A STUDY OF SEX DETERMINATION USING THE HYOID BONE

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CERTIFICATE

This is to certify that this Dissertation entitled "A STUDY OF SEX DETERMINATION USING THE HYOID BONE" is the Bonafide work of Dr. SAYED KHADER NAWAZ AHMED, a postgraduate student at the Institute of Forensic Medicine, Madras Medical College from 2004-2007.

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Last but not least, I would like to pay my respects to the departed souls whose bodies have contributed to this study.

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INTRODUCTION

INTRODUCTION

The identification of unknown remains is very important. In cases such as victims of aircraft accidents, burnt bodies, mutilated bodies and in exhumation, when unknown remains are found, sex and age should be determined for establishing the identity of the individual. When bones are sent for Medicolegal Examination, some of them become very helpful for determination of sex of the subject. If the whole skeleton is available then sex can be determined accurately in all the cases.[19] When skull and pelvis are available accurate result may be obtained in 98% of the cases. With pelvis alone the rate of accuracy is 95%, with skull alone 90%, and with long bones alone 80-85%. Of all the bones of the body, pelvis (hip bones and sacrum), skull, mandible, sternum with manubrium and femur help maximum to know the sex of the subject. In addition to the bones described already, scapula, tibia, vertebra, ribs can also tell about the sex of a person.

The hyoid bone is of considerable interest in forensic medicine owing to its susceptibility to fracture during manual strangulations.[2, 4, 7, 8, 10, 12, 17]

For example, the presence of a fractured hyoid bone is often of great importance in cases involving badly decomposed bodies and skeletal remains lacking soft tissue evidence of neck injury. The shape of the hyoid bone may influence its susceptibility to fracture [3, 14] and hyoid fractures are frequently confused with normal variation in both clinical and forensic settings. Although the relationship between hyoid bone shape and fracture pattern figures prominently in criminal investigations of strangulations, few quantitative data exist on age and sex differences in hyoid morphology. The first reported study on sexual dimorphism in the hyoid bone was by Miller et al.[13] in 1998.

AIMS & OBJECTIVES

AIMS AND OBJECTIVES

In the present study an analysis of sexual dimorphism of the hyoid bone has been attempted by making use of :

1) The weight

&

2) Three morphometric parameters –

(a) the vertical height of the body of the hyoid bone at its midpoint,

(b) the transverse width of the body of the hyoid bone

&

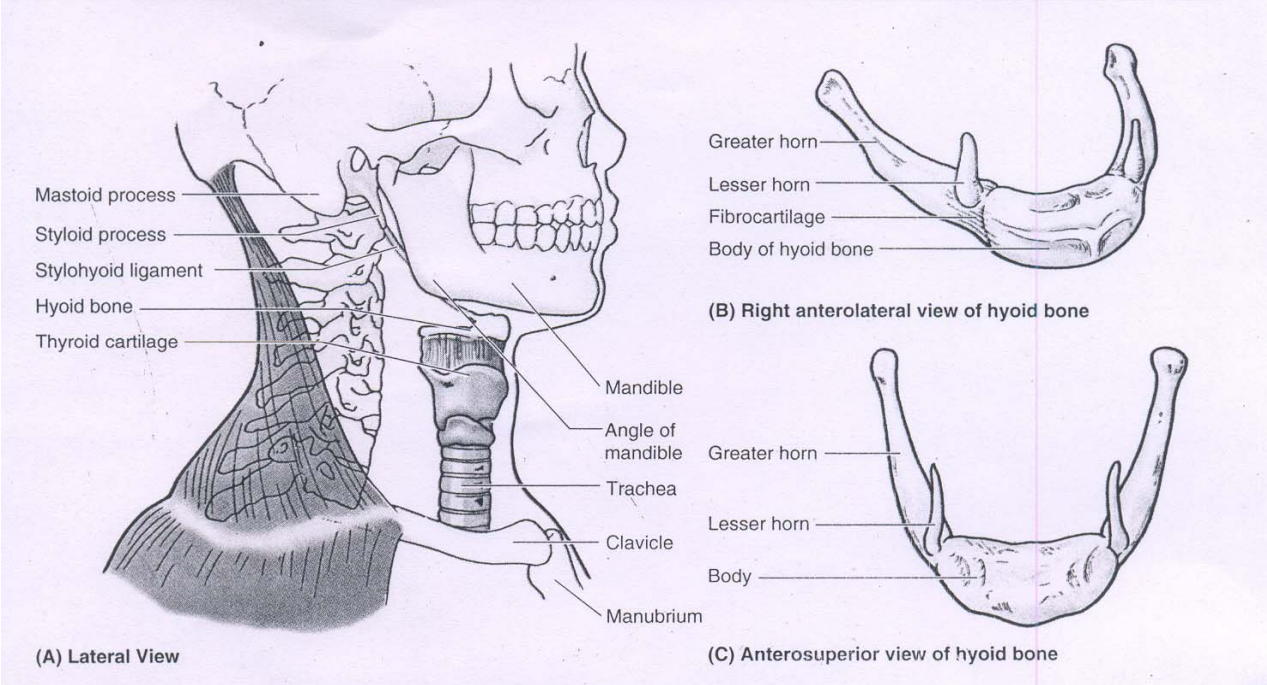
(c) the maximal cornual length of the hyoid bone.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

A detailed understanding of the anatomy of the hyoid bone, the forensic significance and the previous studies of sexual dimorphism are discussed in this section.

I. ANATOMY OF THE HYOID BONE [18]



The U-shaped hyoid bone is suspended from the tips of the styloid process by the styloid ligaments. It has a body, two greater and two lesser horns or cornua.

Body – The body is irregular, elongated and quadrilateral. Its anterior surface is convex, faces anterosuperiorly, and is crossed by a transverse ridge with a slight downward convexity. A vertical median ridge often bisects the upper part of the body; its presence on the lower part is rare. The posterior surface is smooth, concave, faces posterioinferiorly, and is separated from the epiglottis by the thyrohyoid membrane and a loose areolar tissue. There is a bursa between the hyoid bone and the membrane.

Geniohyoid is attached to most of the anterior surface of the body, above and below the transverse ridge, although the medial part of the hyoglossus invades the lateral geniohyoid area. The lower anterior surface gives attachment to mylohyoid; the line of attachment lies above the sternohyoid medially and omohyoid laterally. The lowest fibres of the genioglossus, the hyoepiglottic ligament and (most posteriorly) the thyrohyoid membrane are attached to the rounded superior border.

Sternohyoid is attached to the inferior border medially and omohyoid laterally. Occasionally the medial fibres of thyrohyoid and of levator glandulae thyroidea, when present, are attached along the inferior border.

Greater Cornua – In early life, the greater cornua are connected to the body by cartilage, but after middle age they are usually united by bone. They project backwards(curving posterolaterally) from the lateral ends of the body. They are horizontally flattened, taper posteriorly, and each ends in a tubercle. When the throat is gripped between finger and thumb above the thyroid cartilage, the greater cornua can be identified and the bone can be moved from side to side.

The middle pharyngeal constrictor and more laterally (i.e. superficially) hyoglossus, are attached along the whole length of the upper surface of each greater cornu. Stylohyoid is attached near the junction of the cornu with the body. The fibrous loop for the diagnostic tendon is attached lateral and a little posterior to hyoglossus. The thyrohoid membrane is attached to the medial border and thyrohoid is attached to the lateral border.

The oblique inferior surface is separated form the thyrohoid membrane by fibroareolar tissue.

Lesser Cornua – The lesser cornua are two small conical projections at the junction of the body and greater cornua. At its base, each is connected to the body by fibrous tissue and occasionally to the greater cornu by a synovial joint which occasionally becomes ankylosed.

The middle pharyngeal constrictors are attached to the posterior and lateral spects of the lesser cornua. The stylohyoid ligaments are attached to their apices and are often partly calcified, and the chondroglossi are attached to the medial aspects of their bases.

The hyoid bone serves as a fulcrum for muscles involved in swallowing. When the mandible is fixed, action of the suprahyoid muscles elevates the hyoid bone. This occurs during the swallow sequence's pharyngeal phase**.**

Ossification – The hyoid bone develops from cartilages of the second and third pharyngeal arches, the body from the fused ventral ends of both. Chondrification begins in the fifth foetal week in these elements, and is completed in the third and fourth months. Ossification proceeds from six centres, i.e. a pair for the body and one pair for each cornu. Ossification begins in the greater cornua towards the end of intrauterine life, in the body shortly before or after birth, and in the lesser cornua around puberty. The greater cornual apices remain cartilgenous until the third decade and epiphyses may occur here. Synovial joints between the greater and lesser cornua may be obliterated by ossification in later decades.

II. SIGNIFICANCE OF THE HYOID BONE IN FORENSIC MEDICINE:

The main significance of the hyoid bone in Forensic Medicine is in relation to criminal cases of assault involving manual strangulation (throttling) where the bone may get fractured.[2, 4, 7, 8, 10, 12, 17]

Skeletal Factors that Determine Hyoid Fracture in Manual Strangulation [3, 12, 14]

The reasons why some hyoids fracture during strangulation and others do not may relate to intrinsic anatomic features of the hyoid bone. The fractured hyoids tend to occur in older victims of strangulation (39 ±14 years) when compared to the victims with unfractured hyoids (30 ± 10 years). The age-dependency of hyoid fracture also correlates with the degree of ossification or fusion of the hyoid synchondroses. The hyoid bone is fused in older victims of strangulation (41 ± 12 years) whereas the unfused hyoids are found in the younger victims (28 ± 10 years). The hyoid bone is ossified or fused in 70% of all fractured hyoids.The shape of the hyoid bone was also found to differentiate fractured and unfractured hyoids. Fractured hyoids were longer in the anterio-posterior plane and were more steeply sloping when compared with unfractured hyoids. These data indicate that hyoids of strangulation victims, with and without fracture, are distinguished by various indices of shape and rigidity. On this basis, it may be possible to explain why some victims of strangulation do not have fractured hyoid bones.Injuries to the hyoid bone may yield clues as to the cause of death.

The fractures to the hyoid bone can be classified into three groups[19]:

1. Inward Compression fractures
2. Anteroposterior compression fractures
3. Avulsion fractures

1. Inward Compression Fractures:

In case of throttling where the main force is an inward compression acting on the hyoid bone, the fingers of the grasping hand squeeze the greater horns towards each other, due to which the bone may be fractured and the posterior fragment is displaced inwards. The periosteum is torn on the outer side of the bone, but not on the inner side. In such cases the, if the body of the bone is grasped in one hand, and the distal fragment between the finger and thumb of the other hand, the distal fragment can easily be bent in an inward direction, but outward movement is limited to the normal position only. At the joint between the greater horn of the body and the body of hyoid, a similar fracture may be seen. In some cases, bilateral inward fractures may occur. In cases of putrefaction and maceration, if the soft tissues are not attached to the bone, it is difficult to say whether the small

fragment was fractured inwards or outwards. The bone should be preserved with the soft tissues attached, if it has to be kept as an exhibit.

2. Anteroposterior Compression Fractures:

In cases of hanging, the hyoid bone is forced directly backwards due to which the divergence of greater horns is increased which may fracture with outward diaplacement of the posterior small fragment. In such case, the periosteum is torn on the inner side of the fracture only due to which the fragment can be easily moved outwards, but inward movement is limited to the normal position only. Like the inward compression fracture, anteroposterior compression fracture may be either in the greater horn or at the junction with the body, and it may be bilateral. When compression is severe, the small fragment may be completely detached from the bone and may lie either medially or laterally to the rest of the bone. In such cases, insitu examination of the hyoid bone in the neck will only decide whether the fracture was inward or outward. Outward fractures of the greater horn of the hyoid bone are seen in ligature strangulations, run over motor vehicle accidents, blows on the front of the neck, etc. In these cases, the hyoid bone

is grossly fractured with outward displacement of the fragment and multiple fractures of other structures are also found.

3. Avulsion fractures :

They occur due to muscular overactivity, without there being any direct injury to the hyoid bone. They are also called tug or traction factures. In some cases of bilateral fracture of the hyoid bone in hanging, one greater horn is fractured outwards and the other inwards. The reason why this happens is that the hyoid bone is pressed backwards, as well as moves from side to side in hanging due to which posterior end of the greater horn may be caught against a bony ridge or sides of the vertebrae. An inward fracture of the imprisoned greater horn occurs because of the continued side to side movement and counter-pressure. An outwards fracture of the other greater horn occurs due to the further compression of the vertebral column. The cartilaginous separations between the greater horn and the body, and the joints between the lesser horns and the body, or the presence of incomplete bony union of the hyoid parts should not be mistaken for fractures. Improper dissection of the neck may produce post-mortem fractures.

