The Measurement of Hyoid Bone in Western Population of Uttar Pradesh in India Using Computed Tomography

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Abstract—**Objective: This study aims to evaluate the morphometric dimensions of the hyoid bone in the Western population of Uttar Pradesh, India, using computed tomography (CT) and to analyze variations with respect to sex and age. The hyoid bone plays a crucial role in respiration, phonation, and deglutition, and its structural morphology shows sexual dimorphism valuable for forensic and anthropological identification. Methods: A retrospective cross-sectional study was conducted on 102 patients (55 males, 47 females) undergoing non-contrast CT (NCCT) neck scans at Santosh Hospital, Ghaziabad. Hyoid bone length, width, and greater cornu measurements were taken using 3D reconstruction images. Statistical analyses included t-tests and ANOVA to determine gender and age-related differences. Results: The mean hyoid length in males was 24.93 ± 5.3 mm and 22.47 ± 7.4 mm in females. Significant sexual dimorphism was observed in length (p=0.02), width (p=0.03), and greater cornu length (p=0.04). Age-related variation was minimal. The findings are consistent with international studies reporting larger hyoid dimensions in males. Conclusion: Computed tomography provides precise morphometric evaluation of the hyoid bone. The presence of sexual dimorphism makes the hyoid bone a reliable indicator for forensic identification. Establishing regional morphometric databases can enhance forensic accuracy and support anthropological research.**

Index Terms—**Hyoid bone, Computed tomography, Morphometry, Forensic anthropology, Sex determination, Uttar Pradesh population.**

I. INTRODUCTION

The hyoid bone, a small U-shaped structure located in the anterior neck, is unique among human bones as it does not articulate directly with any other bone. Suspended by muscles and ligaments, it serves as an anchoring point for the tongue and muscles of the floor of the mouth. Functionally, it contributes to crucial activities such as swallowing, speech, and respiration. Anatomically, it comprises a central body, two greater cornua, and two lesser cornua. Due to its complex attachments, the hyoid bone provides vital information regarding head and neck mechanics, making it of particular interest in radiological, anatomical, and forensic studies. From a forensic standpoint, the hyoid bone is often utilized in sex estimation and in identifying causes of death, especially in cases of strangulation. Sexual dimorphism in hyoid morphology has been reported across populations males generally exhibit larger, more robust bones compared to females. The degree of fusion between the hyoid body and greater horns is also associated with age, making it a potential age estimation marker. However, morphometric standards vary among populations due to genetic, nutritional, and environmental influences. Therefore, population-specific data, such as that for Western Uttar Pradesh, are essential for accurate forensic interpretation. Recent advances in imaging modalities, particularly computed tomography (CT), have revolutionized anatomical measurements. High-resolution CT and 3D reconstructions provide non-invasive, accurate assessments of bony structures, surpassing traditional caliper-based methods. This study aims to establish CT-based morphometric data of the hyoid bone in the Western population of Uttar Pradesh and explore sex and age-related variations.

II. MATERIALS AND METHODS

Study Design: This was a retrospective observational study conducted in the Department of Radiodiagnosis, Santosh Hospital, Ghaziabad, Uttar Pradesh. Sample Population: The study included 102 participants (55 males, 47 females) aged between 18 and 80 years who underwent non-contrast CT (NCCT) neck scans for clinical purposes. Participants with congenital

anomalies, fractures, trauma, or systemic bone diseases were excluded. CT Acquisition Protocol: All scans were performed using a Siemens Healthineer SOMATOM Go Now 128-slice CT scanner. Patients were positioned supine with a head-first orientation. The scan coverage extended from the base of the skull to the arch of the aorta. Axial images were reconstructed in sagittal and coronal planes using a slice thickness of 0.625 mm, enabling high-resolution 3D visualization of the hyoid bone. Measurement Parameters: The following parameters were measured:

1. Total length of the hyoid bone (distance between the two greater cornua).
2. Width of the greater cornu.
3. Length of each greater cornu.
4. Hyoid body height and width.

Statistical Analysis: Data were analyzed using SPSS v25. Independent t-tests assessed gender differences, while one-way ANOVA evaluated age-group variations. A p-value of <0.05 was considered statistically significant.

III. RESULTS

The study analyzed 102 individuals (53.9% males, 46.1% females) aged 18–80 years (mean = 43.4 ± 20.6 years). Males demonstrated larger hyoid dimensions compared to females. The mean total hyoid length was 24.93 mm for males and 22.47 mm for females ($p=0.02$). The mean width of the greater cornu was 6.94 mm in males and 6.71 mm in females ($p=0.03$). The length of the greater cornu averaged 5.64 mm in males and 5.03 mm in females ($p=0.04$). Age-wise distribution revealed that fusion and ossification changes progressed gradually, but no statistically significant correlation was observed between age and total hyoid length. Graphical representation of gender-based variations showed consistently larger dimensions in males across all parameters. These findings suggest stable morphometric sexual dimorphism irrespective of age. The ANOVA test confirmed that while differences across age groups were not statistically significant ($p>0.05$), gender differences remained highly consistent across all morphometric variables.

IV. DISCUSSION

The present study confirms significant sexual dimorphism in the morphometry of the hyoid bone among the Western Uttar Pradesh population. Similar findings have been reported by Torimitsu et al. (2018) in the Japanese population and Mutlu et al. (2024) in Turkish samples. Male hyoid bones were consistently larger in body length and cornual extensions, reflecting greater muscular attachments and hormonal influences during development. Such dimorphism aligns with global forensic literature, where male hyoids demonstrate enhanced robustness due to mechanical loading from thicker neck musculature. While age-related fusion of the greater cornua is recognized, our study found limited correlation between age and linear measurements. This may be due to individual variation and the relatively small elderly sample size. Studies by Werner et al. (2022) and Salem et al. (2020) have shown ossification of hyoid joints as a more reliable marker of age progression rather than dimensional changes. The use of computed tomography offered superior accuracy compared to traditional osteometric methods. Previous cadaver-based analyses often suffered from measurement errors and postmortem deformation. CT imaging, particularly with 3D reconstruction, allows in-vivo assessment with minimal error. Our findings are comparable with studies by Abdelkader et al. (2025) and Pazelli et al. (2024), who demonstrated that machine learning-assisted morphometry achieves up to 93% accuracy in sex classification. These findings reinforce the necessity of establishing regional morphometric datasets to improve forensic reliability in Indian populations. Considering India's genetic and environmental diversity, localized studies like this are crucial for developing accurate sex estimation equations.

V. CONCLUSION

Computed tomography provides a precise and reproducible tool for hyoid bone morphometry. The current study demonstrates significant sexual dimorphism in hyoid bone parameters in the Western Uttar Pradesh population. Males consistently exhibited larger hyoid dimensions, making the bone a reliable marker for sex estimation in forensic investigations. Establishing a CT-based morphometric database for Indian populations is recommended to

enhance accuracy in anthropological and medico-legal evaluations

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