MORPHOMETRIC EVALUATION OF FORAMEN MAGNUM FOR SEX DETERMINATION IN A DOCUMENTED NORTH INDIAN SAMPLE

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ABSTRACT: Sex determination is used in anthropology, forensic medicine and medico-legal cases. It is (1) remarked that "next to the pelvis, the skull is the most easily sexed portion of the skeleton". It has been suggested (2-5) that the measurements of the foramen magnum are useful for determining the sex. There are two osteological techniques used to determine the sex of an individual; the first is visual assessment to evaluate the morphological sex traits and second is the metrical, in which the skeletal assessment relies on methods based on measurements. The metric approach is more objective and less dependent on observer experience. **AIM & OBJECTIVE:** The aim of the present study is morphometric evaluation of foramen magnum dimensions in north Indian population and to use these dimensions for sex estimation. **MATERIAL & METHOD:** This study is conducted on 68 human adult skulls of known sex collected from museum of anatomy department of TMMC & RC Moradabad and also from nearby medical colleges of same geographical, cultural and climatic conditions. Well preserved cranial bases were used for this study. Digital stainless steel caliper, osteometric board and blunt craniophore were the instruments used in this study. **ANALYTICAL TEST:** "t" test. **RESULTS:** The dimensions of the foramen magnum were significantly higher in men's skulls. **CONCLUSION:** It is concluded that all values of female are lower than male values, which shows that these parameters are very important for sex determination and constitution of biological profile.

KEY WORDS: Foramen magnum, Morphometric & Sex determination.

INTRODUCTION: The occipital bone is frequently used in forensic anthropology that seeks to determine the sex. Indexes have been built from the dimensions of the foramen magnum, and various authors have reported its usefulness in determining the sex, (6-9) indicated that the sagittal and transverse dimensions of the foramen magnum were significantly higher in men's skulls. In another study, (10) examined the usefulness of determining the dimensions of the foramen magnum in the diagnosis of sex.

The occipital bone being described as perforated by the foramen magnum which is a unique and complex anatomical region within the basal central region of the occipital bone. The anterior border of the foramen magnum is formed by basilar process of the occipital bone, the lateral border by the left and right ex-occipitalis and posterior border is formed by the supra-occipital.

Due to the thickness of the cranial base and its relatively protected anatomical position, this area of the skull tends to withstand both physical insults and inhumation somewhat more successful than many other areas of the cranium (11).

Most of the previous studies of sex differences in the skull were centered on morphological traits in a descriptive manner (cranioscopy). (12-19).

Although, there are numerous methods of measurement used in biological anthropology, but 'anthropometry' is unique in its contribution and peculiarity (20). Anthropometry is a series of systematized measuring techniques that express quantitatively the dimensions of the human body and skeleton. Anthropometry is often viewed as a traditional and perhaps the best tool of anthropology. It is highly objective and reliable in the hands of trained anthropometrist. The metric approach is more objective and less dependent on observer experience. Its replicability is high and it is more amenable to statistical analysis. However, it depends on identifiable and unambiguous osteometric landmarks (21).

(1) Examined sex determination of the skull by discriminant function analysis using ((22) technique. (23) Claimed up to 100% accuracy in predicting sex from foramen magnum region. There has been no previous documented evaluation of the foramen magnum region within the area under study.

The primary goal of this research is to document and analyze the foramen magnum of this region and to investigate its reliability in sex prediction.

MATERIAL AND METHODS: This study was conducted on 68 human adult skulls (38 male and 30 females) of known sex and age (22 to 60 yrs), having no skull anomaly collected from museum of anatomy department of TMMC & RC Moradabad and also from nearby medical colleges of same geographical, cultural and climatic conditions. Sexing of the skull was done as per (24) (see- table-1).