III. PREVIOUS STUDIES OF SEXUAL DIMORPHISM IN THE HYOID BONE

The first detailed study involving an age and sex related variation in the Hyoid Bone Morphology was done by Miller et al.[13] In this study, they analyzed a large sample of hyoid bones (188 male bones and 127 female bones) taken during autopsy. In each case, the hyoid bone was carefully dissected from the larynx and surrounding connective tissues. Each specimen was radiographed with its inferior surface resting directly on the cassette, 50 inches from the X-ray source. The radiographs were converted into digital images using a high resolution scanner and measured using the Sigma Scan image analysis program. After size calibration, multiple measurements were made on each bone. A series of 30 measurements were made using the image analysis system on digitalized radiographs of 315 hyoid bones from people of known age and sex. Both length and width comparison of the bones were made. Analysis of the results showed that the lengths were much more dimorphic than widths. The distal ends of the greater cornu was found to be larger in females than in males, while the portion of the bone proximal to this in contrast was found to be larger in males than in females. The female hyoids have relatively long and thin distal

segments. This is consistent with the observation that hyoid fractures frequently occur in the posterior and middle third and rarely in the anterior third portions of the greater cornu.

There were a few other studies done earlier on hyoid bone morphology and variations between the sexes using samples from strangulation cases[12, 14]. In these studies the authors chose to describe the hyoid bone as U-shaped, hyperbolic (dimensions of breadth and length are similar) and parabolic (dimensions of breadth are greater than length). In the study done by Miller et al.[13], they refute this observation by the earlier investigators. They state that hyoid bone width/length ratios are continuously distributed and do not fall into discrete categories.

Other studies include an article reported by Harjeet[11]- Size, shape and sexual dimorphism of the hyoid bone in northwest Indians. In this a metrical study of hyoid bones was conducted on male and female bones obtained from medicolegal postmortems, from the Departments of Anatomy and Forensic Medicine at the Postgraduate Institute of Medical Education and Research, Chandigarh. In the adults, all the measurements were greater in

the males than in the females. In this they reported that with a single parameter namely, length of the greater cornu or the width of the body or weight of the bone, the sex could be determined in 11 to 37 percent bones.

Professor Dr. Sivasankaran Pillai and Dr. C. Ranjith of Kerala in their study used weight alone as the parameter for determination of sex of the individual.[6]

Professor Dr. P. Ravishankar and his final year MBBS Part-I student Miss Sonali Belapurkar, in their study of 100 hyoid bones ranging in age from 3-75 years of either sex has concluded that [9] :

(1) A hyoid bone (above 18 years) weighing less than 1222 mgs could belong to a female and weighing more than 1255 mg could belong to a male.

(2) A hyoid bone (above 18 years) with the vertical height of the body at its midpoint less than 10 mm could belong to a female and more than 10.9 mm could belong to a male.

(3) Though both the traits namely the weight and the vertical height were found to be reasonable parameters the vertical height of the body of the hyoid bone at its midpoint having attained an accuracy of more than 95 % was decided to be more reliable and preferable.

MATERIALS AND METHODS

MATERIALS AND METHODS

A metric study and estimation of the weight of hyoid bones obtained from medicolegal postmortems (from cases of the Institute of Forensic Medicine, Madras Medical College and Government general hospital, Chennai), was conducted on a total of 200 individuals- 100 male and 100 female adults varying in age from 18-60 years (Table - I).

Preparation of the bones:

The hyoid bones were taken from the cadavers and the soft tissue dissected using a scalpel and forceps. The residual soft tissue was removed by treatment of the bone with antiformin solution for a period of 48 hours. The details of preparation of antiformin solution is as follows:

Three litres of Antiformin solution was prepared by mixing 150 grams of sodium carbonate in 250 ml of water, 100 grams of bleaching powder in 750 ml of water and 1000 ml of 15% sodium hydroxide in 1000 ml of water. After antiformin treatment to remove the soft tissues, the bones were washed with water and then air dried in the shade for a period of one week. Figure 1

– shows a male and a female hyoid bone after removal of soft tissues using this procedure. The bones were then weighed and the various metric measurements made using a vernier calipers. For weighing the bones a POCKET SCALE mini jeweller's balance was used (Reg No. A602751, vendor - SR scales, Chennai). This was a battery operated electronic device and had an accuracy of 0.01 grams (correct to 10 milligrams weight) and could measure upto a maximum of 50.00 grams. A stainless steel vernier calipers was used with an accuracy of 0.01 cm. Figure II-A & B illustrates the estimation of weight using the POCKET SCALE mini jeweller's balance for a male and a female hyoid bone. Figure III – A & B illustrates the estimation of the vertical height of the body of the hyoid bone using the vernier calipers.

Statistical Analysis:

The statistical analysis was done using Microsoft Access SPSS (Statistical Package for Social Sciences) software. Following are the details of the analysis done:

1. The mean, standard deviation and standard error was first calculated for each of the four parameters – Weight, Vertical height of the Body, Transverse width of the body, Average mean cornual length for both sexes (Table-II).

2. Next, the data for both males and females was divided into six groups with age intervals of six years each as – 18-25, 26-32, 33-39, 40-46, 47-53, 54-60 years. The mean and standard deviation for each of the four parameters was calculated for each of the age groups in order to find out in order to find out if there was any age related variation in the values (Table - IV, V & VI). Additionally an analysis of variance (ANOV) was done in order to determine if these differences between the age groups was statistically significant (Table – VIII).

3. Next, a Discriminant analysis using a Multivariant Model was done to determine the sexual dimorphism in each of the four parameters. The purpose of this analysis was to find out which of the four parameters showed the greatest dimorphism (Table VII).

RESULTS AND OBSERVATION

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Table I :

Breakup According to Age and Sex :

S.No.	Age Groups(in years)	No. of Males	No. of Females	Total No.
1.	18-25	35	40	75
2.	26-32	16	14	30
3.	33-39	18	11	29
3.	40-46	17	12	29
4.	47-53	5	9	14
5.	54-60	9	14	23
Total	-	100	100	200

Table II :

Data for Male Bones:

S.No.	P.M. No.	Institute	Age (yrs)	Vertical Height (cm)	Weight (grams)	Average maximal Cornual length (cm)	Tranverse Width (cm)
1.	1461/05	MMC	60	1.07	1.04	3.10	2.10
2.	1255/05	MMC	36	1.04	0.82	2.94	2.21
3.	1492/05	MMC	20	1.15	0.81	2.95	1.87
4.	1347/05	MMC	42	1.06	1.11	3.11	1.99
5.	1339/05	MMC	26	0.85	1.05	3.12	1.93
6.	1218/05	MMC	24	1.10	1.17	3.08	2.14
7.	1311/05	MMC	21	1.13	0.79	3.14	2.18
8.	1288/05	MMC	35	1.05	1.18	2.94	1.98
9.	1312/05	MMC	40	1.33	0.94	3.23	1.91
10.	1425/05	MMC	60	1.32	0.83	3.28	2.46
11.	1439/05	MMC	37	1.25	0.80	2.60	2.09
12.	1417/05	MMC	35	1.14	1.04	3.11	2.51
13.	1446/05	MMC	21	1.14	0.64	3.12	1.69
14.	1468/05	MMC	24	0.96	1.17	3.14	2.32
15.	1484/05	MMC	45	1.06	1.44	3.22	2.12
16.	1379/05	MMC	45	1.06	1.49	3.13	2.26
17.	1095/05	MMC	31	1.14	1.22	3.11	2.35
18.	1347/05	MMC	45	1.18	1.69	3.16	2.05
19.	1480/05	MMC	40	1.06	1.49	3.39	2.11
20.	1346/05	MMC	28	0.95	0.72	2.28	1.79
21.	1409/05	MMC	18	1.10	0.88	2.98	1.91
22.	1408/05	MMC	43	1.11	0.72	3.09	1.92
23.	1288/05	MMC	35	1.05	0.86	3.11	2.57
24.	1467/05	MMC	53	1.00	1.02	3.29	2.19
25.	1397/05	MMC	22	1.24	1.24	3.25	2.26

Table II (continued) :

Data for Male Bones:

S.No.	P.M. No.	Institute	Age (yrs)	Vertical Height (cm)	Weight (grams)	Average maximal Cornual length (cm)	Tranverse Width (cm)
26.	1412/05	MMC	20	1.23	0.99	2.73	1.72
27.	1405/05	MMC	24	0.90	0.87	3.27	1.85
28	1188/05	MMC	30	1.04	0.82	3.45	1.91
29.	1356/05	MMC	24	1.10	0.79	2.88	1.86
30.	1291/05	MMC	26	1.14	0.65	3.25	1.75
31.	1292/05	MMC	23	0.87	0.78	2.75	2.05
32.	1493/05	MMC	28	0.86	0.91	2.76	2.07
33.	1342/05	MMC	38	1.04	0.86	3.31	1.94
34.	1485/05	MMC	28	1.14	1.42	3.40	2.11
35.	1490/05	MMC	28	1.04	1.22	3.29	1.92
36.	1513/05	MMC	23	1.04	0.99	3.05	2.11
37.	1507/05	MMC	52	1.04	0.97	3.43	1.08
38.	1505/05	MMC	22	1.23	1.42	3.67	2.01
39.	1499/05	MMC	40	1.05	0.92	2.63	2.00
40.	1498/05	MMC	19	1.14	1.00	3.17	1.86
41.	1200/05	MMC	26	1.15	1.17	3.38	2.09
42.	1194/05	MMC	45	1.04	0.84	3.41	1.95
43.	1182/05	MMC	60	1.05	1.06	3.16	1.92
44	1094/05	MMC	40	1.32	1.04	3.25	2.11
45.	1184/05	MMC	32	1.13	1.24	3.50	1.96
46.	1186/05	MMC	58	1.24	1.45	2.94	2.52
47.	1443/05	MMC	35	1.04	1.30	2.94	2.22
48.	1061/05	MMC	26	1.14	0.98	2.74	1.83
49.	1144/05	MMC	23	1.23	0.98	2.94	2.11
50.	1117/05	MMC	57	1.33	1.35	4.00	3.03

Table II (continued) :

Data for Male Bones:

S.No.	P.M. No.	Institute	Age (yrs)	Vertical Height (cm)	Weight (grams)	Average maximal Cornual length (cm)	Tranverse Width (cm)
51.	1071/05	MMC	56	1.15	1.01	2.81	2.16
52.	1496/05	MMC	25	1.32	1.16	2.82	2.04
53.	1482/05	MMC	21	1.25	0.72	2.96	1.95
54.	1116/05	MMC	38	1.39	1.14	3.28	2.11
55.	1306/05	MMC	28	1.17	1.12	2.90	2.31
56.	1031/05	MMC	33	1.05	0.70	2.78	1.94
57.	1396/05	MMC	32	1.14	1.04	3.52	2.01
58.	1056/05	MMC	38	0.96	0.89	2.77	1.79
59.	1122/05	MMC	37	1.23	1.08	3.40	2.06
60.	1170/05	MMC	46	1.06	1.88	3.24	2.00
61.	1025/05	MMC	45	1.16	1.29	3.28	3.24
62.	1308/05	MMC	25	1.17	0.87	3.21	1.84
63.	1181/05	MMC	50	1.14	1.09	2.13	3.24
64.	1427/05	MMC	39	1.25	1.02	2.99	1.84
65.	1419/05	MMC	38	0.89	0.85	3.29	1.95
66.	1452/05	MMC	23	1.23	1.04	3.25	2.01
67.	1458/05	MMC	23	1.10	0.96	3.00	1.92
68.	1182/05	MMC	38	0.96	0.91	3.36	2.07
69.	1057/05	MMC	42	0.98	0.96	3.26	1.91
70.	1466/05	MMC	20	1.24	1.02	3.74	2.12
71.	1495/05	MMC	33	1.23	1.06	3.15	1.86
72.	1424/05	MMC	29	1.25	1.89	3.20	2.77
73.	1421/05	MMC	25	1.15	1.32	3.25	2.51
74.	1450/05	MMC	32	1.25	1.08	3.05	2.60
75.	1259/05	MMC	35	0.97	0.99	3.16	2.31

Table II (continued) :

Data for Male Bones:

S.No.	P.M. No.	Institute	Age (yrs)	Vertical Height (cm)	Weight (grams)	Average maximal Cornual length (cm)	Tranverse Width (cm)
76.	1405/05	MMC	24	1.16	1.53	3.52	2.72
77.	1188/05	MMC	30	1.04	1.27	3.16	2.32
78.	1356/05	MMC	24	1.13	1.04	3.28	2.32
79.	1291/05	MMC	20	1.15	1.09	2.96	2.09
80.	1292/05	MMC	20	1.14	1.05	3.31	1.81
81.	1493/05	MMC	21	1.27	0.59	2.81	1.86
82.	1342/05	MMC	56	1.20	1.11	3.12	2.23
83.	1485/05	MMC	22	1.14	0.89	3.37	2.25
84.	1490/05	MMC	54	1.14	0.89	3.34	2.15
85.	1513/05	MMC	36	1.04	1.10	2.79	2.27
86.	1507/05	MMC	42	1.22	1.01	3.29	2.10
87.	1505/05	MMC	40	1.14	1.13	2.79	2.29
88.	1499/05	MMC	20	1.04	0.77	3.29	1.20
89.	1498/05	MMC	35	1.14	0.81	3.19	1.81
90.	1200/05	MMC	45	1.26	0.71	2.92	2.20
91.	1194/05	MMC	21	1.16	0.84	3.34	1.58
92.	1182/05	MMC	54	0.97	0.91	3.37	2.57
93.	1094/05	MMC	50	0.95	0.79	3.27	1.91
94.	1184/05	MMC	25	1.00	1.08	3.40	1.82
95.	1186/05	MMC	21	1.05	0.79	2.85	1.77
96.	1443/05	MMC	18	1.06	0.83	2.79	1.88
97.	1061/05	MMC	25	1.13	0.92	3.35	1.72
98.	1144/05	MMC	18	1.15	0.90	2.50	2.01
99.	1368/05	MMC	50	1.00	0.87	3.10	2.43
100.	1117/05	MMC	40	1.11	1.25	3.12	1.65

