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Radiomorphometric assessment of the pterygoid hamulus as a factor promoting the pterygoid hamulus bursitis

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Background: *The pterygoid hamulus (PH) is a small protrusion on the base of the pterygoid process of the sphenoid bone. PH is a site of insertion of many muscles and ligaments. Its topography can determine predilection for developing the pterygoid hamulus bursitis (PHB).*

Materials and methods: *The study was conducted based on the morphometric analysis of 100 PHs on cone beam computed tomography scans.*

Results: *Based on statistical analysis, we found numerous significant correlations between the morphometric parameters.*

Conclusions: *Considering our results, it can be concluded that the main pathogenic factor in PHB is an extensive medial deviation of the pterygoid hamulus in the frontal plane.* (Folia Morphol 2020; 79, 1: 134–140)

Key words: pterygoid hamulus, pterygoid hamulus bursitis, cone beam computed tomography

INTRODUCTION

The pterygoid hamulus (PH) is a part of the medial pterygoid plate of the sphenoid bone. It consists of the base, body, head and neck (Fig. 1) and, being the lowest point of the sphenoid bone, is the point of insertion for many anatomical structures [14]. These include muscles, such as tensor veli palatini, buccinator, medial pterygoid, pterygopharyngeal part of the superior pharyngeal constrictor, and other structures like pterygomandibular raphe, pharyngobasilar fascia, palatine aponeurosis, and hamulus bundles coursing through the transition zone between the palatopharyngeus and the superior pharyngeal constrictor [10, 11, 14, 21, 22].

A detailed structure of the PH is fascinating. It is sandwich-shaped structure, which consists of a thicker medial plate made of compact bone and a thinner lateral plate. These plates are connected with each

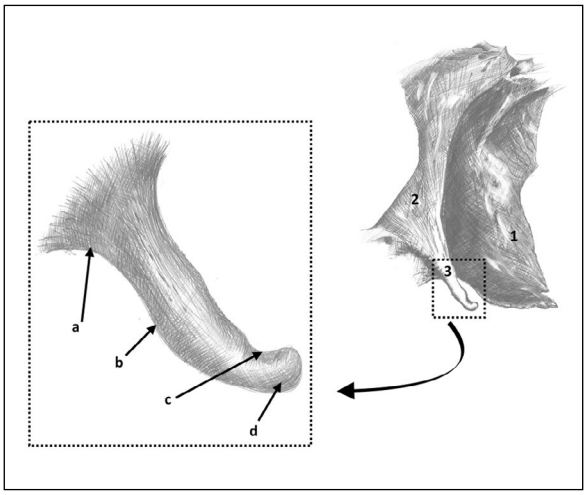

Figure 1. Pterygoid hamulus anatomy (drawing by the author); a — base; b — body; c — neck; d — head; 1 — lateral pterygoid plate; 2 — medial pterygoid plate; 3 — pterygoid hamulus.

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Table 1. Symptoms specific for pterygoid hamulus bursitis

	Number of cases	Gender	Age	Side	Localised pain				Other symptoms		
					Local (PH region)	Oral*	Cranio--facial**	Cervical	Dysphagia/ /odynophagia	Localised erythema	Speech disturbance
Herts, 1968 [8]	1	F	52	L	+	+			+		
Salins et al., 1989 [16]	1	F	50	L		+	+		+		+
Kronman et al., 1991 [13]	1	M	70	L			+		+		
Sasaki et al., 2001 [17]	1	M	47	R+L		+	+				
Ramírez et al., 2006 [15]	2	F F	43 52	L L			+ +				
DuPont et al., 2007 [5]	92	74 F 18 M		48 (R+L) 25 P 20 L	19.8%	Up to 68%	Up to 57%	75%	23%/46%	0.43%	
Sattur et al., 2011 [18]	1	M	52	L	+	+			+		
Cho et al., 2013 [2]	1	F	62	L		+	+		+		
Bandini et al., 2015 [3]	1	F	36	R+L					+	+	
Shetty et al., 2018 [20]	1	F	42	L	+	+	+				

*Oral pain included: palatine pain, maxillary pain, toothaches and oral cavity pain; **Cranio-facial pain included: otic pain, pain from temporal region, pain form orbital region.
F — female; L — left; M — male; PH — pterygoid hamulus; R — right

other by bone trabecula. The course of the trabecula is usually oblique [14]. Studies show that the course of collagen fibres in the medial plate has a more obtuse angle of inclination relative to the vertical axis than in the lateral plate [6, 14]. The structure of PH in adults and children is similar [6, 9, 14].

