex determination.

Table 1: Quality Analysis showing the articles reviewed for the determination of sex using mastoid process by morphometric parameters were subjected for quality analysis and the confidence level scoring was given as level 1, level 2, level 3 and graded low, moderate and high.

S.No	Author Name	Year	Level	Quality
1	Luiz Airton Saavedra de Paiva	2003	Level 1	High
2	Johnson	2020	Level 1	High
3	Sekar	2019	Level 1	High
4	Alves ES	1965	Level 2	Moderate
5	Seppan	2018	Level 1	High
6	Krishna	2916	Level 1	High
7	Arbenz GO	1988	Level 1	High
8	Nandini	2018	Level 1	High
9	Subashri	2016	Level 1	High
10	Jigyasa Passey	2015	Level 2	Moderate
11	Thejeswar	2015	Level 1	High
12	Sriram	2015	Level 1	High
13	Bass WM	2004	Level 3	Low
14	Kalmey JK	1996	Level 1	High
15	Keerthana	2016	Level 1	High
16	Li Luo	2013	Level 1	High
17	Pratha	2016	Level 2	Moderate
18	Pretorius E	2006	Level 3	Low
19	Menon A	2016	Level 1	High
20	Ropper	1993	Level 1	High
21	Samuel	2015	Level 1	High
22	Nauma	2016	Level 1	High
23	Archana Singh	2019	Level 1	High
24	Željana Bašić	2013	Level 2	Moderate
25	Thenmozhi	2016	Level 1	High
26	Kerley	1965	Level 1	High
27	Gibbon V	2013	Level 1	High
28	Bidmos MA	2010	Level 3	Low
29	Bruzek J	2006	Level 2	Moderate
30	Rajni	2017	Level 1	High
31	TanujKanchan	2013	Level 1	High
32	Sinhorini	2019	Level 1	High
33	Deepali Jain	2013	Level 2	Moderate
34	Choudhari	2016	Level 1	High

Table 2: Showing scoring of the articles for quality analysis with a scale range of 1 to 10 based on the article content, parameters analysed, sample size, statistical analysis and discussion.

S.No	1	2	3	4	5	6	7	8	9	10	Yes	No
1	☑	☑	☑	✖	☑	☑	☑	☑	☑	✖	8	2
2	☑	☑	✖	☑	☑	☑	☑	☑	☑	☑	9	1
3	☑	✖	☑	✖	☑	☑	☑	☑	☑	☑	8	2
4	☑	✖	☑	☑	☑	✖	☑	✖	✖	☑	6	4
5	☑	☑	☑	☑	☑	☑	☑	✖	☑	☑	9	1
6	☑	✖	☑	☑	☑	☑	☑	☑	☑	☑	8	2
7	☑	☑	☑	✖	☑	☑	☑	☑	☑	✖	8	2
8	☑	☑	☑	☑	☑	☑	✖	☑	✖	☑	8	2
9	☑	☑	☑	☑	☑	✖	☑	☑	☑	☑	9	1
10	☑	✖	☑	✖	☑	✖	☑	☑	☑	✖	6	4
11	☑	✖	☑	☑	☑	☑	✖	☑	☑	☑	8	2
12	☑	☑	☑	✖	☑	☑	☑	☑	☑	☑	9	1
13	☑	☑	✖	✖	☑	✖	✖	☑	✖	✖	4	6
14	☑	☑	☑	✖	☑	☑	☑	☑	☑	✖	8	2
15	☑	☑	☑	☑	☑	☑	✖	☑	☑	☑	9	1
16	☑	☑	✖	✖	☑	☑	☑	☑	☑	☑	8	2
17	☑	☑	✖	☑	☑	☑	✖	✖	☑	☑	7	3
18	✖	✖	☑	✖	☑	✖	✖	☑	✖	☑	4	6
19	☑	☑	☑	☑	☑	☑	☑	☑	✖	☑	9	1
20	☑	☑	✖	☑	☑	✖	☑	☑	☑	☑	8	2
21	☑	✖	☑	☑	☑	☑	☑	☑	☑	☑	9	1
22	☑	☑	☑	✖	☑	☑	☑	☑	✖	☑	8	2
23	☑	☑	☑	✖	☑	☑	☑	☑	☑	✖	8	2
24	☑	☑	✖	☑	☑	✖	☑	☑	✖	☑	7	3
25	☑	☑	✖	☑	☑	☑	☑	☑	☑	☑	9	1
26	☑	✖	☑	☑	☑	☑	✖	☑	☑	☑	8	2
27	☑	✖	☑	✖	☑	☑	☑	☑	☑	☑	8	2
28	✖	✖	✖	✖	☑	✖	✖	✖	✖	☑	2	8
29	✖	✖	☑	☑	☑	☑	☑	✖	✖	✖	5	5
30	☑	✖	☑	☑	☑	☑	☑	☑	☑	✖	8	2
31	✖	☑	☑	☑	☑	☑	☑	☑	✖	☑	8	2
32	☑	☑	☑	☑	☑	☑	☑	✖	☑	☑	9	1
33	✖	☑	☑	☑	☑	☑	✖	✖	☑	✖	6	4
34	☑	☑	☑	✖	☑	☑	☑	☑	☑	✖	8	2

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Conflict of Interest: None Declared

Ethical Clearance: As it is a review article so it is not required.

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