Table II (continued) :

Data for Female Bones :

S.No.	P.M. No.	Institute	Age (yrs)	Vertical Height (cm)	Weight (grams)	Average maximal Cornual length (cm)	Tranverse Width (cm)
1.	1939/05	MMC	28	0.94	0.85	2.36	1.81
2.	2024/05	MMC	20	0.84	0.64	2.47	1.62
3.	1918/05	MMC	22	1.04	0.54	2.78	1.45
4.	2003/05	MMC	39	1.10	0.72	2.79	1.96
5.	1988/05	MMC	42	0.85	0.56	2.61	1.66
6.	1956/05	MMC	20	0.93	0.57	2.03	1.42
7.	1785/05	MMC	27	1.10	0.61	2.31	1.70
8.	1884/05	MMC	25	1.04	0.85	2.82	1.62
9.	1667/05	MMC	48	1.05	0.61	2.81	1.95
10.	1774/05	MMC	57	1.04	0.74	2.85	2.12
11.	1187/05	MMC	60	0.87	0.50	2.87	1.50
12.	1123/05	MMC	30	0.99	0.92	3.15	1.99
13.	1114/05	MMC	35	0.95	0.68	2.57	1.90
14.	1178/05	MMC	35	0.89	0.39	3.32	1.91
15.	1428/05	MMC	26	1.00	0.79	2.71	1.59
16.	1500/05	MMC	19	0.87	0.64	2.35	1.80
17.	1092/05	MMC	50	0.98	0.76	2.72	2.12
18.	1131/05	MMC	30	1.02	0.64	2.67	1.80
19.	1661/05	MMC	55	1.04	0.76	2.92	2.10
20.	1643/05	MMC	35	0.96	0.63	2.80	1.87
21.	1212/05	MMC	32	0.94	0.59	2.60	1.82
22.	1219/05	MMC	60	0.96	0.57	2.83	1.72
23.	1238/05	MMC	40	0.88	0.59	3.19	1.63
24.	1258/05	MMC	18	0.87	0.59	2.55	1.92
25.	1251/05	MMC	53	0.94	0.81	2.65	2.01

Table II (continued) :

Data for Female Bones :

S.No.	P.M No.	Institute	Age (yrs)	Vertical Height (cm)	Weight (grams)	Average maximal Cornual length (cm)	Tranverse Width (cm)
26.	1407/05	MMC	23	1.03	0.66	2.73	1.59
27.	1447/05	MMC	55	1.04	0.65	2.78	1.60
28	1413/05	MMC	40	0.83	0.70	3.10	1.90
29.	1174/05	MMC	40	1.03	0.53	3.22	2.02
30.	1169/05	MMC	55	1.04	0.59	2.62	2.20
31.	1062/05	MMC	60	0.89	0.42	2.52	1.86
32.	1355/05	MMC	32	0.96	0.76	2.62	1.64
33.	1854/05	MMC	35	0.86	0.47	2.29	1.55
34.	1663/05	MMC	18	0.89	0.47	2.59	1.24
35.	1796/05	MMC	25	1.05	0.68	2.85	1.92
36.	1258/05	MMC	18	1.05	1.14	2.91	2.01
37.	1747/05	MMC	23	0.99	0.68	2.75	1.70
38.	1752/05	MMC	23	0.93	0.67	2.89	1.72
39.	1214/05	MMC	18	0.90	0.45	2.78	1.60
40.	1254/05	MMC	18	0.83	0.43	2.93	1.32
41.	2134/05	MMC	35	1.10	1.05	2.92	1.90
42.	2253/05	MMC	40	0.94	0.83	2.92	2.00
43.	2311/05	MMC	50	0.90	0.80	2.86	1.64
44	2343/05	MMC	27	0.92	0.49	3.00	1.65
45.	2249/05	MMC	40	0.99	0.82	2.59	1.66
46.	2427/05	MMC	28	0.98	0.76	2.82	1.82
47.	2344/05	MMC	45	1.15	0.57	2.59	1.56
48.	2354/05	MMC	18	0.82	0.60	2.58	1.22
49.	1568/05	MMC	19	0.85	0.61	2.37	1.52
50.	24/06	MMC	25	0.98	1.08	3.01	1.69

Table II (continued) :

Data for Female Bones :

S.No	P.M No.	Institute	Age (yrs)	Vertical Height (cm)	Weight (grams)	Average maximal Cornual length (cm)	Tranverse Width (cm)
51.	33/06	MMC	22	0.87	1.00	2.87	1.60
52.	103/06	MMC	50	0.94	0.72	2.73	1.95
53.	120/06	MMC	23	0.93	0.53	2.60	1.35
54.	140/06	MMC	19	0.87	0.59	2.37	1.58
55.	81/06	MMC	26	0.96	0.99	2.81	2.01
56.	85/06	MMC	54	0.89	0.51	2.41	1.35
57.	144/06	MMC	18	1.06	0.63	2.52	1.62
58.	162/06	MMC	25	0.98	0.81	2.75	1.59
59.	166/06	MMC	24	0.84	0.94	2.76	2.12
60.	202/06	MMC	18	0.87	0.69	2.84	1.55
61.	187/06	MMC	22	0.85	0.64	2.91	1.50
62.	200/06	MMC	18	1.00	0.61	2.30	1.25
63.	201/06	MMC	18	0.90	0.69	2.89	1.55
64.	206/06	MMC	18	0.87	0.62	2.92	1.85
65.	217/06	MMC	24	1.06	0.67	2.83	1.78
66.	283/06	MMC	42	0.87	0.44	2.82	1.62
67.	379/06	MMC	46	0.96	0.65	2.64	1.01
68.	417/06	MMC	19	0.94	0.76	3.05	1.72
69.	473/06	MMC	55	0.96	0.44	2.86	1.75
70.	206/06	MMC	39	0.87	0.65	2.86	1.87
71.	220/06	MMC	40	0.87	0.89	2.63	1.92
72.	254/06	MMC	50	0.99	0.64	3.12	1.86
73.	280/06	MMC	19	0.91	0.56	2.62	1.52
74.	276/06	MMC	18	0.95	0.78	2.52	1.75
75.	333/06	MMC	57	0.98	0.53	2.78	1.80

Table II (continued) :

Data for Female Bones :

S.No	P.M No.	Institute	Age (yrs)	Vertical Height (cm)	Weight (grams)	Average maximal Cornual length (cm)	Tranverse Width (cm)
76.	340/06	MMC	18	0.87	0.68	2.60	1.51
77.	378/06	MMC	35	0.87	0.62	2.82	1.74
78.	43/06	MMC	25	0.80	0.69	2.89	1.40
79.	1402/06	MMC	50	0.98	0.40	2.48	1.81
80.	1426/06	MMC	57	0.99	0.64	3.02	1.59
81.	1432/06	MMC	19	0.95	0.83	2.54	1.54
82.	1471/06	MMC	23	0.86	0.78	2.52	1.54
83.	1485/06	MMC	58	0.97	0.60	2.00	3.05
84.	1489/05	MMC	54	1.07	0.96	2.79	2.05
85.	1493/05	MMC	25	0.96	0.69	2.78	1.92
86.	1495/05	MMC	30	1.10	1.20	3.64	1.82
87.	1496/05	MMC	27	0.90	0.54	2.59	1.60
88.	1506/05	MMC	20	1.20	0.82	2.76	1.80
89.	1509/05	MMC	60	0.88	0.99	2.16	3.02
90.	1510/05	MMC	35	1.10	0.68	2.55	2.05
91.	1525/05	MMC	40	0.87	1.13	2.90	1.72
92.	1527/05	MMC	19	0.98	0.56	2.56	1.68
93.	1544/05	MMC	27	1.00	0.73	2.64	1.59
94.	1566/05	MMC	40	0.96	0.64	2.30	1.58
95.	1569/05	MMC	18	0.74	0.50	2.11	1.41
96.	68/06	MMC	50	0.95	0.66	2.72	1.74
97.	77/06	MMC	35	0.94	0.61	2.41	1.82
98.	159/06	MMC	37	0.75	0.91	2.61	2.05
99.	1533/06	MMC	50	1.15	0.90	2.69	2.15
100.	371/06	MMC	28	1.07	0.83	3.16	2.05

Table III :

Statistical Analysis For Male Hyoid Bones :

S.No.	Bone Case No.	Weight (gms) (x)	A. M. (xi)	M.D. (x-xi)	(x-xi)2	Height (cm) (x)	A. M. (xi)	M.D. (x-xi)	(x-xi)2
1.	1461/05	1.04	1.03	0.01	0.0001	1.07	1.11	0.04	0.0016
2.	1255/05	0.82	1.03	0.21	0.0441	1.04	1.11	0.07	0.0049
3.	1492/05	0.81	1.03	0.02	0.0004	1.15	1.11	0.04	0.0016
4.	1347/05	1.11	1.03	0.08	0.0064	1.06	1.11	0.05	0.0025
5.	1339/05	1.05	1.03	0.02	0.0004	0.85	1.11	0.26	0.0676
6.	1218/05	1.17	1.03	0.14	0.0196	1.10	1.11	0.01	0.0001
7.	1311/05	0.79	1.03	0.24	0.0576	1.13	1.11	0.02	0.0004
8.	1288/05	1.18	1.03	0.15	0.0225	1.05	1.11	0.06	0.0036
9.	1312/05	0.94	1.03	0.09	0.0081	1.33	1.11	0.22	0.0484
10.	1425/05	0.83	1.03	0.20	0.0400	1.32	1.11	0.21	0.0441
11.	1439/05	0.80	1.03	0.23	0.0529	1.25	1.11	0.14	0.0196
12.	1417/05	1.04	1.03	0.01	0.0001	1.14	1.11	0.03	0.0009
13.	1446/05	0.66	1.03	0.37	0.1369	1.14	1.11	0.03	0.0009
14.	1468/05	1.77	1.03	0.14	0.0196	0.96	1.11	0.15	0.0225
15.	1484/05	1.44	1.03	0.41	0.1681	1.06	1.11	0.05	0.0025
16.	1379/05	1.49	1.03	0.46	0.2116	1.06	1.11	0.05	0.0025
17.	1095/05	1.22	1.03	0.19	0.0361	1.14	1.11	0.03	0.0009
18.	1347/05	1.69	1.03	0.66	0.4356	1.18	1.11	0.07	0.0049
19.	1480/05	0.95	1.03	0.08	0.0064	1.06	1.11	0.05	0.0025
20.	1346/05	0.72	1.03	0.31	0.0961	0.95	1.11	0.16	0.0256
21.	1409/05	0.88	1.03	0.15	0.0225	1.10	1.11	0.01	0.0001
22.	1408/05	0.72	1.03	0.31	0.0961	1.11	1.11	0.00	0.0000
23.	1288/05	0.86	1.03	0.17	0.0289	1.05	1.11	0.06	0.0036
24.	1467/05	1.02	1.03	0.01	0.0001	1.00	1.11	0.11	0.0121
25.	1397/05	1.24	1.03	0.21	0.0441	1.24	1.11	0.13	0.0169

Table III (continued):

Statistical Analysis For Male Hyoid Bones (continued) :