The topography of PH and its structure are considered the main cause of the chronic pain syndrome called pterygoid hamulus bursitis (PHB). This rare entity was first described in a patient with total toothlessness [7]. It manifests with various pain sensations within the pharynx and palate [7, 23]. The pain may radiate to the temporal region or neck mimicking tension-type pain [5] or to the alveolar process of maxilla imitating dental disease [2]. There are also cases of PHB radiating to the orbital area [20]. In rare cases, the pain may spread out to half of the face [13, 17, 18]. In the literature, there are numerous case reports on PHB, with atypical palatine pain being the shared feature (Table 1).

Pterygoid hamulus morphology may be related to development of PHB. Muscles attached to the hamulus exert on it a dorsal and medial pressure while, in contrast, the pterygomandibular raphe exerts pressure in dorsal and lateral direction [14]. The predominance of forces bending the PH in the medial direction is observed. Therefore, the greater thickness of the medial plate of pterygoid process is related to a greater pressure caused by various forces [9]. From a clinical point of view, the tensor veli palatini muscle has the greatest impact on the occurrence of pain syndrome [8, 12].

The diagnosis of the PHB is based on a detailed interview and clinical examination of the head and neck with particular focus on the oral cavity, hard and soft palate, upper dental arch, maxillary tuberosity, temporomandibular joints and masticatory muscles [2, 4, 5, 19]. Differential diagnosis should include diseases of the stylo-hyoid and stylo-mandibular muscular complex, disorders of the pterygopalatine ganglion, parotid gland tumours [15], presence of foreign bodies or infections of the upper respiratory tract [23]. Clinical examination is usually supported by imaging, such as is panoramic radiography or cone beam computed tomography (CBCT) [2, 3, 20], in order to exclude odontogenic foci of infection and other pathologies. The treatment consists of two approaches: medical and surgical (when medical approach fails). Medical treatment is based on patient education, dietary counselling, avoidance of soft palate irritation [1, 18, 23] and steroids injected around the PH [2]. When the medical treatment fails, surgical treatment should be instituted, consisting of PH resection [2, 8, 13].

Due to limited number of reports explicitly characterising the morphology of the PH and the predilection for pain syndromes, we conducted a study aiming to explain this issue from the anatomical point of view. Our goal was to establish a morphologic feature of PH promoting the development of PHB.

MATERIALS AND METHODS

The study was conducted based on anonymised CBCT scans obtained with Toshiba PCH650 scanner at the Clinical Department of Craniomaxillofacial Surgery, Military Institute of Medicine in Warsaw, Poland. The analysis was conducted using Ez3D Plus software. All the scans were obtained in the course of standard diagnostics.

We analysed 100 pterygoid hamuli, 38 in men and 62 in women. The patients' mean age was 53.6 (16–87) years. We measured the width, length and angle of inclination of the PH in the sagittal plane and the width and inclination angle in the frontal plane. The angle of inclination was measured according to the protocol shown in Figure 2. We recorded the age and gender of the subjects, as well as the presence of maxillary toothlessness (17 cases), the direction of PH inclination in the frontal plane (lateral: 95 cases; medial: 5 cases) and this direction in the sagittal plane (posterior: 91 cases; anterior: 2 cases; combined postero-anterior: 7 cases). In 1 case a presence of PHB symptoms was noted — the patient suffered from odynophagia and left-sided palatine pain radiating to alveolar process and left temporal/ear area. She had a panoramic radiography and CBCT scans performed (Figs. 3, 4).

