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A Study of Morphometrical Analysis of Human Stapes Using Cadavers

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ABSTRACT

The auditory ossicles (AO) transfer sound vibrations in the tympanic membrane (TM) from the middle ear to the inner ear. These ossicles (malleus, incus & stapes) can be found in the petrous part of the temporal bone (TB). In the TM they form a chain across the tympanic cavity. The present study was aimed at providing the morphometrical dimensions of the stapes among male Nigerian population and comparing the values obtained with previous studies. The study was carried out on 27 Stapes (R=10, L=17) from 20 adult male cadavers in various Anatomy Department in Nigerian Universities. Various measurements were taken with digital vernier caliper and weighed with Mettler Toledo weighing balance. This study revealed no statistical significant difference ($p > 0.05$) between morphometric parameters of the right and left bones. The precise dimensions of these ossicles have been obtained in this study among male Nigerian Population, which would be of great importance to the prostheticians in Nigeria.

Keywords: Morphometry, Human Stapes, Cadaver, Nigeria

INTRODUCTION

Ear is a sensory organ that shows detailed organization in anatomical and functional features among all organisms¹. In addition, it plays an important role in receiving sounds and body balance^{2,3,4,5}. The AO (malleus, incus and stapes) help in transmission of sound waves across the tympanic cavity in a latero-medial sequence^{6,7}. These ossicles are found in the petrous part of the TB and in the dorsal aspect of the TM^{8,9,10}. They form a chain across the tympanic cavity from TM to oval window^{11,12}. The stapes is made up of the head (caput stapedis), neck, anterior crus, posterior crus and footplate of stapes which attaches to the oval window^{13,10,14,15}.

Congenital malformations of these ossicles have been reported to cause hearing loss^{16,17,18,19}.

To restore appropriate sound transmission, ossicular chain reconstruction has to be performed^{20,21}. The ossiculoplasty done by the otolaryngologists can bring great improvement in conductive hearing losses due to ossicular discontinuity^{22,23}.

W.H.O reported that, over 5% of the world population (430 million) require repairing of their disabling hearing loss (432 million adults and 34 million children). They also stated that by 2050, 2.5 billion people or 1 in 4 people will be living with some degree of hearing loss²⁴ and nearly 80% of these people live in low and middle-income countries. Nigeria with the largest population in Africa falls into this category²⁴. Therefore, Nigeria needs more than 32 million hearing aids per year²⁴.

MATERIALS AND METHODS

The study was carried out on 27 Stapes (R=10, L=17) from 20 unidentified adult male cadavers from the Anatomy Department of various Universities in Nigeria.

The stapes were obtained manually following dissection of the petrous part of TB using Cobbler's Cut Method²⁵. Measurements were made according to previous studies^{26,27}. Measurements were taken with a digital vernier caliper and weighed on Mettler Toledo weighing balance.



Figure 1: Diagram showing harvested Stapes

Measurements of Stapes:

- Total height (TH): distance from the tip of the head to the foot plate (mm)
- Length of foot plate (LFP): distance of the long axis of foot plate (mm)
- Width of foot plate (WFP): distance of the width of foot plate (mm)
- Index (I): Length of foot plate X 100/ total height of stapes (%)
- Weight of Stapes (W mg)

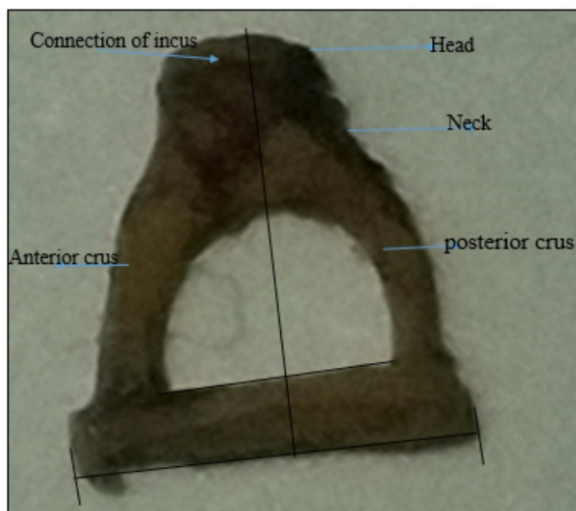


Figure 2: Diagram showing various measurements of stapes

RESULTS

The morphometrical data from the stapes were statistically analyzed using SPSS software version 20 in table 1.