S.No.	Bone Case No.	Weight (gm) (x)	A. M. (xi)	M.D. (x-xi)	(x-xi)2	Height (cm) (x)	A. M. (xi)	M.D. (x-xi)	(x-xi)2
26.	1412/05	0.99	1.03	0.04	0.0016	1.23	1.11	0.12	0.0144
27.	1405/05	0.87	1.03	0.16	0.0256	0.90	1.11	0.21	0.0441
28.	1188/05	0.82	1.03	0.21	0.0441	1.04	1.11	0.07	0.0049
29.	1356/05	0.79	1.03	0.24	0.0576	1.10	1.11	0.01	0.0001
30.	1291/05	0.65	1.03	0.38	0.1444	1.08	1.11	0.03	0.0009
31.	1292/05	0.78	1.03	0.25	0.0625	1.14	1.11	0.03	0.0009
32.	1493/05	0.91	1.03	0.21	0.0441	0.87	1.11	0.24	0.0576
33.	1342/05	0.86	1.03	0.17	0.0289	0.86	1.11	0.25	0.0625
34.	1485/05	0.42	1.03	0.39	0.1521	1.04	1.11	0.07	0.0049
35.	1490/05	0.22	1.03	0.19	0.1361	1.14	1.11	0.03	0.0009
36.	1513/05	0.99	1.03	0.04	0.0016	1.04	1.11	0.07	0.0049
37.	1507/05	0.97	1.03	0.06	0.0036	1.04	1.11	0.07	0.0049
38.	1505/05	1.42	1.03	0.39	0.1521	1.23	1.11	0.12	0.0144
39.	1499/05	0.92	1.03	0.11	0.0121	1.05	1.11	0.06	0.0036
40.	1498/05	1.00	1.03	0.03	0.0009	1.14	1.11	0.03	0.0009
41.	1200/05	1.17	1.03	0.14	0.0196	1.15	1.11	0.04	0.0016
42.	1194/05	0.84	1.03	0.19	0.0361	1.04	1.11	0.07	0.0049
43.	1182/05	1.06	1.03	0.03	0.0009	1.05	1.11	0.06	0.0036
44.	1094/05	1.04	1.03	0.01	0.0001	1.32	1.11	0.21	0.0441
45.	1184/05	1.24	1.03	0.21	0.0441	1.13	1.11	0.02	0.0004
46.	1186/05	1.45	1.03	0.42	0.1764	1.24	1.11	0.13	0.0169
47.	1443/05	1.30	1.03	0.27	0.0729	1.04	1.11	0.07	0.0049
48.	1061/05	0.98	1.03	0.05	0.0025	1.14	1.11	0.03	0.0009
49.	1144/05	0.98	1.03	0.05	0.0025	1.23	1.11	0.12	0.0144
50.	1117/05	1.34	1.03	0.32	0.1024	1.33	1.11	0.22	0.0484

Table III (continued):

Statistical Analysis For Male Hyoid Bones (continued) :

S.No.	Bone Case No.	Weight (gm) (x)	A. M. (xi)	M.D. (x-xi)	(x-xi)2	Height (cm) (x)	A. M. (xi)	M.D. (x-xi)	(x-xi)2
51.	1071/05	1.01	1.03	0.02	0.0004	1.15	1.11	0.04	0.0016
52.	1496/05	1.16	1.03	0.13	0.0169	1.32	1.11	0.21	0.0441
53.	1482/05	0.72	1.03	0.31	0.0961	1.25	1.11	0.14	0.0196
54.	1116/05	1.14	1.03	0.11	0.0121	1.39	1.11	0.28	0.0784
55.	1306/05	1.12	1.03	0.09	0.0081	1.17	1.11	0.06	0.0036
56.	1031/05	0.70	1.03	0.33	0.1089	1.05	1.11	0.06	0.0036
57.	1396/05	1.04	1.03	0.01	0.0001	1.14	1.11	0.03	0.0009
58.	1056/05	0.89	1.03	0.14	0.0196	0.96	1.11	0.15	0.0225
59.	1122/05	1.08	1.03	0.05	0.0025	1.23	1.11	0.12	0.0144
60.	1176/05	1.88	1.03	0.85	0.7225	1.06	1.11	0.05	0.0025
61.	1025/05	1.29	1.03	0.26	0.0676	1.16	1.11	0.05	0.0025
62.	1308/05	0.87	1.03	0.16	0.0256	1.17	1.11	0.06	0.0036
63.	1181/05	1.09	1.03	0.06	0.0036	1.14	1.11	0.03	0.0009
64.	1427/05	1.02	1.03	0.01	0.0001	1.25	1.11	0.14	0.0196
65.	1419/05	0.85	1.03	0.18	0.0324	0.89	1.11	0.22	0.0484
66.	1452/05	1.04	1.03	0.01	0.0001	1.23	1.11	0.12	0.0144
67.	1458/05	0.96	1.03	0.07	0.0049	1.10	1.11	0.01	0.0001
68.	1464/05	0.91	1.03	0.12	0.0144	0.96	1.11	0.15	0.0225
69.	1057/05	0.96	1.03	0.07	0.0049	0.98	1.11	0.13	0.0169
70.	1466/05	1.02	1.03	0.01	0.0001	1.24	1.11	0.13	0.0169
71.	1495/05	1.06	1.03	0.03	0.0009	1.23	1.11	0.12	0.0144
72.	1424/05	1.89	1.03	0.86	0.7396	1.25	1.11	0.14	0.0196
73.	1421/05	1.32	1.03	0.29	0.0841	1.15	1.11	0.04	0.0016
74.	1450/05	1.08	1.03	0.05	0.0025	1.25	1.11	0.14	0.0196
75.	1259/05	0.99	1.03	0.04	0.0016	0.93	1.11	0.18	0.0324

Table III (continued):

Statistical Analysis For Male Hyoid Bones (continued) :

S.No.	Bone Case No.	Weight (gm) (x)	A. M. (xi)	M.D. (x-xi)	(x-xi)2	Height (cm) (x)	A. M. (xi)	M.D. (x-xi)	(x-xi)2
76.	1201/05	1.53	1.03	0.50	0.2500	1.16	1.11	0.05	0.0025
77.	1244/05	1.27	1.03	0.24	0.0576	1.04	1.11	0.07	0.0049
78.	1206/05	1.04	1.03	0.01	0.0001	1.13	1.11	0.02	0.0004
79.	1489/05	1.09	1.03	0.06	0.0036	1.15	1.11	0.04	0.0016
80.	1372/05	1.05	1.03	0.02	0.0004	1.14	1.11	0.03	0.0009
81.	1358/05	0.59	1.03	0.56	0.3136	1.27	1.11	0.16	0.0256
82.	1343/05	1.11	1.03	0.08	0.0064	1.20	1.11	0.09	0.0081
83.	1325/05	0.89	1.03	0.86	0.7396	1.14	1.11	0.03	0.0009
84.	1260/05	0.89	1.03	0.14	0.0196	1.14	1.11	0.03	0.0009
85.	1173/05	1.10	1.03	0.07	0.0049	1.04	1.11	0.07	0.0049
86.	1202/05	1.01	1.03	0.01	0.0001	1.22	1.11	0.11	0.0121
87.	1257/05	1.13	1.03	0.10	0.0100	1.14	1.11	0.03	0.0009
88.	1234/05	0.77	1.03	0.26	0.0676	1.04	1.11	0.07	0.0049
89.	1227/05	0.81	1.03	0.22	0.0484	1.14	1.11	0.03	0.0009
90.	1228/05	0.71	1.03	0.32	0.1024	1.26	1.11	0.15	0.0225
91.	1230/05	0.84	1.03	0.19	0.0100	1.16	1.11	0.05	0.0025
92.	1229/05	0.91	1.03	0.22	0.0484	0.97	1.11	0.14	0.0196
93.	1241/05	0.79	1.03	0.24	0.0576	0.95	1.11	0.16	0.0256
94.	1235/05	1.08	1.03	0.05	0.0025	1.00	1.11	0.11	0.0121
95.	1232/05	0.79	1.03	0.76	0.5776	1.05	1.11	0.06	0.0036
96.	1213/05	0.83	1.03	0.80	0.6400	1.06	1.11	0.05	0.0025
97.	1215/05	0.92	1.03	0.11	0.0121	1.13	1.11	0.02	0.0004
98.	1210/05	0.90	1.03	0.13	0.0169	1.15	1.11	0.04	0.0016
99.	1368/05	0.87	1.03	0.16	0.0256	1.00	1.11	0.11	0.0121
100.	1107/05	1.25	1.03	0.21	0.0441	1.11	1.11	0.00	0.0000

Table III (continued):

Statistical Analysis For Male Hyoid Bones :

S.No.	Bone Case No.	Average Maximum Cornual Length (cm)	A. M. (xi)	M.D. (x-xi)	(x-xi)2	Transverse Width of the body of the Hyoid (cm) (x)	A. M. (xi)	M.D. (x-xi)	(x-xi)2
1.	1461/05	3.10	3.12	0.02	0.0040	2.10	2.08	0.02	0.0004
2.	1255/05	2.94	3.12	0.18	0.0324	2.21	2.08	0.13	0.0169
3.	1492/05	2.95	3.12	0.17	0.0289	1.87	2.08	0.21	0.0441
4.	1347/05	3.11	3.12	0.01	0.0001	1.99	2.08	0.09	0.0081
5.	1339/05	3.12	3.12	0.00	0.0000	1.93	2.08	0.15	0.0225
6.	1218/05	3.08	3.12	0.04	0.0016	2.14	2.08	0.06	0.0036
7.	1311/05	3.14	3.12	0.02	0.0004	2.18	2.08	0.10	0.0100
8.	1288/05	2.94	3.12	0.18	0.0324	1.98	2.08	0.10	0.0100
9.	1312/05	3.23	3.12	0.11	0.0121	1.91	2.08	0.17	0.0289
10.	1425/05	3.28	3.12	0.16	0.0256	2.46	2.08	0.38	0.1444
11.	1439/05	2.60	3.12	0.52	0.2704	2.09	2.08	0.01	0.0001
12.	1417/05	3.11	3.12	0.01	0.0001	2.51	2.08	0.43	0.1849
13.	1446/05	3.12	3.12	0.00	0.0000	1.69	2.08	0.39	0.1521
14.	1468/05	3.14	3.12	0.02	0.0004	2.32	2.08	0.24	0.0576
15.	1484/05	3.22	3.12	0.10	0.0100	2.12	2.08	0.04	0.0016
16.	1379/05	3.13	3.12	0.01	0.0001	2.26	2.08	0.18	0.0324
17.	1095/05	3.11	3.12	0.01	0.0001	2.35	2.08	0.27	0.0729
18.	1347/05	3.16	3.12	0.04	0.0016	2.05	2.08	0.03	0.0009
19.	1480/05	3.39	3.12	0.11	0.0121	2.11	2.08	0.03	0.0009
20.	1346/05	2.28	3.12	0.84	0.7056	1.79	2.08	0.29	0.0841
21.	1409/05	2.98	3.12	0.14	0.0196	1.91	2.08	0.17	0.0289
22.	1408/05	3.09	3.12	0.03	0.0009	1.92	2.08	0.16	0.0256
23.	1288/05	3.11	3.12	0.01	0.0001	2.57	2.08	0.49	0.2401
24.	1467/05	3.29	3.12	0.17	0.0289	2.19	2.08	0.11	0.0121
25.	1397/05	3.25	3.12	0.13	0.0169	2.26	2.08	0.18	0.0324

Table III (continued):

Statistical Analysis For Male Hyoid Bones (continued) :

S.No.	Bone Case No.	Average Maximum Cornual Length (cm) (x)	A. M. (xi)	M.D. (x-xi)	(x-xi)2	Transverse Width of the body of the Hyoid (cm) (x)	A. M. (xi)	M.D. (x-xi)	(x-xi)2
26.	1412/05	2.73	3.12	0.39	0.1521	1.72	2.08	0.36	0.1296
27.	1405/05	3.27	3.12	0.15	0.0225	1.85	2.08	0.23	0.0529
28.	1188/05	3.45	3.12	0.33	0.1089	1.91	2.08	0.17	0.0289
29.	1356/05	2.88	3.12	0.24	0.0576	1.86	2.08	0.22	0.0484
30.	1291/05	3.25	3.12	0.13	0.0169	1.75	2.08	0.33	0.1089
31.	1292/05	2.75	3.12	0.37	0.1369	2.05	2.08	0.03	0.0009
32.	1493/05	2.76	3.12	0.36	0.1296	2.07	2.08	0.01	0.0001
33.	1342/05	3.31	3.12	0.19	0.0361	1.94	2.08	0.14	0.0196
34.	1485/05	3.40	3.12	0.28	0.0784	2.11	2.08	0.03	0.0009
35.	1490/05	3.29	3.12	0.17	0.0289	1.92	2.08	0.16	0.0256
36.	1513/05	3.05	3.12	0.07	0.0049	2.11	2.08	0.03	0.0009
37.	1507/05	3.43	3.12	0.31	0.0961	1.08	2.08	1.00	1.0000
38.	1505/05	3.67	3.12	0.55	0.3025	2.01	2.08	0.07	0.0049
39.	1499/05	2.63	3.12	0.49	0.2401	2.00	2.08	0.08	0.0064
40.	1498/05	3.17	3.12	0.05	0.0025	1.86	2.08	0.22	0.0484
41.	1200/05	3.38	3.12	0.26	0.0676	2.09	2.08	0.01	0.0001
42.	1194/05	3.41	3.12	0.29	0.0841	1.95	2.08	0.13	0.0169
43.	1182/05	3.16	3.12	0.04	0.0016	1.92	2.08	0.16	0.0256
44.	1094/05	3.25	3.12	0.13	0.0169	2.11	2.08	0.03	0.0009
45.	1184/05	3.50	3.12	0.38	0.1444	1.96	2.08	0.12	0.0144
46.	1186/05	2.94	3.12	0.18	0.0324	2.52	2.08	0.44	0.1936
47.	1443/05	2.94	3.12	0.18	0.0324	2.22	2.08	0.14	0.0196
48.	1061/05	2.74	3.12	0.38	0.1444	1.83	2.08	0.25	0.0625
49.	1144/05	2.94	3.12	0.18	0.0324	2.11	2.08	0.03	0.0009
50.	1117/05	4.00	3.12	0.88	0.7744	3.03	2.08	0.95	0.9025