Statistical analysis

The results were statistically analysed using StatSoft Statistica 13.1 PL software. For all measured parameters basic statistics were performed. The normality was evaluated with Shapiro-Wilk, Kolmogorov-Smirnov and Lilliefors tests. For the results, the average value, standard deviation (SD), median value and minimum–maximum range were calculated. The parameters were compared with respect to gender, side, toothlessness and PH inclination in frontal and sagittal planes. We used parametric tests for the following parameters: length in frontal plane, angle in frontal plane, angle in sagittal plane, and non-parametric tests for the width in frontal plane and the width in sagittal plane. For each parameter, the correlation with age was calculated (Pearson's coefficient, Spearman's rho). For multivariate analysis ANOVA and Kruskal-Wallis tests were used. We assumed a significance level at $p < 0.05$.

RESULTS

Typical values of PH dimensions are presented in Table 2. Based on the statistical analysis, we found no differences in PH measurements with respect to gender and side. We found a very weak correlation of the morphometric parameters and age (correlation coefficients from 0.03 to 0.16).

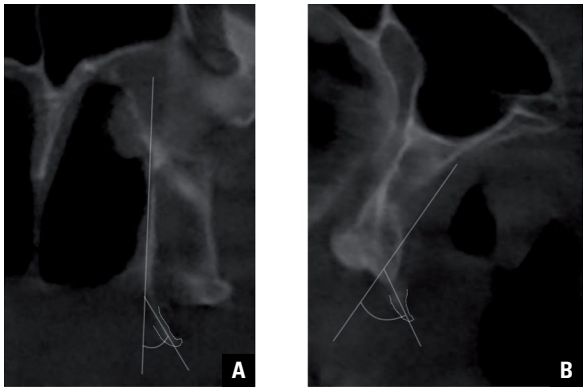

Figure 2. Protocol for angle measurement of the left pterygoid hamulus (source: Clinical Department of Craniomaxillofacial Surgery, Warsaw, Poland); **A.** In frontal plane; **B.** In sagittal plane.

The width of PH in the sagittal plane on the left side was slightly larger (2.5 ± 0.6 mm) than on the right (2.2 ± 0.6 mm) (U-test, $p < 0.05$). We also noticed differences between edentulous and dentate individuals. The PH was shorter in the frontal plane in toothless subjects (5.2 ± 2.3 mm) when compared to dentate individuals (7.2 ± 2.0 mm) (t-test, $p < 0.05$). We observed that the inclination angle in the frontal plane in toothless subjects was also smaller (17.6 ± 10.6 mm) as compared to these with complete dentition (23.5 ± 8.3 mm) (t-test, $p < 0.05$). We found a statistically significant difference in the length of PH in respect to the direction of inclination in the frontal plane. The average length was greater in lateral PH deviation (7.0 ± 2.1 mm) than in medial PH deviation (3.9 ± 1.7 mm) (t-test, $p < 0.05$). There was also a relationship between the inclination angle and inclination direction in the frontal plane. The angle was significantly greater in medial PH deviation (30.1 ± 8.7°) compared to lateral PH deviation (22.1 ± 8.8°) (t-test, $p < 0.05$). Moreover, in the sagittal plane the angle was greater in posterior inclination (36.0 ± 13.5°) compared to much smaller angle associated with anterior inclination (12.4 ± 3.2°) (ANOVA, Tukey test, $p < 0.05$). The differences between the angle and direction of inclination in the sagittal plane were not statistically significant.

The measured parameters were significantly different in the patient with PHB. They are presented in Table 3.

