



Is there a relationship between the presence of ponticulus posticus and elongated styloid process? ☆



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ARTICLE INFO

Article history:

Received 11 June 2014

Received in revised form 17 November 2014

Accepted 18 November 2014

Keywords:

Ponticulus posticus

Styloid process

Cone-beam computed tomography

Eagle's syndrome

Elongated styloid process

ABSTRACT

This study aimed to determine if there is a possible relationship concerning the presence of ponticulus posticus (PP) in patients with elongated styloid process (ESP) on three-dimensional cone beam computed tomography (CBCT) images. The presence or absence of the PP (whether partial or complete) was determined and noted as a positive or negative finding. Then, the patients with PP were evaluated for ESP. For this purpose, 3-D CBCT scanning digital images of 542 patients having ESP (247 males and 295 females) were examined retrospectively. There was a significant relationship between the presence of PP and ESP ($P=.03$). The results of this study suggest that there is a significant correlation between the presence of PP and ESP. To our knowledge, this is the first study investigating the relationship between the two disorders in the literature.

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1. Introduction

As described by several authors [1,2] the symptoms of ponticulus posticus (PP) anomaly include cervical pain and headache. These symptoms have also been associated with elongated styloid process (ESP) [3,4]. When surgical removal of an ESP is considered, inspection as to whether the patient has a PP seems reasonable to ensure that all or some of the symptoms do not arise from a congenital anomaly of the atlas [4].

The styloid process (SP) is a cylindrical, long cartilaginous bone located on the temporal bone. Many nerves and vessels, such as the carotid arteries, lie adjacent to the SP [5]. The normal SP length is approximately 20–30 mm [6]. ESP can be assumed if either the SP or adjacent stylohyoid ligament ossification shows an overall length in excess of 30 mm [5,6]. The symptoms associated with ESP are directly related to the anatomical relationship between the SP and surrounding structures [7]. It is supposed that these symptoms and signs are due to the compression of the SP on some neural and vascular structures. The exact cause of elongated SP is not clear [6].

The normal atlas is a ring-like structure consisting of two lateral masses connected by a short anterior arch and a longer posterior arch. It is the widest cervical vertebra, with its anterior arch being approximately half as long as the posterior arch [8]. The clinical significance of the PP is subject to ongoing research. It has been associated with headaches, Barré-Lieou syndrome, photophobia, and migraine. However, little epidemiologic evidence for this exists [1]. A link between PP and head pain was observed by Wight et al. [1] who noted a significant overrepresentation of the ring in chiropractic patients presenting with head pain without aura (i.e., visual or auditory disturbances).

CBCT, which can definitively measure the length of the anatomical structures of the craniofacial region, was introduced as a new and alternative modality. This recently designed technology has become a relevant tool for diagnostic imaging of oral and maxillofacial osseous structures, providing professionals with access to excellent image quality and greater diagnostic accuracy and sensitivity [9].

In the present study, our aim was to investigate PP prevalence in patients with ESP. To our knowledge, this is the first study investigating the relationship between the two disorders in the literature.

2. Material and methods

We designed a retrospective study composed of the CBCT (Newtom 5G, QR, Verona, Italy) images of patients who presented to the Dentomaxillofacial Radiology service at X University's Dentistry Faculty. All the patients had been referred for diagnosis and treatment planning for different problems involving the maxillofacial region.

☆ Conflict of Interest: The authors declare no potential conflicts of interest with respect to the authorship and/or publication of this article.

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CBCT scans were retrieved from the archives of the faculty and examined for cervical spine anomalies, in particular, PP. Exclusion criteria included inadequate picture quality (artifacts caused by metallic implants or osteosynthesis plates; low resolution; patient movement during imaging). Patients presenting with congenital anomalies such as cleft lip and palate were not included. In addition, patients with other syndromic conditions involving the craniofacial region were excluded. Any patient who had disorders related to calcium and phosphorus metabolism was excluded. All medical data were obtained from the files. The 3-D CBCT scanning digital images of 542 consecutive patients, comprising 247 males and 295 females, were examined.

2.1. Evaluation of the images

The CBCT images were analyzed with the inbuilt software (NNT) in a Dell Precision T5400 workstation (Dell, Round Rock, TX, USA), using a 32-in. Dell LCD screen with a resolution of 1280×1024 pixels. These images were reconstructed into three-dimensional images and carefully inspected for the presence of PP and whether it was complete or partial. Complete type was defined as a clear bony bridge between the superior articular process and the posterior arch of the atlas in 3-D CBCT images. We did not class a bony protrusion due to noticeable impression for vertebral arteries as partial type. Partial type was considered as partial PP which was noted as a distinct bony spicule extending from the superior articular facet overhanging the dorsal arch.