Table III (continued):

Statistical Analysis For Male Hyoid Bones (continued) :

S.No.	Bone Case No.	Average Maximum Cornual Length (cm)	A. M. (xi)	M.D. (x-xi)	(x-xi)2	Transverse Width of the body of the Hyoid (cm) (x)	A. M. (xi)	M.D. (x-xi)	(x-xi)2
51.	1071/05	2.81	3.12	0.31	0.0961	2.16	2.08	0.08	0.0064
52.	1496/05	2.82	3.12	0.17	0.0289	2.04	2.08	0.04	0.0016
53.	1482/05	2.96	3.12	0.16	0.0256	1.95	2.08	0.13	0.0169
54.	1116/05	3.28	3.12	0.16	0.0256	2.11	2.08	0.03	0.0009
55.	1306/05	2.90	3.12	0.22	0.0484	2.31	2.08	0.23	0.0529
56.	1031/05	2.78	3.12	0.34	0.1156	1.94	2.08	0.14	0.0196
57.	1396/05	3.52	3.12	0.40	0.1600	2.01	2.08	0.07	0.0049
58.	1056/05	2.77	3.12	0.35	0.1225	1.79	2.08	0.29	0.0841
59.	1122/05	3.40	3.12	0.28	0.0784	2.06	2.08	0.02	0.0004
60.	1176/05	3.24	3.12	0.12	0.0144	2.00	2.08	0.17	0.0289
61.	1025/05	3.28	3.12	0.16	0.0256	3.24	2.08	0.02	0.0004
62.	1308/05	3.21	3.12	0.09	0.0081	1.84	2.08	0.08	0.0064
63.	1181/05	2.13	3.12	0.99	0.9801	3.24	2.08	1.16	1.3456
64.	1427/05	2.99	3.12	0.13	0.0169	1.84	2.08	0.24	0.0576
65.	1419/05	3.29	3.12	0.17	0.0289	1.95	2.08	0.13	0.0169
66.	1452/05	3.25	3.12	0.13	0.0169	2.01	2.08	0.07	0.0049
67.	1458/05	3.00	3.12	0.12	0.0144	1.92	2.08	0.16	0.0256
68.	1464/05	3.36	3.12	0.24	0.0576	2.07	2.08	0.01	0.0001
69.	1057/05	3.26	3.12	0.14	0.0196	1.91	2.08	0.17	0.0289
70.	1466/05	3.74	3.12	0.62	0.3844	2.12	2.08	0.04	0.0016
71.	1495/05	3.15	3.12	0.03	0.0009	1.86	2.08	0.22	0.0484
72.	1424/05	3.20	3.12	0.08	0.0064	2.77	2.08	0.69	0.4761
73.	1421/05	3.25	3.12	0.13	0.0169	2.51	2.08	0.43	0.1849
74.	1450/05	3.05	3.12	0.07	0.0049	2.60	2.08	0.52	0.2704
75.	1259/05	3.16	3.12	0.04	0.0016	2.31	2.08	0.23	0.0529

Table III (continued):

Statistical Analysis For Male Hyoid Bones (continued) :

S.No.	Bone Case No.	Average Maximum Cornual Length (cm)	A. M. (xi)	M.D. (x-xi)	(x-xi)2	Transverse Width of the body of the Hyoid (cm) (x)	A. M. (xi)	M.D. (x-xi)	(x-xi)2
76.	1201/05	3.52	3.12	0.40	0.1600	2.72	2.08	0.64	0.4096
77.	1244/05	3.16	3.12	0.04	0.0016	2.32	2.08	0.24	0.0576
78.	1206/05	3.28	3.12	0.16	0.0256	2.32	2.08	0.24	0.0576
79.	1489/05	2.96	3.12	0.16	0.0256	2.09	2.08	0.01	0.0001
80.	1372/05	3.31	3.12	0.19	0.0361	1.81	2.08	0.27	0.0729
81.	1358/05	2.81	3.12	0.31	0.0961	1.86	2.08	0.22	0.0484
82.	1343/05	3.12	3.12	0.00	0.0000	2.23	2.08	0.15	0.0225
83.	1325/05	3.37	3.12	0.25	0.0625	2.25	2.08	0.17	0.0289
84.	1260/05	3.34	3.12	0.22	0.0484	2.15	2.08	0.07	0.0049
85.	1173/05	2.79	3.12	0.17	0.0289	2.27	2.08	0.19	0.0361
86.	1202/05	3.29	3.12	0.17	0.0289	2.10	2.08	0.02	0.0004
87.	1257/05	2.79	3.12	0.33	0.1089	2.29	2.08	0.21	0.0441
88.	1234/05	3.29	3.12	0.17	0.0289	1.20	2.08	0.88	0.7744
89.	1227/05	3.19	3.12	0.07	0.0049	1.81	2.08	0.27	0.0729
90.	1228/05	2.92	3.12	0.20	0.0400	2.20	2.08	0.12	0.0144
91.	1230/05	3.34	3.12	0.22	0.0484	1.58	2.08	0.50	0.2500
92.	1229/05	3.37	3.12	0.25	0.0625	2.57	2.08	0.49	0.2401
93.	1241/05	3.27	3.12	0.15	0.0225	1.91	2.08	0.17	0.0289
94.	1235/05	3.40	3.12	0.28	0.0784	1.82	2.08	0.26	0.0676
95.	1232/05	2.85	3.12	0.27	0.0729	1.77	2.08	0.31	0.0961
96.	1213/05	2.79	3.12	0.33	0.1089	1.88	2.08	0.20	0.0400
97.	1215/05	3.35	3.12	0.23	0.0529	1.72	2.08	0.36	0.1296
98.	1210/05	2.50	3.12	0.62	0.3844	2.01	2.08	0.07	0.0049
99.	1368/05	3.10	3.12	0.02	0.0004	2.43	2.08	0.35	0.1225
100.	1107/05	3.12	3.12	0.00	0.0000	1.65	2.08	0.43	0.1849

Table III (continued):

Statistical Analysis For Female Hyoid Bones :

S.No.	Bone Case No.	Weight (gm) (x)	A. M. (xi)	M.D. (x-xi)	(x-xi)2	Height (cm) (x)	A. M. (xi)	M.D. (x-xi)	(x-xi)2
1.	1939/05	0.85	0.69	0.16	0.0256	0.94	0.95	0.01	0.0001
2.	2024/05	0.64	0.69	0.05	0.0025	0.85	0.95	0.10	0.0100
3.	1918/05	0.54	0.69	0.15	0.0225	1.04	0.95	0.09	0.0081
4.	2003/05	0.72	0.69	0.03	0.0009	1.10	0.95	0.15	0.0225
5.	1988/05	0. 56	0.69	0.13	0.0169	0.85	0.95	0.10	0.0100
6.	1956/05	0.57	0.69	0.12	0.0144	0.93	0.95	0.02	0.0004
7.	1785/05	0.61	0.69	0.08	0.0064	1.10	0.95	0.15	0.0225
8.	1884/05	0.85	0.69	0.16	0.0256	1.04	0.95	0.09	0.0081
9.	1667/05	0.61	0.69	0.08	0.0064	1.05	0.95	0.10	0.0100
10.	1774/05	0.74	0.69	0.05	0.0025	1.04	0.95	0.09	0.0081
11.	1187/05	0.50	0.69	0.19	0.0361	0.87	0.95	0.08	0.0064
12.	1123/05	0.92	0.69	0.23	0.0529	0.99	0.95	0.04	0.0016
13.	1114/05	0.68	0.69	0.01	0.0001	0.95	0.95	0.00	0.0000
14.	1178/05	0.39	0.69	0.30	0.0900	0.89	0.95	0.06	0.0036
15.	1428/05	0.79	0.69	0.10	0.0100	1.00	0.95	0.05	0.0025
16.	1500/05	0.64	0.69	0.05	0.0025	0.87	0.95	0.08	0.0064
17.	1092/05	0.76	0.69	0.10	0.0100	0.98	0.95	0.03	0.0009
18.	1131/05	0.68	0.69	0.01	0.0001	1.02	0.95	0.07	0.0049
19.	1661/05	0.55	0.69	0.14	0.0196	1.04	0.95	0.09	0.0081
20.	1643/05	0.63	0.69	0.06	0.0036	0.96	0.95	0.01	0.0001
21.	1212/05	0.59	0.69	0.10	0.0100	0.94	0.95	0.01	0.0001
22.	1219/05	0.57	0.69	0.12	0.0144	0.96	0.95	0.01	0.0001
23.	1238/05	0.59	0.69	0.10	0.0100	0.88	0.95	0.07	0.0049
24.	1258/05	0.59	0.69	0.10	0.0100	0.87	0.95	0.08	0.0064
25.	1253/05	0.81	0.69	0.12	0.0144	0.94	0.95	0.01	0.0001

Table III (continued):

Statistical Analysis For Female Hyoid Bones (continued) :

S.No.	Bone Case No.	Weight (gm) (x)	A. M. (xi)	M.D. (x-xi)	(x-xi)2	Height (cm) (x)	A. M. (xi)	M.D. (x-xi)	(x-xi)2
26.	1407/05	0.66	0.69	0.03	0.0009	1.03	0.95	0.08	0.0064
27.	1447/05	0.65	0.69	0.04	0.0016	1.04	0.95	0.09	0.0081
28.	1413/05	0.70	0.69	0.01	0.0001	0.83	0.95	0.12	0.0144
29.	1174/05	0.53	0.69	0.16	0.0256	1.03	0.95	0.08	0.0064
30.	1169/05	0.59	0.69	0.10	0.0100	1.04	0.95	0.09	0.0081
31.	1062/05	0.42	0.69	0.27	0.0729	0.89	0.95	0.06	0.0036
32.	1355/05	0.76	0.69	0.07	0.0049	0.96	0.95	0.01	0.0001
33.	1854/05	0.47	0.69	0.22	0.0484	0.86	0.95	0.09	0.0081
34.	1663/05	0.47	0.69	0.22	0.0484	0.89	0.95	0.06	0.0036
35.	1796/05	0.68	0.69	0.01	0.0001	1.05	0.95	0.10	0.0100
36.	1258/05	1.14	0.69	0.15	0.0225	1.05	0.95	0.10	0.0100
37.	1747/05	0.68	0.69	0.01	0.0001	0.99	0.95	0.04	0.0016
38.	1752/05	0.67	0.69	0.02	0.0004	0.93	0.95	0.02	0.0004
39.	1214/05	0.45	0.69	0.24	0.0576	0.90	0.95	0.05	0.0025
40.	1254/05	0.43	0.69	0.26	0.0676	0.83	0.95	0.12	0.0144
41.	2134/05	1.05	0.69	0.36	0.1296	1.10	0.95	0.15	0.0225
42.	2253/05	0.83	0.69	0.14	0.0121	0.94	0.95	0.01	0.0001
43.	2311/05	0.80	0.69	0.11	0.0400	0.90	0.95	0.05	0.0025
44.	2343/05	0.49	0.69	0.20	0.0400	0.92	0.95	0.03	0.0009
45.	2249/05	0.82	0.69	0.13	0.0169	0.99	0.95	0.04	0.0016
46.	2427/05	0.76	0.69	0.07	0.0049	0.98	0.95	0.03	0.0009
47.	2344/05	0.57	0.69	0.12	0.0144	1.15	0.95	0.10	0.0100
48.	2354/05	0.60	0.69	0.09	0.00081	0.82	0.95	0.13	0.0169
49.	1568/05	0.61	0.69	0.08	0.0064	0.85	0.95	0.10	0.0100
50.	24/06	1.08	0.69	0.39	0.1521	0.98	0.95	0.03	0.0009

Table III (continued):

Statistical Analysis For Female Hyoid Bones (continued) :