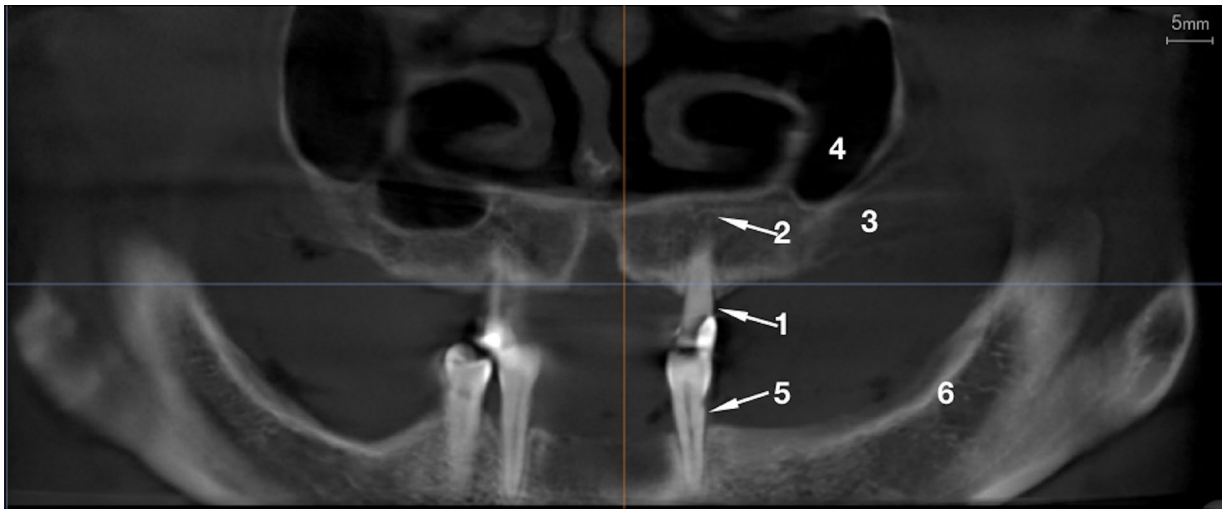

Figure 3. Panoramic cone beam computed tomography-based reconstruction in left-sided pterygoid hamulus bursitis (PHB) patient. Note the difference of the heads of left and right pterygoid hamulus (PH; arrows). Left PH markedly thinner than right PH; 1 — tooth 23 surrounded by bone resorption; 2 — periapical lesion at the root of tooth 23; 3 — alveolar process of left maxilla; 4 — left maxillary sinus; 5 — tooth 33 surrounded by bone resorption; 6 — alveolar part of the mandible.

