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Evaluation of Pterygoid Hamulus Dimensions in Completely Edentulous Patients Using Cone Beam Computed Tomography

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Abstract

The inferior border of the medial pterygoid plate extends to form the pterygoid hamulus (PH). The PH's length and location are crucial for these functions. The PH's morphology helps in interpreting the imaging and also provides information regarding anatomical determinants to limit the posterolateral borders of maxillary complete dentures. This can also aid in gender identification in forensic situations. This study analyzed 80 CBCT scans from 40 male and 40 female patients (ages 25–67, median 38). Significant differences were found in pterygoid hamulus length between sexes: males had longer hamuli on both the right (8.840±0.299 mm vs. 7.940±0.349 mm, P=0.000) and left sides (7.899±0.419 mm vs. 7.277±0.271 mm, P=0.002). However, no significant differences in hamulus width were observed between males and females. These findings suggest length variations could be useful in clinical and anthropological contexts. Dimensions of pterygoid hamulus in completely edentulous patients will aid the clinician in precisely recording the posterolateral borders of maxillary dentures; this can also aid in gender determination in fragmented skulls in forensic applications.

Keywords: *CBCT, Forensics, Maxillary Complete Denture, Pterygoid Hamulus.*

Introduction

A projection shaped similar to a hook located at the inferior border of each medial pterygoid plate is referred to as pterygoid hamulus (PH). The pterygoid hamulus, a hook-shaped process created by the medial pterygoid plate of the sphenoid bone curving laterally at its lower extremity, is glided about by the tendon of the tensor veli palatini (TVP) muscle [1]. During the phases of development and maturation and into adulthood, this hook-like process helps to when swallowing and sucking, keep the nasal cavity and the oral cavity apart. It is also essential for the operation of various muscles. Consequently, for these reasons, the PH's length and location are crucial [2]. Understanding the morphology of this structure well has proven beneficial for understanding imaging results and is essential for differentiating between oral and pharyngeal pains that do not have a known aetiology [3-6]. Pain and discomfort caused particularly while swallowing is associated with pterygoid hamulus syndrome and manifests a complex variety of symptoms in the pharyngeal and palate regions, associated with elongation of the PH [7]. The severity of sleep apnea is inversely correlated with the pterygoid hamulus length. The findings, which imply that the size of the PH plays a major influence in controlling the degree of muscle activity and, consequently, the airway collapse, still require confirmation in larger study groups looking at various anatomic structures and their effect on surrounding soft tissues [8].

The maxillary tuberosity, the palatine bone's pyramidal projection, and the pterygoid hamulus combine to form the hamular notch.

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This trough, which has collagenous tissue and is easily displaced by the action of the pterygomandibular raphe, is the lateral indication for completing the posterior palatal seal. The border seal may be affected by the prominent superior attachments of the raphe to the maxillary tuberosity, which function as active frenums [8].

A maxillary complete denture's posterior border's form and contours should permit the soft palate's dual valving action, allowing for uninterrupted swallowing and speech, and enabling the denture to function in harmony with the patient's work [9]. The posterior palatal seal's depth and width, or both, may be deficient in the distal border. Because there is no peripheral seal as a result of these errors, retention may be poor [10-12]. Even though the length, position, and form of the PH have all been studied extensively, the anatomic relationships between the pterygoid hamulus and the structures surrounding them have seldom been examined for entire denture boundaries. Furthermore, no research has been done on the identification and investigation of PH in prosthodontics for denture extent and forensics employing cone beam computed tomography (CBCT) imaging with 3-dimensional depictions of skulls created with a surface rendering program.

The aim of this study is to comprehensively assess the dimensions of the pterygoid hamulus in completely edentulous patients using CBCT imaging. Understanding the variations in hamulus dimensions can aid in the development of individualized treatment plans and enhance clinical outcomes.

Materials and Methods

In the present study, 80 full skull CBCT scans from 40 male and female patients each were assessed, and the sample size was calculated using G power software 3.1.9.3. Coronal sections of CBCT scans have been used to measure the width and length of the pterygoid hamulus on both sides. The patients' age was 25–67 years old, with 38 as the median age. Full skull CBCT scans involving the posterior maxillary region were included in the study, irrespective of the patient's age or gender. Excluded from the study were CBCT scans with artefacts at the region of interest, scans where the pterygoid hamulus border is not detectable, maxillofacial trauma involving pterygoid hamulus fracture, traumatic extraction of maxillary third molars, pathology in the posterior maxillary region, and bone disorders like skeletal asymmetries or osteoporosis.

All the full skull CBCT scans were obtained using KODAK CARESTREAM CS 9600-16 X 17 FOV CBCT (Full Skull) as shown in Fig 1. Standard protocol was followed for exposure parameters and patient positioning for scanning all the images. The parameters were adjusted to 80 kV, 5 mA, the needed voxel size of 200 µm × 200 µm × 200 µm, the required field of view (FOV) and an image acquisition period of 10.8 seconds. The Digital Imaging and Communications in Medicine (DICOM) provided the CBCT pictures. The software called CS 3D Imaging Light was used to view the images.