S.No.	Bone Case No.	Weight (gm) (x)	A. M. (xi)	M.D. (x-xi)	(x-xi)2	Height (cm) (x)	A. M. (xi)	M.D. (x-xi)	(x-xi)2
51.	33/06	1.00	0.69	0.31	0.0961	0.87	0.95	0.08	0.0064
52.	103/06	0.72	0.69	0.03	0.0009	0.94	0.95	0.01	0.0001
53.	120/06	0.53	0.69	0.16	0.0256	0.93	0.95	0.02	0.0004
54.	140/06	0.59	0.69	0.10	0.0100	0.87	0.95	0.08	0.0064
55.	81/06	0.99	0.69	0.30	0.0900	0.96	0.95	0.01	0.0001
56.	85/06	0.51	0.69	0.18	0.0324	0.89	0.95	0.06	0.0036
57.	144/06	0.63	0.69	0.06	0.0036	1.06	0.95	0.11	0.0121
58.	162/06	0.81	0.69	0.12	0.0144	0.98	0.95	0.03	0.0009
59.	166/06	0.94	0.69	0.25	0.0625	0.84	0.95	0.11	0.0121
60.	202/06	0.69	0.69	0.0	0.0000	0.87	0.95	0.08	0.0064
61.	187/06	0.64	0.69	0.05	0.0025	0.85	0.95	0.10	0.0100
62.	200/06	0.61	0.69	0.08	0.0064	1.00	0.95	0.05	0.0025
63.	201/06	0.69	0.69	0.00	0.0000	0.90	0.95	0.05	0.0025
64.	206/06	0.62	0.69	0.07	0.0049	0.87	0.95	0.08	0.0064
65.	217/06	0.67	0.69	0.02	0.0004	1.06	0.95	0.11	0.0121
66.	283/06	0.44	0.69	0.25	0.0625	0.87	0.95	0.08	0.0064
67.	379/06	0.65	0.69	0.04	0.0016	0.96	0.95	0.01	0.0001
68.	417/06	0.76	0.69	0.07	0.0049	0.94	0.95	0.01	0.0001
69.	437/06	0.44	0.69	0.25	0.0625	0.96	0.95	0.01	0.0001
70.	206/06	0.65	0.69	0.04	0.0016	0.87	0.95	0.08	0.0064
71.	220/06	0.89	0.69	0.20	0.0400	0.87	0.95	0.08	0.0064
72.	254/06	0.64	0.69	0.05	0.0025	0.99	0.95	0.04	0.0016
73.	280/06	0.56	0.69	0.13	0.0169	0.91	0.95	0.04	0.0016
74.	276/06	0.78	0.69	0.09	0.0081	0.95	0.95	0.00	0.0000
75.	333/06	0.53	0.69	0.16	0.0256	0.98	0.95	0.03	0.0009

Table III (continued):

Statistical Analysis For Female Hyoid Bones (continued) :

S.No.	Bone Case No.	Weight (gm) (x)	A. M. (xi)	M.D. (x-xi)	(x-xi)2	Height (cm) (x)	A. M. (xi)	M.D. (x-xi)	(x-xi)2
76.	340/06	0.68	0.69	0.01	0.0001	0.87	0.95	0.08	0.0064
77.	378/06	0.62	0.69	0.07	0.0049	0.97	0.95	0.08	0.0064
78.	43/06	0.69	0.69	0.00	0.0000	0.80	0.95	0.15	0.0225
79.	1402/05	0.40	0.69	0.29	0.0841	0.98	0.95	0.03	0.0009
80.	1426/05	0.64	0.69	0.05	0.0025	0.99	0.95	0.04	0.0016
81.	1432/05	0.83	0.69	0.14	0.0196	0.95	0.95	0.00	0.0000
82.	1471/05	0.78	0.69	0.09	0.0081	0.86	0.95	0.09	0.0081
83.	1485/05	0.60	0.69	0.09	0.0081	0.97	0.95	0.02	0.0004
84.	1489/05	0.96	0.69	0.27	0.0729	1.07	0.95	0.12	0.0144
85.	1493/05	0.69	0.69	0.00	0.0000	0.96	0.95	0.01	0.0001
86.	1495/05	1.20	0.69	0.51	0.2601	1.10	0.95	0.15	0.0225
87.	1496/05	0.54	0.69	0.15	0.0025	0.90	0.95	0.05	0.0025
88.	1506/05	0.82	0.69	0.13	0.0169	1.20	0.95	0.25	0.0625
89.	1509/05	0.99	0.69	0.30	0.0900	0.88	0.95	0.07	0.0049
90.	1510/05	0.68	0.69	0.01	0.0001	1.10	0.95	0.15	0.0225
91.	1525/05	1.13	0.69	0.44	0.1936	0.87	0.95	0.08	0.0064
92.	1527/05	0.56	0.69	0.10	0.0100	0.98	0.95	0.03	0.0009
93.	1544/05	0.73	0.69	0.04	0.0016	1.00	0.95	0.05	0.0025
94.	1566/05	0.64	0.69	0.05	0.0025	0.96	0.95	0.01	0.0001
95.	1569/05	0.50	0.69	0.19	0.0361	0.74	0.95	0.21	0.0441
96.	68/06	0.66	0.69	0.03	0.0009	0.95	0.95	0.00	0.0000
97.	77/06	0.61	0.69	0.08	0.0064	0.94	0.95	0.01	0.0001
98.	159/06	0.91	0.69	0.22	0.0484	0.75	0.95	0.20	0.0400
99.	1533/05	0.90	0.69	0.21	0.0441	1.15	0.95	0.20	0.0400
100.	371/06	0.83	0.69	0.14	0.0196	1.07	0.95	0.12	0.0144

Table III (continued):

Statistical Analysis For Female Hyoid Bones :

S.No.	Bone Case No.	Average Maximum Cornual Length (cm)	A. M. (xi)	M.D. (x-xi)	(x-xi)2	Transverse Width of the body of the Hyoid (cm) (x)	A. M. (xi)	M.D. (x-xi)	(x-xi)2
1.	1939/05	2.36	2.71	0.35	0.1225	1.81	1.75	0.06	0.0036
2.	2024/05	2.47	2.71	0.24	0.0576	1.62	1.75	0.13	0.0169
3.	1918/05	2.78	2.71	0.07	0.0049	1.45	1.75	0.30	0.0900
4.	2003/05	2.79	2.71	0.08	0.0064	1.96	1.75	0.21	0.0441
5.	1988/05	2.61	2.71	0.10	0.0100	1.66	1.75	0.09	0.0081
6.	1956/05	2.03	2.71	0.68	0.4624	1.42	1.75	0.33	0.1089
7.	1785/05	2.31	2.71	0.40	0.1600	1.70	1.75	0.05	0.0025
8.	1884/05	2.82	2.71	0.11	0.0121	1.62	1.75	0.13	0.0169
9.	1667/05	2.81	2.71	0.10	0.0100	1.95	1.75	0.20	0.0400
10.	1774/05	2.85	2.71	0.14	0.0196	2.12	1.75	0.37	0.1369
11.	1187/05	2.87	2.71	0.16	0.0256	1.50	1.75	0.25	0.0625
12.	1123/05	3.15	2.71	0.44	0.1936	1.99	1.75	0.24	0.0576
13.	1114/05	2.57	2.71	0.14	0.0196	1.90	1.75	0.15	0.0225
14.	1178/05	3.32	2.71	0.61	0.3721	1.91	1.75	0.16	0.0256
15.	1428/05	2.71	2.71	0.00	0.0000	1.59	1.75	0.16	0.0256
16.	1500/05	2.35	2.71	0.36	0.1296	1.80	1.75	0.05	0.0025
17.	1092/05	2.72	2.71	0.01	0.0001	2.12	1.75	0.37	0.1369
18.	1131/05	2.67	2.71	0.04	0.016	1.80	1.75	0.05	0.0025
19.	1661/05	2.92	2.71	0.21	0.0441	2.10	1.75	0.35	0.1225
20.	1643/05	2.80	2.71	0.09	0.0081	1.87	1.75	0.12	0.0144
21.	1212/05	2.60	2.71	0.11	0.0121	1.82	1.75	0.07	0.0049
22.	1219/05	2.83	2.71	0.12	0.0144	1.72	1.75	0.03	0.0009
23.	1238/05	3.19	2.71	0.48	0.2304	1.63	1.75	0.12	0.0144
24.	1258/05	2.55	2.71	0.16	0.0256	1.92	1.75	0.17	0.0289
25.	1253/05	2.65	2.71	0.06	0.0036	2.01	1.75	0.26	0.0676

Table III (continued):

Statistical Analysis For Female Hyoid Bones (continued) :

S.No.	Bone Case No.	Average Maximum Cornual Length (cm)	A. M. (xi)	M.D. (x-xi)	(x-xi)2	Transverse Width of the body of the Hyoid (cm) (x)	A. M. (xi)	M.D. (x-xi)	(x-xi)2
26.	1407/05	2.73	2.71	0.02	0.0004	1.59	1.75	0.16	0.0256
27.	1447/05	2.78	2.71	0.07	0.0049	1.60	1.75	0.15	0.0225
28.	1413/05	3.10	2.71	0.39	0.1521	1.90	1.75	0.15	0.0225
29.	1174/05	3.22	2.71	0.51	0.2601	2.02	1.75	0.27	0.0729
30.	1169/05	2.62	2.71	0.09	0.0081	2.20	1.75	0.45	0.2025
31.	1062/05	2.52	2.71	0.19	0.0361	1.86	1.75	0.11	0.0121
32.	1355/05	2.62	2.71	0.09	0.0081	1.64	1.75	0.11	0.0121
33.	1854/05	2.29	2.71	0.42	0.1764	1.55	1.75	0.20	0.0400
34.	1663/05	2.59	2.71	0.12	0.0144	1.24	1.75	0.51	0.2601
35.	1796/05	2.85	2.71	0.14	0.0196	1.92	1.75	0.17	0.0289
36.	1258/05	2.91	2.71	0.20	0.0400	2.01	1.75	0.26	0.0676
37.	1747/05	2.75	2.71	0.04	0.0016	1.70	1.75	0.05	0.0025
38.	1752/05	2.89	2.71	0.18	0.0324	1.72	1.75	0.03	0.0009
39.	1214/05	2.78	2.71	0.07	0.0049	1.60	1.75	0.15	0.0225
40.	1254/05	2.93	2.71	0.22	0.0484	1.32	1.75	0.43	0.1849
41.	2134/05	2.92	2.71	0.21	0.0441	1.90	1.75	0.15	0.0225
42.	2253/05	2.92	2.71	0.21	0.0441	2.00	1.75	0.25	0.0625
43.	2311/05	2.86	2.71	0.15	0.0225	1.64	1.75	0.11	0.0121
44.	2343/05	3.00	2.71	0.29	0.0841	1.65	1.75	0.10	0.0100
45.	2249/05	2.59	2.71	0.12	0.0144	1.66	1.75	0.09	0.0081
46.	2427/05	2.82	2.71	0.11	0.0121	1.82	1.75	0.07	0.0049
47.	2344/05	2.59	2.71	0.12	0.0144	1.56	1.75	0.19	0.0361
48.	2354/05	2.58	2.71	0.13	0.0169	1.22	1.75	0.53	0.2809
49.	1568/05	2.37	2.71	0.34	0.1156	1.52	1.75	0.23	0.0529
50.	24/06	3.01	2.71	0.30	0.0900	1.69	1.75	0.06	0.0036

Table III (continued):

Statistical Analysis For Female Hyoid Bones (continued) :

S.No.	Bone Case No.	Average Maximum Cornual Length (cm)	A. M. (xi)	M.D. (x-xi)	(x-xi)2	Transverse Width of the body of the Hyoid (cm) (x)	A. M. (xi)	M.D. (x-xi)	(x-xi)2
51.	33/06	2.87	2.71	0.61	0.0256	1.60	1.75	0.15	0.0225
52.	103/06	2.73	2.71	0.02	0.0004	1.95	1.75	0.20	0.0400
53.	120/06	2.60	2.71	0.11	0.0121	1.35	1.75	0.40	0.1600
54.	140/06	2.37	2.71	0.34	0.1156	1.58	1.75	0.17	0.0289
55.	81/06	2.81	2.71	0.10	0.0100	2.01	1.75	0.26	0.0676
56.	85/06	2.41	2.71	0.30	0.0900	1.35	1.75	0.40	0.1600
57.	144/06	2.52	2.71	0.19	0.0361	1.62	1.75	0.13	0.0169
58.	162/06	2.75	2.71	0.04	0.0016	1.59	1.75	0.16	0.0256
59.	166/06	2.76	2.71	0.05	0.0025	2.12	1.75	0.37	0.1369
60.	202/06	2.84	2.71	0.13	0.0169	1.55	1.75	0.20	0.0400
61.	187/06	2.91	2.71	0.20	0.0400	1.50	1.75	0.25	0.0625
62.	200/06	2.30	2.71	0.41	0.1681	1.25	1.75	0.50	0.2500
63.	201/06	2.89	2.71	0.18	0.0324	1.55	1.75	0.20	0.0400
64.	206/06	2.92	2.71	0.21	0.0441	1.85	1.75	0.10	0.0100
65.	217/06	2.83	2.71	0.12	0.0144	1.78	1.75	0.03	0.0009
66.	283/06	2.82	2.71	0.11	0.0121	1.62	1.75	0.13	0.0169
67.	379/06	2.64	2.71	0.07	0.0049	1.01	1.75	0.74	0.5476
68.	417/06	3.05	2.71	0.34	0.1156	1.72	1.75	0.03	0.0009
69.	437/06	2.86	2.71	0.15	0.0225	1.75	1.75	0.00	0.0000
70.	206/06	2.86	2.71	0.09	0.0081	1.87	1.75	0.12	0.0144
71.	220/06	2.63	2.71	0.08	0.0064	1.92	1.75	0.17	0.0289
72.	254/06	3.12	2.71	0.41	0.1681	1.86	1.75	0.11	0.0121
73.	280/06	2.62	2.71	0.09	0.0081	1.52	1.75	0.23	0.0529
74.	276/06	2.52	2.71	0.19	0.0361	1.75	1.75	0.00	0.0000
75.	333/06	2.78	2.71	0.07	0.0049	1.80	1.75	0.05	0.0025