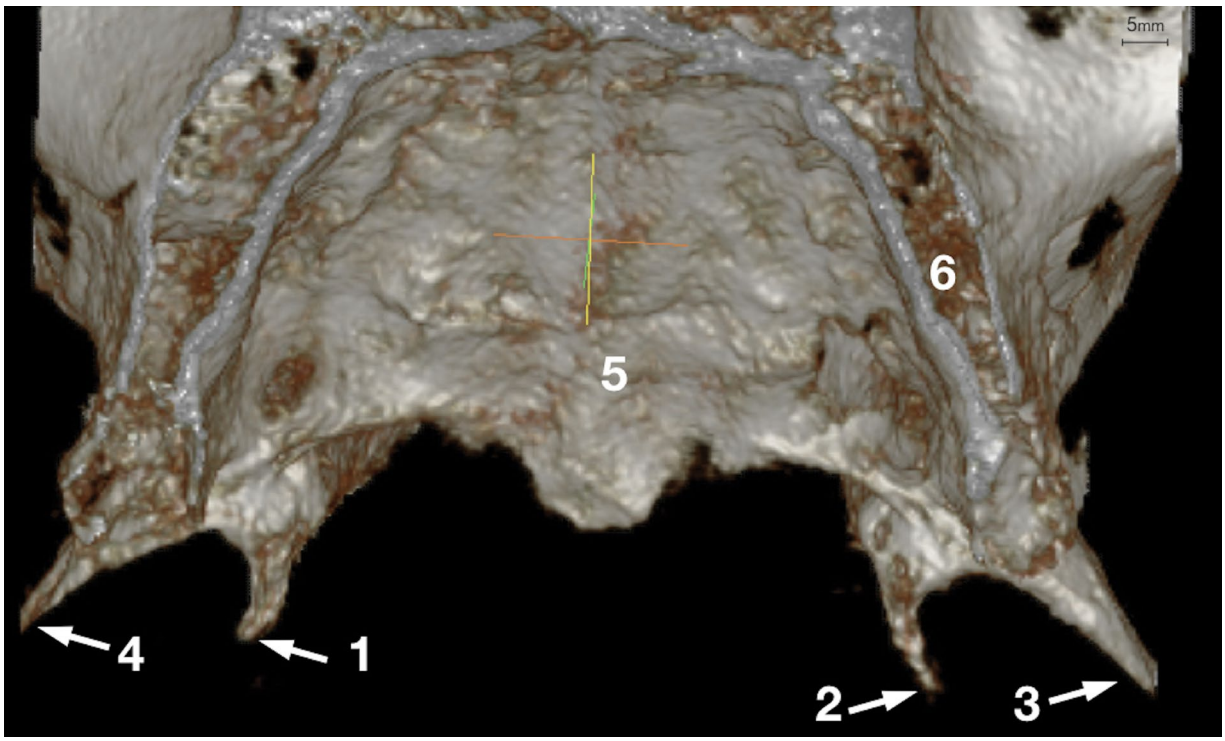

Figure 4. Three-dimensional cone beam computed tomography-based reconstruction in left-sided pterygoid hamulus bursitis (PHB) patient showing no teeth-related causes of PHB; 1 — right pterygoid hamulus (PH); 2 — left PH; 3 — lateral plate of left pterygoid process of the sphenoid; 4 — lateral plate of right pterygoid process of the sphenoid; 5 — hard palate; 6 — alveolar process of the left maxilla.

DISCUSSION

There are numerous theories as to the PHB mechanism, including: a) osteophytes within the tensor veli palatini muscle, b) abnormal PH shape (elongation, abnormal deviation) or c) repeated chronic trauma to this region. Anatomical abnormality may trigger the pain by mechanical irritation of surrounding tissues, impaired contraction of tensor veli palatini muscle, or fibrosis or inflammation of the tensor veli palatini bursa due to an excessive pressure to the palatine aponeu-

Table 2. Descriptive statistics for measured hamuli (n = 100; male = 38; female = 62)

	Average	Standard deviation	Median	Minimum	Maximum
Age [years]	53.6	17.8	56.5	16.0	87.0
Length [mm] — frontal plane	6.88	2.20	6.80	0.90	12.00
Width [mm] — frontal plane	1.81	0.55	1.70	0.80	3.80
Inclination angle [°] — frontal plane	22.47	8.95	21.60	4.60	51.20
Width [mm] — sagittal plane	2.38	0.60	2.40	1.10	4.60
Inclination angle [°] — sagittal plane	35.30	13.68	34.35	10.10	75.00

Table 3. Comparison of parameters between painless individuals and the symptomatic pterygoid hamulus bursitis (PHB) patient

Average values	Non-PHB group	PHB patient	P
Length [mm] — frontal plane	6.88	4.00	< 0.0001
Width [mm] — frontal plane	1.81	0.90	< 0.0001
Inclination angle [°] — frontal plane	22.47	29.70	< 0.0001
Width [mm] — sagittal plane	2.38	3.40	< 0.0001
Inclination angle [°] — sagittal plane	35.30	55.80	< 0.0001

rosis. In these mechanisms the greater palatine, lesser palatine, facial or glossopharyngeal nerves can be stimulated which causes pain in various regions of the head and neck [13, 17, 18]. Also, other mechanisms have been described, including: a) abnormal position of the medial plate of the pterygoid process of the sphenoid, and b) the soft palate mucous membrane too thin or located too close to the PH [1].

The primary diagnostic problem is that in patients with PHB there are no specific clinical symptoms for an unequivocal diagnosis. According to the literature, the characteristic feature of this syndrome is throat pain and dysphagia (Table 1) [2, 3, 16, 22]. In our work, in the only patient with PHB, a throat pain and dysphagia was a dominant symptom. According to the literature, some of PHB symptoms may mimic i.a. glossopharyngeal neuralgia [20] and diseases affecting the temporomandibular joints [5]. The differentiation of orofacial pain is crucial from the point of view of physicians involved in their practice in the diagnostics and treatment.