The PH's width and length were measured in the CBCT scan's coronal regions. The study data were divided depending on gender and length width of both the sides of pterygoid hamulus respectively. The length was calculated as the distance between the tip of the pterygoid hamulus and the junction formed by the medial pterygoid plate and the pterygoid hamulus. The distance between the pterygoid hamulus’s most prominent points on its lateral and medial aspects was used to measure the width (Fig 1,2,3).

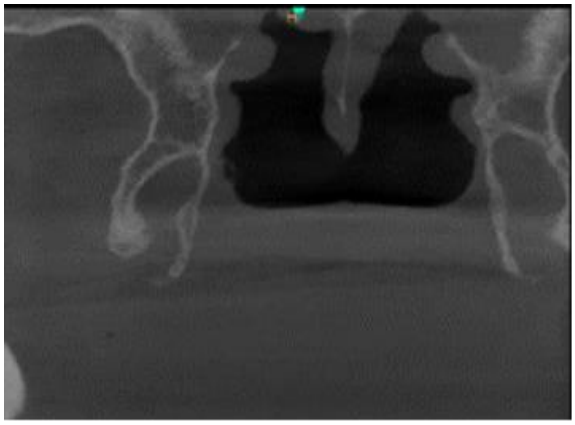

Figure 1. Coronal Section of CBCT Showing Pterygoid Hamulus

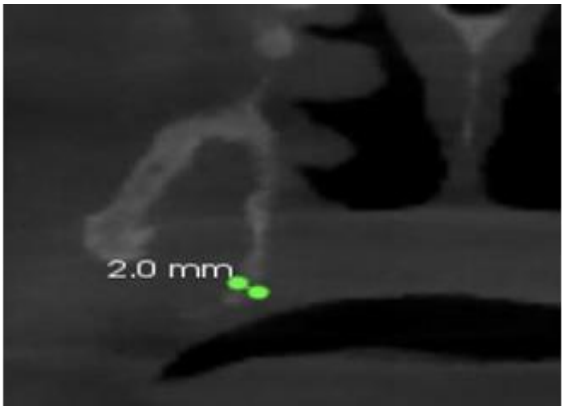

Figure 2. The most Prominent Part of the Medial Pterygoid Plate was used to Measure the Pterygoid Hamulus Width

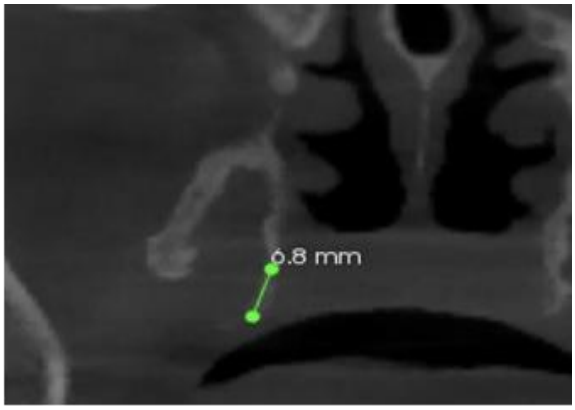

Figure 3. Distance Measured from the Base to Tip of the Medial Pterygoid Plate to Measure Pterygoid Hamulus Length

Results

The results of the pterygoid hamulus measurements reveal notable differences between males and females, particularly in terms of length. On the right side, males had a significantly longer pterygoid hamulus (8.840 ±0.299 mm) compared to females (7.940±0.349 mm), with a highly significant P value of 0.000. Similarly, on the left side, males exhibited a longer hamulus (7.899 ±0.419mm) than females (7.277 ±0.271mm), with a P value of 0.002, further confirming a statistically significant difference in length between the sexes. In contrast, the width of the pterygoid hamulus showed no significant variation

between males and females. On the right side, the width was 2.028±0.434 mm for males and 1.928±0.434 mm for females, with a P value of 0.990, indicating no statistical significance. The left side measurements were also close, with males at 2.122±0.063 mm and females at 2.02 ±0.076mm, and a P value of 0.217, suggesting the difference was not statistically meaningful (Table 1, Fig 4).

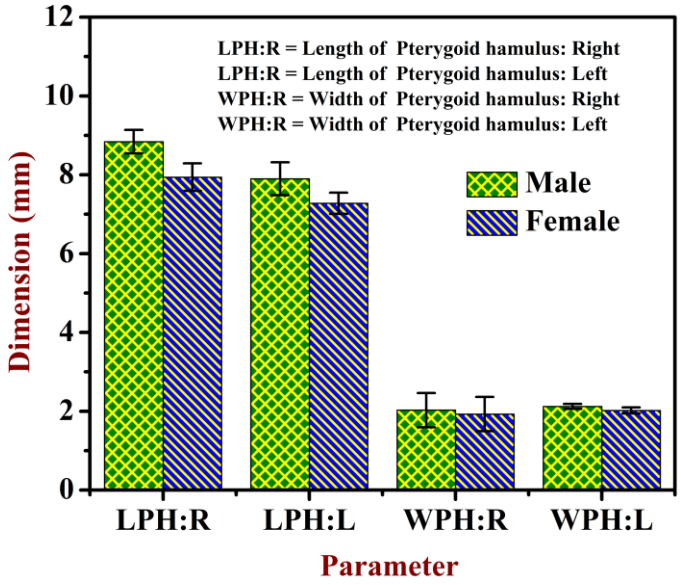

Figure 4. The Bar Graph Visualizes the Differences in Dimensions between Males and Females for both the Right and Left Pterygoid Hamulus