Table III (continued):

Statistical Analysis For Female Hyoid Bones (continued) :

S.No.	Bone Case No.	Average Maximum Cornual Length (cm)	A. M. (xi)	M.D. (x-xi)	(x-xi)2	Transverse Width of the body of the Hyoid (cm) (x)	A. M. (xi)	M.D. (x-xi)	(x-xi)2
76.	340/06	2.60	2.71	0.11	0.0121	1.51	1.75	0.24	0.0576
77.	378/06	2.82	2.71	0.11	0.0121	1.74	1.75	0.01	0.0001
78.	43/06	2.89	2.71	0.18	0.0324	1.40	1.75	0.35	0.1225
79.	1402/05	2.48	2.71	0.23	0.0529	1.81	1.75	0.33	0.1089
80.	1426/05	3.02	2.71	0.31	0.0961	1.59	1.75	0.06	0.0036
81.	1432/05	2.54	2.71	0.37	0.1369	1.54	1.75	0.16	0.0256
82.	1471/05	2.52	2.71	0.35	0.1225	1.54	1.75	0.21	0.0441
83.	1485/05	2.00	2.71	0.71	0.5041	3.05	1.75	1.30	1.6900
84.	1489/05	2.79	2.71	0.08	0.0064	2.05	1.75	0.30	0.0900
85.	1493/05	2.78	2.71	0.07	0.0049	1.92	1.75	0.17	0.0289
86.	1495/05	3.64	2.71	0.93	0.8649	1.82	1.75	0.07	0.0049
87.	1496/05	2.59	2.71	0.12	0.0144	1.60	1.75	0.15	0.0225
88.	1506/05	2.76	2.71	0.05	0.0025	1.80	1.75	0.056	0.0025
89.	1509/05	2.16	2.71	0.55	0.3025	3.02	1.75	1.27	1.6129
90.	1510/05	2.55	2.71	0.16	0.0256	2.05	1.75	0.30	0.0900
91.	1525/05	2.90	2.71	0.19	0.0361	1.72	1.75	0.03	0.0009
92.	1527/05	2.56	2.71	0.15	0.0225	1.68	1.75	0.07	0.0049
93.	1544/05	2.64	2.71	0.07	0.0049	1.59	1.75	0.16	0.0256
94.	1566/05	2.30	2.71	0.41	0.1681	1.58	1.75	0.17	0.0289
95.	1569/05	2.11	2.71	0.60	0.3600	1.41	1.75	0.34	0.1156
96.	68/06	2.72	2.71	0.01	0.0001	1.74	1.75	0.01	0.0001
97.	77/06	2.41	2.71	0.30	0.0900	1.82	1.75	0.07	0.0049
98.	159/06	2.61	2.71	0.10	0.0100	2.05	1.75	0.30	0.0900
99.	1533/05	2.69	2.71	0.02	0.0004	2.15	1.75	0.40	0.1600
100.	371/06	3.16	2.71	0.90	0.8100	2.05	1.75	0.30	0.0900

Table IV:

Statistical Analysis for each of the Age Brackets for Male and Female Bones:

I. Summary for Weight

For Males

Group No.	Age Group	Mean	Standard Deviation	No. of Cases
	18-60 years	1.03	0.24	100
1.	18-25 years	0.97	0.20	35
2.	26-32 years	1.11	0.29	16
3.	33-39 years	0.96	0.15	18
4.	40-46 years	1.17	0.33	17
5.	47-53 years	0.94	0.11	5
6.	54-60 years	1.07	0.20	9

For Females

Group No.	Age Group	Mean	Standard Deviation	No. of Cases
	18-60 years	0.69	0.17	100
1.	18-25 years	0.68	0.15	40
2.	26-32 years	0.76	0.19	14
3.	33-39 years	0.67	0.18	11
4.	40-46 years	0.69	0.19	12
5.	47-53 years	0.70	0.14	9
6.	54-60 years	0.63	0.17	14

Table IV (continued):

II. Summary for Vertical Height of the Body

For Males

Group No.	Age Group	Mean	Standard Deviation	No. of Cases
	18-60 years	1.11	0.11	100
1.	18-25 years	1.13	0.09	35
2.	26-32 years	1.08	0.11	16
3.	33-39 years	1.09	0.13	18
4.	40-46 years	1.13	0.10	17
5.	47-53 years	1.02	0.07	5
6.	54-60 years	1.16	0.12	9

For Females

Group No.	Age Group	Mean	Standard Deviation	No. of Cases
	18-60 years	0.95	0.08	100
1.	18-25 years	0.93	0.09	40
2.	26-32 years	0.99	0.06	14
3.	33-39 years	0.94	0.11	11
4.	40-46 years	0.93	0.09	12
5.	47-53 years	0.98	0.07	9
6.	54-60 years	0.97	0.06	14

Table IV (continued):

III. Summary for Transverse Width of the Body

For Males

Group No.	Age Group	Mean	Standard Deviation	No. of Cases
	18-60 years	2.08	0.33	100
1.	18-25 years	1.98	0.27	35
2.	26-32 years	2.10	0.29	16
3.	33-39 years	2.08	0.22	18
4.	40-46 years	2.10	0.32	17
5.	47-53 years	2.17	0.78	5
6.	54-60 years	2.35	0.33	9

For Females

Group No.	Age Group	Mean	Standard Deviation	No. of Cases
	18-60 years	1.75	0.29	100
1.	18-25 years	1.61	0.20	40
2.	26-32 years	1.77	0.15	14
3.	33-39 years	1.87	0.14	11
4.	40-46 years	1.69	0.27	12
5.	47-53 years	1.91	0.16	9
6.	54-60 years	1.98	0.51	14

Table IV (continued):

IV. Summary for Average Mean Cornual Length

For Males

Group No.	Age Group	Mean	Standard Deviation	No. of Cases
	18-60 years	3.12	0.28	100
1.	18-25 years	3.12	0.27	35
2.	26-32 years	3.13	0.33	16
3.	33-39 years	3.06	0.23	18
4.	40-46 years	3.15	0.20	17
5.	47-53 years	3.04	0.52	5
6.	54-60 years	3.23	0.33	9

For Females

Group No.	Age Group	Mean	Standard Deviation	No. of Cases
	18-60 years	2.71	0.26	100
1.	18-25 years	2.67	0.23	40
2.	26-32 years	2.79	0.35	14
3.	33-39 years	2.72	0.28	11
4.	40-46 years	2.79	0.28	12
5.	47-53 years	2.75	0.17	9
6.	54-60 years	2.67	0.29	14

Results of Statistical Analysis :

The mean, standard deviation and standard error for both the male and female hyoid bones was calculated as shown in the above tables and summarized in the following table:

Table V:

1. **Weight**

	Mean (in gm)	Standard Deviation (in gm)	Standard Error (in gm)
Male	1.03	0.24	0.025
Female	0.69	0.17	0.017

2. **Vertical Height of the Body**

	Mean (in cm)	Standard Deviation (in cm)	Standard Error (in cm)
Male	1.11	0.11	0.011
Female	0.95	0.08	0.009

Table V (continued):

3. Transverse Width of the body

	Mean (in cm)	Standard Deviation (in cm)	Standard Error (in cm)
Male	2.08	0.33	0.033
Female	1.75	0.29	0.030

4. Average Maximum Cornual Length

	Mean (in cm)	Standard Deviation (in cm)	Standard Error (in cm)
Male	3.12	0.28	0.028
Female	2.71	0.26	0.027

Table VI:

Consolidated Tables showing the Mean and Standard Deviation for each of the four parameters for Male and Female Bones:

	Average Weight (in grams)	Average Vertical Height (in cm)	Average maximal Cornual Length (in cm)	Transverse Width (in cm)
Male Hyoid Bones	1.03 +/- 0.24	1.11 +/- 0.11	3.12 +/- 0.28	2.08 +/- 0.33
Female Hyoid Bones	0.69 +/- 0.17	0.95 +/- 0.09	2.17 +/- 0.27	1.75 +/- 0.29

Table VI (continued):

Consolidated Tables showing the Mean for each of the four parameters for each age group for Male and Female Bones :

S.No.	Age Groups (in years)	Average Weight for males (gm)	Average Weight for females (gm)	Average Body Height for males (cm)	Average Body Height for females (cm)	Average maximal Cornual Length for males (cm)	Average maximal Cornual Length for females (cm)	Average Transverse Body Width for males (cm)	Average Tansverse Body Width for females (cm)
	18-60	1.03	0.69	1.11	0.95	3.12	2.71	2.08	1.75
1.	< = 25	0.97	0.68	1.13	0.93	3.12	2.67	1.98	1.61
2.	26-32	1.11	0.76	1.08	0.99	3.13	2.79	2.10	1.77
3.	33-39	0.96	0.67	1.09	0.94	3.06	2.72	2.08	1.87
4.	40-46	1.17	0.69	1.13	0.93	3.15	2.79	2.10	1.69
5.	47-53	0.94	0.70	1.02	0.98	3.04	2.75	2.17	1.91
6.	54-60	1.07	0.63	1.16	0.97	3.23	2.67	2.35	1.98

Table VII:

Multivariant Model for Discriminant Analysis to find out which parameter is most dimorphic:

	Variable	Wilkis Lambda	Significant Level	Rao's Value	Significant Level	Change in Value	Significant Level
1.	Vertical Height of the Body	0.598	0.01	132.85	0.01	132.85	0.01
2.	Weight	0.472	0.01	220.97	0.01	88.12	0.01
3.	Average Mean Cornual Length	0.426	0.01	226.46	0.01	45.48	0.01
4.	Transverse width of the Body	0.419	0.01	274.04	0.01	7.58	0.01

From the above table it could be concluded that the Vertical Height of the Body is the most dimorphic parameter (Highest value for Wilkis Lambda and least value for Rao's value).

Table VIII:

Analysis of Variance (ANOVA) for Difference Between the Various Age Groups (The purpose of this study was to test if there is a significant difference between the various age groups for a given parameter) :

1. Weight

Males

Source	Degrees of Freedom	Sum of Squares	Mean Squares	F. Ratio	Significance Level
Between Groups	5	0.6948	0.139	2.4250	0.05 (95% Confidence Level)
Within Groups	94	5.3865	0.0573		
Total	99	6.0813			

Females

Source	Degrees of Freedom	Sum of Squares	Mean Squares	F. Ratio	Significance Level
Between Groups	5	0.1241	0.0248	0.8492	Not Significant
Within Groups	94	2.7470	0.0292		
Total	99	2.8711			

Table VIII (continued):

Analysis of Variance (ANOVA) for Difference Between the Various Age Groups (The purpose of this study was to test if there is a significant difference between the various age groups for a given parameter) :

2. Vertical Height of the Body

Males

Source	Degrees of Freedom	Sum of Squares	Mean Squares	F. Ratio	Significance Level
Between Groups	5	0.0909	0.018	1.4935	Not Significant
Within Groups	94	1.1442	0.0122		
Total	99	1.2351			

Females

Source	Degrees of Freedom	Sum of Squares	Mean Squares	F. Ratio	Significance Level
Between Groups	5	0.0641	0.0128	1.7042	Not Significant
Within Groups	94	0.7075	0.0075		
Total	99	0.7716			

Table VIII (continued):

Analysis of Variance (ANOVA) for Difference Between the Various Age Groups (The purpose of this study was to test if there is a significant difference between the various age groups for a given parameter) :

3. Transverse width of the Body

Males

Source	Degrees of Freedom	Sum of Squares	Mean Squares	F. Ratio	Significance Level
Between Groups	5	1.0521	0.2104	2.0192	Not Significant
Within Groups	94	9.7957	0.1042		
Total	99	10.8478			

Females

Source	Degrees of Freedom	Sum of Squares	Mean Squares	F. Ratio	Significance Level
Between Groups	5	1.9626	0.3925	5.5371	0.01 (99% Confidence level)
Within Groups	94	6.6635	0.0709		
Total	99	8.6261			

Table VIII (continued):

Analysis of Variance (ANOVA) for Difference Between the Various Age Groups (The purpose of this study was to test if there is a significant difference between the various age groups for a given parameter) :

4. Average Mean Cornual Length

Males

Source	Degrees of Freedom	Sum of Squares	Mean Squares	F. Ratio	Significance Level
Between Groups	5	0.2259	0.0452	0.5482	Not Significant
Within Groups	94	7.7473	0.0824		
Total	99	7.9732			

Females

Source	Degrees of Freedom	Sum of Squares	Mean Squares	F. Ratio	Significance Level
Between Groups	5	0.0641	0.0128	1.7042	Not Significant
Within Groups	94	0.7075	0.0075		
Total	99	0.7716			

DISCUSSION

DISCUSSION

In this study we investigated the sexual dimorphism in the hyoid bone using four parameters namely – the weight, vertical height of the body, the transverse width of the body and the mean cornual length. An analysis of the results has been done with the following points in consideration:

1. Is there an appreciable sexual dimorphism in the hyoid bone? Which is the best parameter ? What is the relationship of dimorphism with age ?