Table 1: Descriptive analysis of Stapes (n= R (10), L (17))

	MEAN \pm SD (RIGHT)	MEAN \pm SD (LEFT)
Total Height (mm)	3.19 \pm 0.21	3.15 \pm 0.21
Length of FootPlate (mm)	1.96 \pm 0.07	1.94 \pm 0.09
Width of FootPlate (mm)	2.88 \pm 0.18	2.90 \pm 0.18
Weight (mg)	3.32 \pm 0.05	3.34 \pm 0.05
Index (%)	61.70 \pm 2.45	62.30 \pm 2.35

There was no statistical difference ($p > 0.05$) observed when all the morphometric data of stapes were compared in terms of sides

Table 2: Comparison between morphometric data of Stapes with previous reports

Author	Population	Sample size	Mean Total Height	Mean Length of Footplate	Mean Width of Footplate	Weight	Index
Dass (1966) ¹⁵	Patiala	165	3.29	2.79	1.43	3.02	--
Dass (1969) ²⁸	Patiala	100(feta)	3.32	2.82	1.41	--	--
Harneja (1973) ²⁹	Jaipur	50	3.12	2.68	1.26	3.17	--
Arrensburg (1981) ³⁰	Isreal	--	3.2	2.8	1.3	--	85.1
Awenger (1995) ³¹	Switzerland	10	--	2.48	--	--	--
Unur (2002) ³²	Turkey	40	3.22	2.57	1.29	--	80.06
Wadwa (2005) ¹⁴	New Delhi	17	3.41	2.97	0.38	--	--
Farahani (2008) ²⁶	Iran	12	3.28	2.99	1.43	--	--
Jyoti (2015) ²⁷	Mysore	50	3.11	3.12	1.51	2.23	--
Gulrez (2013) ³³	Aligarh	30	3.18	2.93	1.60	--	--
Padmini (2014) ³⁴	AP	100	2.71	2.36	--	--	87.2
Rathava (2014) ³⁵	Jamnagar	60	3.33	2.78	1.34	--	--
Sodhi (2017) ⁹	North India	100	3.38	2.80	1.36	2.55	83.22
Present Study	Nigeria	27	3.17	1.95	2.89	3.33	62.00

DISCUSSION

The ear ossicles were firstly reported in 16th century. Hast and Garrisson³⁶ reported that Vesalius was the first to describe the incus and malleus in 1543 in his monumental work “De Humani Corporis Fabrica” while Ingrassia and Eustachius³⁷ described Stapes firstly in 1546.

Lempert and Wolff³⁸ stated that, the ear ossicles is of a miniature size, it attained its adult state during fetal life having complete development of mucosa which is continuous with mucosa of tympanic cavity. These ossicles continues to undergo changes throughout life. Therefore, variations of the size and morphology of these bones can be seen²⁹.

There are several literatures about the middle ear ossicle, but few studies are on the individual differences in stapes which were based on either adult or animals^{30,32}. There is paucity of data regarding the morphometry of the stapes among Nigerian population. The various measurements of stapes have been compared with previous studies over the period of time (Table 2).

The values of the present study were not similar when compared to previous studies (Table 2) (Turkey, Iran, Switzerland and Israel). Within India including Patiala, Jaipur, New Delhi and Uttar Pradesh, the dimensions were also at higher side. The study revealed that the adult stapes showed marked morphometric variations which may be due to racial differences between the Caucasians, Asians and Negroids or regional population difference (Indian population). There was no statistical difference ($p > 0.05$) observed when all the morphometric data of stapes were compared in terms of sides.

CONCLUSION

Stapes are morphometrically identical in both ears. The precise measurements of the stapes have been reported in this study for Nigerian population (males). These values obtained will be very helpful in designing the prosthesis in ossicular chain pathology in Nigeria.

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