S.N	Traits	Male	Female
1	General size	Large	Small
2	Architecture	Rugged	Smooth
3	Supraorbital ridge	Medium to large	Small to medium
4	Mastoid processes	Medium to large	Small to medium
5	Occipital area	Muscle lines and protuberance marked	Muscle lines and protuberance marked not marked
6	Frontal eminences	Small	Large
7	Parietal eminence	Small	Large
8	Orbits	Squared, lower, relatively smaller	With rounded, higher, relatively larger, with sharp margins
9	Forehead	Steeper, less rounded	Rounded, full ,infantile
10	Cheek bones	Heavier, more laterally arched	Lighter, more compressed
11	Mandible	Larger, higher symphysis, broader ascending ramus	Small with less corpal and ramus dimensions
12	Palate	Larger, broader, tends to U- shape	Small and tends to parabola
13	Occipital condyle	Large	Small
14	Teeth	Large, lower M1 more often 5 cusped	Small, more often 4 cusp

Table: 1

Following measurements of foramen magnum were taken for the study:

1. Anteroposterior diameter of foramen magnum – maximum internal length of the foramen magnum along the midsagittal plane, from opisthion to basion (25).

2. **Transverse diameter of foramen magnum** – maximum internal width of the foramen magnum along the transverse plane.

Other researchers have used image analysis techniques in such as (5) analyzing the sagittal and transverse diameters and the area of the foramen magnum in computerized tomographic images.

Statistical analysis was done using t-test, and a value of $p<0.05$ was considered significant.

RESULTS: The dimensions of the foramen magnum were significantly higher in men's skulls (table-2.1) & (table 2.2)

S.N. M=38	Parameter	Max	SD
1	Transverse diameter	31.5	±0.27
2	Antero posterior diameter	36.9	±0.2

Table-2.1

S.N. F=30	Parameter	Max	SD
1	Transverse diameter	29.5	±0.28
2	Antero posterior diameter	32.9	±0.3

Table-2.2

DISCUSSION: The sex discriminant value of the foramen magnum has attracted attention of (26) (9) (27) (1) & (2) .In the sample analyzed, a significant sexual dimorphism in the foramen magnum dimensions was observed. Metrically the indexes have been built from the dimensions of the foramen magnum and various authors have reported its usefulness in determining the sex. (6-8).Sexual dimorphism using Foramen Magnum have been established by direct metric measurements on the skull(28-30) and also by using computed tomographic images on skull as well as living individuals (31) & (32). (31) Found all dimensions were larger in males than females. (See table-2.3 & 2.4).

S.N. M=144	Parameter	Max	SD
1	Transverse diameter	30.6	±2.5
2	Antero posterior diameter	36.5	±0.2

Table-2.3

S.N. F=71	Parameter	Max	SD
1	Transverse diameter	29.5	±1.9
2	Antero posterior diameter	35.6	±2.5

Table-2.4

The comparison of the morphometric analysis obtained in this study with the results of other studies showed that the anteroposterior diameter of the foramen magnum (male) in the present study is (36.9±0.2) Similar to anteroposterior diameter of foramen magnum of female skulls of present study (32.9±0.3). Regarding the transverse diameter of the foramen magnum, in present study male skulls (31.5±0.27) the same measure for the female skulls of the present study (29.5±0.28). Our study well correlates with the study of (31) One very interesting fact can be observed that all values of female are lower than male values, which shows that these parameters are very important for sex determination and constitution of biological profile.

The width of the foramen magnum of Brazilian skulls showed significant results with the predominance of males over females. According to (33) this difference is related to the fact that the main neurovascular bundle such as the cervical spinal cord, vertebral arteries before and after, nerves and meninges pass through the skull base. Thus, the area of foramen magnum is larger in males due to larger structure of skeletal muscle in men.

In another study, (34) found the dimensions of foramen magnum in Indian sample to be sexually dimorphic and reported up to 100% accuracy of correctly identifying sex using simple demarking points.

The accuracy in the classification is lower than those reported for majority of sexual dimorphism morphological indicators for the occipital bone, and hence, the indexes and tables of the expected range of foramen magnum dimensions in skulls of men and women should be used only as a first approximation to the diagnosis of sex, which is more accurate when we look at the qualitative features of the occipital bone, such as the roughness of the nuchal lines, the shape of the occipital condyles, and the characteristics of the external occipital protuberance.

Values are specific for a particular population, and become low when applied to populations with a large ethnic mix, this also happens in other indicators (35-37).

A review of literature reveals scanty information in sexual dimorphism based on foramen magnum in Indian populations. Therefore, present study has been undertaken with a view to augment data in this direction and to assess the level of sexual dimorphism present in the basal region of the occipital bone in a documented Indian sample.

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