Due to the rarity of PHB, a statistical analysis of risk factors poses a significant challenge. Many previous papers investigated the relation between the morphometric characteristics of PH and their impact on PHB promotion. The average PH values obtained in our study are similar to the measurements described by other authors. The average length and width in the frontal and sagittal planes in our study (6.88; 1.81 and 2.38 mm, respectively) were comparable with these from the paper by Putz and Kroyer [14] (7.22; 1.81 and 1.4 mm, respectively). Both our study and the paper by Sattur et al. [18] were based on a single PHB case, which does not allow for any statistical conclusions. However, it should be mentioned that our symptomatic PHB patient presented morphological features of PH similar to these observed by other authors, i.e. medial PH position in relation to the pterygoid process of the sphenoid bone [2, 18]. According to Sattur et al. [18], PH deviation angle is greater on the affected than on the healthy side. The authors measured PH deviation along the horizontal axis in the frontal plane based on CBCT scans. On the PHB side the angle was 60.3°. Considering our research, a quick diagnosis is possible based on CBCT scans with frontal plane measurements. However, it seems more convenient to use a vertical line passing through the long axis of the pterygoid process of the sphenoid bone (Fig. 2A). This measurement is easier to obtain due to the fact that PH is deviated relative to the medial plate of the pterygoid process. According to our results, the deviation angle along the vertical line was 29.7° (the same angle being 90°–29.7° = 60.3° in the horizontal axis), which is in ideal accordance with other authors' results [18]. Therefore, a medial PH position might promote PHB development.

It is worth noticing the sharpened top of PH on the side of pain symptoms in comparison to the healthy side (Fig. 2). According to the literature, the greatest forces act on the medial plate of the pterygoid process of the sphenoid. In young people, this force is of 0.1 kg/mm^2 [9]. The analysis of the forces revealed a significant predominance of their medial vector with the greatest pressure exerted by the tensor veli palatini muscle, cooperating with PH in a block mechanism. It was observed that increased pressure on PH causes thickening of the plate of the

compacted bone on the pressure side, whereas the reduction of pressure is the cause of bone resorption [14]. It can be concluded that in dysfunction of the stomatognathic muscles there may be an incorrect distribution of forces acting on the PH, which in turn may affect the resorption of PH in its distal part and provoke the sharpness of PH ending. A sharpened PH, irritating delicate soft tissues, may be a factor causing local inflammation. Such a PH thinning process might have led to PH head loss, observed in our PHB patient. In addition, the research shows that the head of the hamulus is a subject of lateral and dorsal overload. As the pterygomandibular raphe and medial pterygoid muscle are attached to the head, the disturbances in the distribution of forces exerted by these structures may also contribute to the thinning of the head of PH.

In addition to atypical symptoms, another typical feature of PHB is the lack of other abnormalities pointing towards the diagnosis [18]. The diagnosis is based on thorough history and physical examination of the head and neck, including the oral cavity, palate, upper dental arch, maxillary alveolar process, temporomandibular joints and muscles of mastication. Physical examination should be supported by diagnostic imaging, CBCT in particular [2, 15]. In our study, the comparison of the average measurements of PH in patients without PHB and in the one presenting with pain showed significant differences in all studied parameters (Table 3). However, as the PHB was found in only 1 patient, it is impossible to extrapolate these results to the population as a whole.

CONCLUSIONS

In dental and maxillofacial surgery, the PH is a structure prone to be damaged during operation on the posterior alveolar processes, e.g. for impacted upper wisdom teeth. According to our study, the PH morphology may promote the development of the pterygoid hamulus bursitis syndrome. Comparing PH measurements between healthy individuals and the PHB patient, we noticed significant differences in all the studied parameters. Considering reports by other authors, it can be assumed that the main factor in PHB pathogenesis is an extensive medial deviation of the PH in the frontal plane. Taking into account numerous disorders, which may cause pain imitating the PHB, the diagnosis should be based on the clinical examination and morphometric measurements (with special regard to inclination angles) on CBCT.

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