Table 1. Pterygoid Hamulus Measurements

Parameter	Male (Mean ± SD)	Female (Mean ± SD)	P value
Length of Pterygoid hamulus: Right	8.840±0.299	7.940±0.349	0.000
Length of Pterygoid hamulus: Left	7.899±0.419	7.277±0.271	0.002
Width of Pterygoid hamulus: Right	2.028±0.434	1.928±0.434	0.990
Width of Pterygoid hamulus: Left	2.122±0.063	2.02±0.076	0.217

These results suggest that the length of the pterygoid hamulus is a key distinguishing factor between males and females, likely due to differences in skeletal development. However, the width of the hamulus remains relatively consistent across both sexes. This finding could be valuable for clinical and anthropological studies involving the anatomy of the pterygoid region.

Discussion

The pterygoid hamulus, a small hook-like projection from the medial pterygoid plate of the sphenoid bone, increases in both width and length with age due to bone growth and remodelling processes. This phenomenon is influenced by factors such as genetics, nutrition, and the mechanical forces exerted on the bone through activities like chewing and swallowing. Additionally, males tend to have significantly larger pterygoid hamuli than females, a difference attributed to sexual dimorphism and hormonal influences, particularly the effects of testosterone, which promotes greater bone growth in males. These differences may also result from variations in muscle mass and functional demands on the craniofacial structures between sexes. Clinically, the size of the pterygoid hamulus is significant, as abnormalities in its structure can

contribute to conditions such as hamular bursitis, making the understanding of these variations valuable for healthcare professionals, particularly in maxillofacial surgery and dentistry.

The morphology and position of the pterygoid hamulus, particularly its length, have a significant impact on the way the muscles in the region function. Changes in the PH's morphology or structures that are associated with it might result in symptoms that are similar to those of other diseases, including erythema and oedema in the palate's posterior region, autophony, hearing loss and auricular pain. These lesions may be mistaken as glossopharyngeal neuralgia or temporomandibular disorders [10].

The current study showed that males had PHs that were statistically significantly longer than those of females. Males had a wider PH than females did, although the variations in width were not statistically significant. Romoozi et al. found, in line with our findings, that males had considerably longer average PH on both sides (6.6 mm) than females (6.4 mm). Did not discover any appreciable variations in PH dimensions based on gender [13].

To accurately diagnose, prevent, and manage diseases in the oropharyngeal region and record borders of the denture, dentists must possess a detailed understanding of the PH and its functional and anatomical relationships with associated surrounding structures [13]. On the other hand, there aren't many studies on PH morphology in the literature, and the available ones have been done in different populations with different outcomes. There is no research in the literature that demonstrates a discernible difference in the width measures between the left and right sides based on gender or age, and the length findings in this study are consistent with those of previous studies [8].

The assessment of pterygoid hamulus dimensions in completely edentulous patients using CBCT provides valuable insights into the anatomical variations within this region. These variations can significantly impact dental prosthetic and surgical interventions [14]. For instance, an elongated or thickened pterygoid hamulus may increase the risk of complications during prosthesis placement or implant surgery [3]. Individualized treatment planning that considers these variations is essential to ensure successful outcomes and minimize patient discomfort. This study's main drawback is that it only included patients receiving treatment at one particular institution. Research should be conducted at multiple locations with a substantial study population to develop more accurate reference standards for PH dimensions. Future research should assess PH dimensions over a broader population to develop reference standards for PH dimensions depending on gender and age. These parameters may be useful for age determination in the forensic domain [15].

Many studies are delving into the anatomy of the pterygoid bone and associated structures, yet there are many aspects to be explored additionally for a more comprehensive understanding [16-20]. Furthermore, the findings of this study emphasize the importance of employing advanced imaging techniques like CBCT for preoperative assessment. Understanding these variations allows clinicians to anticipate potential challenges and make necessary adjustments to their treatment plans. Additionally, these results can serve as a reference for future studies and clinical guidelines related to maxillofacial procedures in completely edentulous patients. Limitations of this study are the sample size, though representative, may not capture the full spectrum of anatomical variations present in the broader population and the need for long-term clinical follow-up to validate the clinical implications of the observed variations.

Conclusion

The width and length measurement of the pterygoid hamulus increased with age. Males were measured to have significantly greater

length and width of pterygoid hamulus than females. Understanding the dimensions of pterygoid hamulus in completely edentulous patients will aid the clinician to precisely record the posteo lateral borders of maxillary dentures this can also aid in gender determination in fragmented skulls in forensic applications.

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Conflict of Interest

The authors declare no conflicts of interest

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