All the CBCT images were evaluated by two observes with 5 years of experience. The CBCT mandibular images were analyzed in an NNT viewer; which is a simple version of the NNT software of the CBCT (Newtom 5G, QR, Verona, Italy) machine in a Dell Precision T5400 workstation (Dell, Round Rock, TX, USA), and a 32-in. Dell LCD screen with a resolution of 1280×1024 pixels in a darkroom. The contrast and brightness of the images were adjusted using the image processing tool in the software to ensure optimal visualization.

a. Evaluation of the PP

The direct visual method of examination under adequate illumination was used. The initial examination of the PP was made by a consensus of two experts with prior experience in assessing CBCT volumetric data. To eliminate any error, 120 randomly selected images were reexamined separately by the same two experts 1 month after initial examination. There was complete agreement between the two authors and the two examinations. The prevalence according to gender was calculated.

b. Evaluation of the ESP

Axial images were obtained for the ESP and were reformatted as three-dimensional computed tomography (CT) images. SP was evaluated on axial, coronal, and sagittal planes. For mineralized stylohyoid, the complexes and lengths of bilateral SPs were evaluated using the measurement method employed in the study by Jung et al. [10]. In brief, the measurements were taken on the temporal bone's frontal side. A thin transparent line is usually imagined between the SP shadows and the tympanic bone in this area. The tip of the SP is its bony end including calcified parts of the ligament. Length of SP or stylohyoid ligament longer than 30 mm was considered to be ESP. Images were reviewed on a digital imaging workstation. The two investigators looked at the images together and reached a consensus.

Statistical analysis was conducted using Statistical Package for the Social Sciences (SPSS) 16.0 for Windows (SPSS, Chicago, IL, USA). Data were analyzed by independent *t* test, Pearson correlation relation test, and chi-square. Statistical significance was considered at *P*<.05.

3. Results

The study group comprised 247 (45.6%) males and 295 (54.4%) females with a mean age of 32.7±11.4 years (range: total, 18–72);

male, 19–68; female, 18–72). Analysis of the 42 3-D CBCT scan images revealed PP on one or both sides in 213 patients (39.3%). In a total 213 patients, bilateral complete PP was identified in 36, bilateral partial in 100, bilateral mixed in 18, unilateral complete in 34, and unilateral partial in 25 (Table 1) (Figs. 1 a,b; 2 a–c). The data indicate that the distribution of the presence of the bony bridge in the first cervical vertebra is higher in males [42.5% (105 of 247)] than in females [36.6% (108 of 295)]. There was a significant difference in prevalence between males and females (*P*<.05).

Out of 542 patients, 31 (26.4%) had left side, 14 (11.9%) had right side, and 72 (61.5%) had bilateral elongation of SP. ESP was observed in 117 cases (21.6%). In the study group, the mean length of SPs in patients with PP was 38.18±8.87 mm on the right and 36.17±8.92 mm on the left. There were no statistically significant differences in length values of SP between males and females in either group. There was a significant relationship between the presence of PP and ESP (*P*=.03).

4. Discussion

This is the first study investigating the relationship between the two disorders (PP and ESP) in the literature.

PP was originally thought to occur as a result of ossification of the atlanto-occipital membrane. Lamberty and Zivanovic [11] identified the PP as the causative factor in headaches. It had not been a subject of concern for spine of surgeons until its surgical significance in the insertion of screws into the lateral mass of the atlas was recently reported [12]. There has been a steady increase in the number of patients treated with C1 lateral mass screw (C1LMS) through the posterior arch. Although the skeletal maturation evaluation [13] using cervical vertebrae and its modified version are now commonly used to interpret the growth potential of young patients, inadequate attention is paid to the radiological anatomy of this region with a view to identifying pathology [14]. Knowledge of this anomaly is critical to surgeons performing posterior atlantoaxial fusions [15]. Since the treatment of atlantoaxial instability was revolutionized by the introduction of the C1LMS insertion [16] many alterations to the method have been described and used successfully [17–19]. Young et al. [12] reported that mistaking the PP for just a broad posterior arch of the atlas during C1LMS placement could cause injury to the vertebral artery. Considering the growing clinical importance of PP, we need to understand the morphological features and the prevalence of this anomaly. PP, which seems to be the consequence of the complete or incomplete ossification of the posterior atlanto-occipital membrane over the vertebral artery groove [11], has become a significant abnormality of the atlas in the management of atlantoaxial instability, which has gained popularity [18]. Therefore, developmental anomalies of the atlas are of interest not only to anatomists but also to clinicians, radiologists, surgeons, and chiropractors, who should be

Table 1
Morphologic analysis of patients examined for PP

		Male		Female		Total		
		n	%	n	%	n	%	
Valid	Bilateral absent	142	57.5	187	63.4	329	60.7	
	Right absent–left complete	17	6.9	5	1.7	22	4.1	
	Right absent–left parcial	6	2.4	9	3.1	15	2.8	
	Right complete–left absent	9	3.6	3	1.0	12	2.2	
	Bilateral complete	21	8.5	15	5.1	36	6.6	
	Right complete–left parcial	5	2.0	4	1.4	9	1.7	
	Right parcial–left absent	2	0.8	8	2.7	10	1.8	
	Right parcial–left complete	2	0.8	7	2.4	9	1.7	
	Bilateral parcial	43	17.4	57	19.3	100	18.5	
	Total	247	100	295	100	542	100	
			<i>P</i> =.001					
	n: number of subjects							

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