2. How do the various measurements compare with the results of the Miller et al.[13] study? If there are appreciable differences - is it because of ethnic differences in the subjects employed in the study?

DIMORPHISM IN THE VARIOUS PARAMETERS :

The following is an analysis of the results of the weight and the morphometric measurements of the Hyoid Bones (Table V & VI)

1. Weight of the Hyoid Bone

The mean weight of the hyoid bone for males above the age of 18 years was found to be 1.03 grams. The mean weight of the hyoid bone for females above the age of 18 years was found to be 0.69 grams. For male bones, the weights were found to range from 0.59 to 1.89 grams. For female bones, the weights were found to range from 0.40 to 1.20 grams.

It could thus be inferred that bones weighing more than 1.20 grams could only be male bones while bones weighing less than 0.59 grams could only be female bones. Further it was observed that 99% of the male bones weighed more than 0.60 grams.

2. Vertical Height of the Body of the Hyoid Bone

The mean height of the body of the hyoid bone for males was found to be 1.11 cm. The mean height of the body of the hyoid bone for females was found to be 0.95 cm. For male bones, the heights were found to range from 0.85 to 1.39 cm. For female bones, the heights were found to range from 0.74 to 1.20 cm. It could thus be inferred that bones with height greater than 1.20 cm could only be male, while bones with height less than 0.85 cm could only be female.

3. Average Cornual Length of the Hyoid Bone

The mean cornual length of the hyoid bone for males was found to be 3.12 cm. The mean cornual length of the hyoid bone for female bone was found to be 2.71 cm. For male bones, the average cornual length was found to range from 2.13 to 4.00 cm, additionally in 98% of the male bones it was found to be greater than 2.50 cm in length. For female bones, the average cornual length was found to range from 2.00 to 3.64 cm, additionally in 98% of the female bones it was found to be less than 3.30 cm. It could thus be inferred that bones with length greater than 3.64 cm could only be male, while bones with length less than 2.13 cm could only be female.

4. Transverse Width of the Body of the Hyoid Bone

The mean transverse width of the body of the hyoid bone for males was found to 2.08 cm. The mean width of the body of the hyoid bone for females was found to be 1.75 cm. For male bones, the width of the body of the hyoid bone was found to range from 1.08 to 3.24 cm, additionally in 98% of the male bones it was found to be greater than 1.60 cm in width. For female bones, width of the body of the hyoid was found to range from 1.01 to 3.05 cm, additionally in 98% of the female bones it was found to be less than 2.75 cm in width. It could thus be inferred that bones with width greater than 3.05 cm could only be male, while bones with width less than 1.08 cm could only be female.

Thus we were able to demonstrate a significant sexual dimorphism in the hyoid bone with regard to all the parameters. Using the multivariantmodel for discriminant analysis it was determined that sexual dimorphism is most marked in the vertical height of the body followed by weight, next the average mean cornual length and finally in the transverse width of the body of the hyoid bone.

RELATIONSHIP OF SEXUAL DIMOPHISM WITH AGE :

An age-wise assessment was also done and the results were found to be as follows (Table IV):

1. **18 - 25 years :**

The mean weight of the hyoid bone for males was found to be 0.97 grams. The mean weight of the hyoid bone for females was found to be 0.68 grams. The mean height of the hyoid bone for males was found to be 1.13 cm. The mean height of the hyoid bone for females was found to be 0.93 cm. The mean cornual length for males was found to be 3.12 cm. The mean cornual length for females was found to be 2.67 cm. The mean width of the hyoid bone for males was found to 1.98 cm. The mean width of the hyoid bone for females was found to be 1.61 cm.

2. **26-32 years :**

The mean weight of the hyoid bone for males was found to be 1.11 grams. The mean weight of the hyoid bone for females was found to be 0.76

grams. The mean height of the hyoid bone for males was found to be 1.08cm. The mean height of the hyoid bone for females was found to be 0.99 cm. The mean cornual length of the hyoid bone for males was found to be 3.13 cm. The mean cornual length of the hyoid for the females was found to be 2.79 cm. The mean width of the hyoid bone for males was found to 2.10 cm. The mean width of the hyoid bone for females was found to be 1.77 cm.

3. **<u>33-39 years</u> :**

The mean weight of hyoid bone for males was found to be 0.96 grams. The mean weight of the hyoid bone for females was found to be 0.67 grams. The mean height of the hyoid bone for males was found to be 1.09 cm. The mean height of the hyoid bone for females was found to be 0.94 cm. The mean cornual length of the hyoid bone for males was found to be 3.06 cm. The mean cornual length of the hyoid bone for females was found to be 2.72 cm. The mean width of the hyoid bone for males was found to 2.08 cm. The mean width of the hyoid bone for females was found to be 1.87 cm.

4. <u>40-46 years</u> :

The mean weight of the hyoid bone for males was found to be 1.17 grams. The mean weight of the hyoid bone for females was found to be 0.69 grams. The mean height of hyoid bone for males was found to be 1.13 cm. The mean height of the hyoid bone for females was found to be 0.93 cm. The mean cornual length of the hyoid bone for males was found to be 3.15 cm. The mean cornual length of the hyoid bone for females was found to be 2.79 cm. The mean width of the hyoid bone for males was found to 2.10 cm. The mean width of the hyoid bone for females was found to be 1.69 cm.

5. <u>47-53 years</u> :

The mean weight of the hyoid bone for males was found to be 0.94 grams. The mean weight of the hyoid bone for females was found to be 0.70 grams. The mean height of the hyoid bone for males was found to be 1.02 cm. The mean height of the hyoid bone for females was found to be 0.98 cm. The mean cornual length of the hyoid bone for males was found to be 3.04 cm. The mean cornual length of the hyoid bone for the females was found to

be 2.75 cm. The mean width of the hyoid bone for males was found to 2.17 cm. The mean width of the hyoid bone for females was found to be 1.91 cm.

6. **<u>53-60 years</u> :**

The mean weight of the hyoid bone for males was found to be 1.07 grams. The mean weight of the hyoid bone for females was found to be 0.63 grams. The mean height of the hyoid bone for males was found to be 1.16 cm. The mean height of the hyoid bone for females was found to be 0.97 cm. The mean cornual length of the hyoid bone for males was found to be 3.23 cm. The mean cornual length of the hyoid bone for the females was found to be 2.67 cm. The mean width of the hyoid bone for males was found to 2.35 cm. The mean width of the hyoid bone for females was found to be 1.98 cm.

COMPARISON OF RESULTS IN THIS STUDY WITH THAT OF MILLER ET. AL [13] :

1. In the Miller et al.[13] study, the weight of the hyoid bones was not estimated as the study involved only measurements which were made using the image analysis system on digitalized radiographs of hyoid bones.

2. In our study we found that the vertical height of the hyoid bone at its midpoint perpendicular to the bone surface was 1.11 cm for males versus 0.95 cm for females. By comparison the corresponding values reported by Miller et al.[13] were 0.79 cm for males and 0.74 cm for females.

3. In our study we found that the average maximum cornual lengths were 3.12 cm for males and 2.71 cm for females. By comparison the corresponding values reported by Miller et al.[13] were 2.83 cm for males, 2.74 cm for females.

4. In our study we found that the transverse width of the body of the hyoid bone was 2.08 cm for males and 1.75 cm for females. By comparison the corresponding values reported by Miller et al.[13] were 2.14 cm for males and 1.98 cm for females.

The study done by Miller was in the United Stated using mostly Caucasian subjects (using hyoid bone specimens obtained from cadavers at the Ventura county State Medical Examiners Table – California State). Here the study involved exclusively subjects from the Indian subcontinent with the overwhelming majority of the subjects being of South Indian origin. The dimorphism observed in our study was greater for all the parameters than that in the study by Miller et al.[13] involving Caucasian subjects, suffice it to say that there is a relatively greater dimorphism for the Hyoid Bone in Asian Indians than for the Caucasians. Of the four parameters studied, the Vertical Height was the most dimorphic parameter, this was followed by the weight, next the cornual length and finally the width of the body of the hyoid bone. By comparison in the study by Miller et al.[13], the Cornual Length was the most dimorphic parameter.

CONCLUSION

CONCLUSION

The following were the conclusions that could be drawn from this study:

1. There is a definite sexual dimorphism in the hyoid bone and the extent was demonstrated in this study using four parameters. The sexual dimorphism is most marked in the vertical height of the body followed by weight, next the average mean cornual length and finally in the transverse width of the body. The dimorphism is constant across the age spectrum for all the parameters except for weight which shows increased dimorphism in the age groups of 40-46 years. This could be explained on the basis of the hormonal changes that are seen in the post-menopausal females which fall in this group.

2. The findings in this study confirm the results obtained in the best previous study to date by Miller et al.[13] An improvement was made on this study by adding weight as one of the parameters studied. The dimorphism observed in our study was greater than that in the study by Miller et al.[13] The conclusion drawn from this observation is that

the dimorphism in the hyoid bone is greater in Asian Indians than in the Occidental population as employed by Miller et al.[13]

3. It is possible to utilize the various indices obtained in this study to determine the sex of the bone, given a situation where a hyoid bone from an unknown subject is obtained by measuring the various parameters. When more than one parameter is used it is possible to determine the sex of the individual to a reasonable degree of accuracy. In such cases, the vertical height of the body of the hyoid bone should be used as one of the parameters in conjunction with other metric measurements as the dimorphism is more marked in this parameter and more so in the age group falling between 40-46 years.

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FIGURE - I

MALE & FEMALE HYOID BONE AFTER REMOVAL OF SOFT TISSUES :

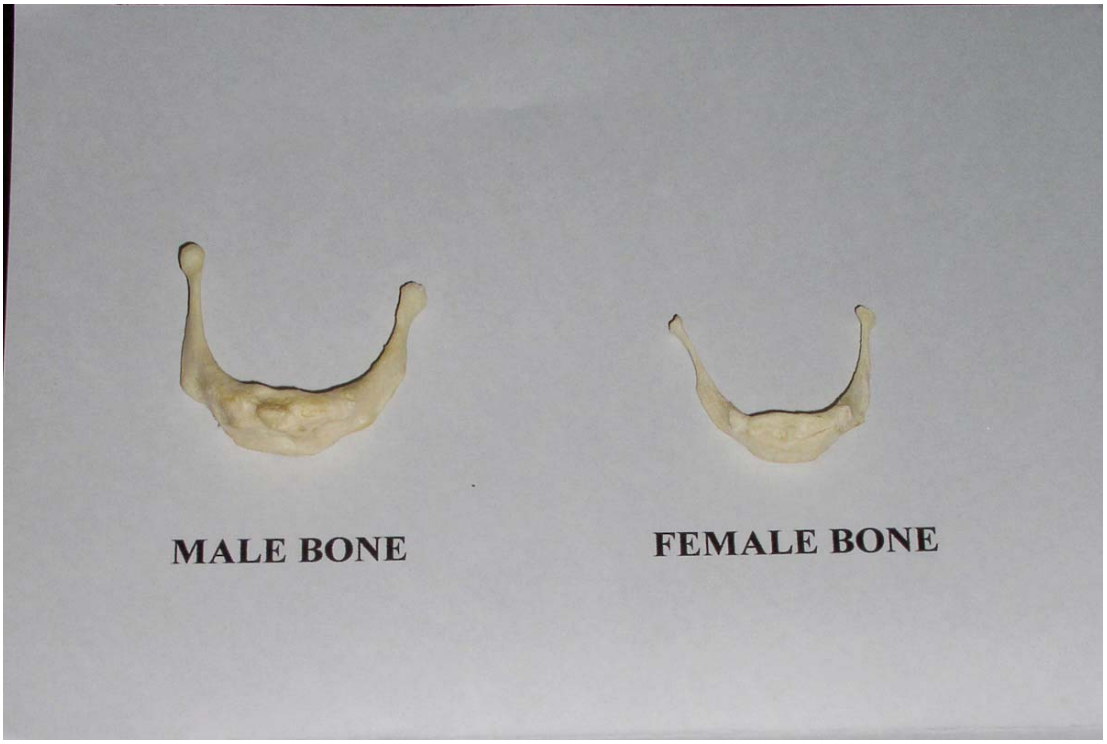

FIGURE II - A :

ESTIMATION OF WEIGHT OF MALE HYOID BONE USING DIGITAL BALANCE :

FIGURE II - B :

ESTIMATION OF WEIGHT OF FEMALE HYOID BONE USING DIGITAL BALANCE :

FIGURE III – A :

ESTIMATION OF THE VERTICAL HEIGHT OF THE BODY OF THE MALE HYOID BONE USING VERNIER CALLIPERS:

FIGURE III – B :

ESTIMATION OF THE VERTICAL HEIGHT OF THE BODY OF THE FEMALE HYOID BONE USING VERNIER CALLIPERS: