

The Study of Styloid Process: A Morphometric Analysis with Clinical Implications

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Abstract

Eagle syndrome represents symptoms manifested by compression of regional structures by elongation of the styloid process or ossification of the stylohyoid membrane. The aim of the study is to assess the distribution of SP length and its correlation with side asymmetry. Present study was conducted in collaboration with department of Anatomy and department of Forensic Medicine at Jaipur National University Institute for Medical Sciences and research Center, Jaipur. A total of 38 dry skulls held by the Department of Anatomy were analyzed. The measures were synthesized in one mean measure. Descriptive statistics involved the calculation of central tendency and dispersion measures for each side of the styloid process and for each anatomic position. The length of the SP ranged from 5 mm to 43 mm and from 10 mm to 46 mm, based on the lateral view of the left and right styloid, respectively. From the posterior view, the values for the left and right sides of the skulls, respectively, ranged from 10 mm to 54 mm and from 15mm to 58 mm. This morpho-metric data of the styloid process is important to the physicians, neurosurgeons, otorhino-laryngologist and dentists for accurate diagnosis and treatment of dysphagia and chronic neck pain. The mere presence of an elongated styloid process does not automatically confirm a case of Eagle syndrome. The knowledge of SP variability apart from its anatomic value is of special interest for clinicians when managing atypical pain in the head and neck area as well as for forensic medicine and medico legal cases.

Keywords: Eagle's Syndrome; Styloid Process; Elongated Styloid Process.

Introduction

The stylohyoid syndrome is a generally unknown and rarely identified anatomical and clinical entity involving the oro-maxillo-facial region. The styloid process (SP) is a slender, cylindrical, smooth bony projection of the petrous part of the temporal bone immediately posterior to the tympanic plate and vaginal process, which hide its attachment. The SP, stylohyoid ligament (SHL) and lesser cornu of the hyoid bone constitute the stylohyoid chain that derives from Reichert's cartilage. The stylohyoid

chain is divided into distinct segments: the tympanohyal, stylohyal, ceratohyal and hypohyal. The ossification of SP begins before birth and continues over the first 8 years Goss 1973 [1].

The first studies on the styloid process date back to the 16th century. In 1543, Vesalius [2] observed some stylohyoid chain abnormalities in animals, and in 1652 Marchetti [3] first described an elongated styloid process, considering it to be a "paraphysiologic" variant. From 1937 to 1949, Eagle carefully investigated the syndrome, which would later bear his name [4,5,6] pointing out that approximately 4% of individuals with an elongated styloid process suffered from facial-pharyngeal pain. Although Eagle suggested tonsillectomy as the causative event, in the same period Fritz evaluated 43 patients reporting that only 11 had had tonsillar surgery [7].

The stylohyoid chain arises from the second Reichert's brachial arch, initially consisting of cartilage, in the second week of fetal life. During the third month Reichert's arch divides into four

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segments. The proximal segment (formed by an inferior part called the stylohyal and by a superior infratemporal part called the tympanohyal) gives rise to the styloid process. Respectively the ceratohyal, the hypohyal and the basihyal segment become, through ossification, the stylohyoid ligament, the hyoid minor horn and the hyoid body [8,9]. Ossification begins in the first or second year of life and is complete in 7 to 8 years [10]. Normal SP length varies between 2.5 and 3 cm Eagle 1949 [6], while Moffat et al. 1977 [11] regarded the normal range as being between 1.5 and 4.8 cm. Generally, if the length is more than 3 cm, the process is considered elongated, and in 4% of the subjects, this elongation causes a plethora of symptoms known as Eagle's syndrome Eagle 1958 [12]. The aim of the study is to assess the distribution of SP length in Jaipur population and its correlation with side asymmetry.

Material and Method

Present study was conducted in collaboration with department of Anatomy and department of Forensic Medicine at Jaipur National University Institute for Medical Sciences and research Center, Jaipur. A total of 38 dry skulls held by the Department of Anatomy were analyzed. The osteological collection consisted of disarticulated skeletons that had been selected 3 years previously for educational and research purposes. Included in the study were specimens that exhibited the two styloid processes without damage and/or fracture signs. The skulls of children, damaged skulls and skulls with pathological conditions were excluded from the study. An exclusion of 2 dry skulls was necessary, resulting in a sample of 38 skulls. As in two dry skulls both the styloid processes were damaged. Two points were determined to standardize measurements, which were obtained using a sliding caliper. The measures were as follows, Posterior Measure. This was obtained by measuring the distance from the tip of the styloid process to the flat surface on the side of stylomastoid foramen. Lateral Measure, This was obtained by measuring

the distance from the tip of the styloid process to its base, on the side of it, where it joins the surface of the anterior wall of the ear canal.

Statistical Analysis

The measures were synthesized in one mean measure. Descriptive statistics involved the calculation of central tendency and dispersion measures for each side of the styloid process and for each anatomic position (posterior or lateral). We checked for the normal distribution of each variable, using small sample T tests ($p < 0.05$). We compared the measures for the both sides of the styloid process in each anatomic position, using small sample T test ($p < 0.05$).

Results

The results obtained from the metric parameters of the lengths are summarized in Table 1. There was a large variability in the length of left and right sides of the styloid process (in lateral and posterior views). There was no normal distribution for these measures ($p < 0.05$). The central tendency measures of each side in each view are presented on Table 1. In Posterior measure there is no as such significant difference between right and left styloid process according to our study. In Lateral measure there is a difference between right and left styloid process.

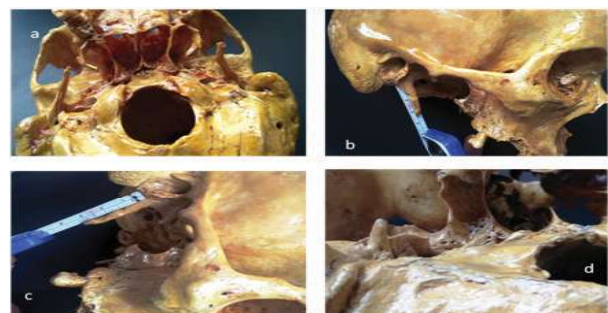


Fig. 1: a: Inferior view of the skull base, where the asymmetrical styloid processes appear, b: Posterior View and measurement of SP, c: Lateral view and measurement of SP d: Small size Styloid process.

| Skull Details | | Mean | Standard Deviation | Confidence Interval |
|---------------|-----------------------|---------|--------------------|---------------------|
| Left | Lateral Measurement | 1.15526 | 0.57643 | 1.1553 ± 0.1833 |
| | Posterior Measurement | 1.68684 | 0.62436 | 1.6868 ± 0.1985 |
| Right | Lateral Measurement | 1.42632 | 0.68721 | 1.4263 ± 0.2185 |
| | Posterior Measurement | 1.82895 | 0.69434 | 1.829 ± 0.2208 |

Left Lateral = Right Lateral P - value = 0.03323 < alpha = 0.05 Left Lateral = Right Lateral P - value = 0.17564 > alpha = 0.05

Discussion

The SP is located in the parapharyngeal area adjacent to the neural and vascular structures, which can be stimulated by the process elongation and/or angulation, resulting in a plethora of symptoms. Thus, meticulous knowledge of the anatomy of the process and surrounding structures is important for clinicians Piagkou et al. 2009 [13]. During embryological development, the SP came from Reichert's cartilage of the second pharyngeal arch [14]. Its length ranges from 15.2 mm to 47.7 mm [15], but other studies have found different dimensions: Jung et al. (2004) [16] suggested that the length of this bone process was longer when it presents more than 45 mm.

There are a variety of ways to determine the dimensions of SP and diagnose Eagle syndrome: panoramic radiographs, X-ray lateral views of the neck, orthopantomograms, and computed tomography. In addition, many studies are based on measurements of dry skulls or cadavers. In some cases the elongated SP can be clinically detected by palpating the tonsillar fossa [17]. These variations can occur due to the technique used to measure this length.

In the literature, the elongated SP is the most described type due to its association with clinical manifestations. Although Eagle's syndrome is thought to be caused by an elongated process, it has been documented that abnormal angulation rather than process elongation is responsible for symptoms Bas, ekim et al. 2005[18]. The lateral angulation may impinge on the ECA bifurcation; the posterior may affect cranial nerves IX–XII; the ICA and internal jugular vein and the anteromedial angulation may irritate the tonsillar fossa Piagkou et al. 2009 [13]. In addition, branches of the mandibular nerve and the chorda tympani may be compressed and entrapped by a deviated process Rechtweg and Wax 1998 [19]

The variability of SP and especially its elongation may coexist with other ossification abnormalities, such as atlas occipitalization, paracondylar processes, ossified pterygoalar and pterygospinous ligaments Natsis et al. 2013 [20], torus palatinus Sisman et al. 2009 [21] and osteophytes of the cervical spine Guo et al. 1997 [22]. In addition, abnormalities of the vascular structures at the atlanto-axial level may occur in subjects with ossified SHLs.

Understanding the frequency of elongated SP in Jaipur can help clinicians diagnose Eagle syndrome

and treat it. In the present study, the length of the SP ranged from 5 mm to 43 mm and from 10 mm to 46 mm, based on the lateral view of the left and right styloid, respectively. From the posterior view, the values for the left and right sides of the skulls, respectively, ranged from 10 mm to 54 mm and from 15 mm to 58 mm. The normal length of SP varies in the literature from 15.2 mm to 47.7 mm, according to Mofft et al. 1977 [23]; measures less than 30 mm, according to Kaufman et al. 1970 [24]; and measures from 20 mm to 30 mm, according to Lindeman 1985 [25]. Considering the normal length of SP as defined by Eagle (i.e., 25 mm to 30 mm) 1937 [4], the presence of one elongated SP was observed in this research among 17 dry skulls with a prevalence rate of 5% of the total analyzed. The prevalence of elongated styloid process in the earlier studies was 1% [26], 4% [27], and 8.2% [28]. The 5% prevalence rate in the present study is similar to the rate observed by Eagle. Other Indian studies by Rathva et al. 2013 [29] reported the prevalence of elongated styloid process as up to 2%.

Apart from the clinical interest, SP elongation has forensic significance, as it may result in blood flow disturbances in the ECA or ICA (aneurysm, pseudoaneurysm, carotid artery dissection and sudden death) Dao et al. 2011 [30]. Furthermore, SP elongation helps in the identification of unknown individuals. Also the complete ossification of the stylohyoid chain may have medicolegal implications for manipulations of the cervical region due to the risk of fracture Vougiouklakis 2006 [31].

Conclusion

This article adds important information about the length of SP and its diversity in a previously unstudied population. Anatomical knowledge of the styloid process and elongated styloid process is clinically important because of its close proximity to important neurovascular structures. Any anatomical variations may present with compression symptoms, dysphagia and neck pain. This morpho-metric data of the styloid process is important to the physicians, neurosurgeons, otorhino-laryngologist and dentists for accurate diagnosis and treatment of dysphagia and chronic neck pain. The mere presence of an elongated styloid process does not automatically confirm a case of Eagle syndrome. The knowledge of SP variability apart from its anatomic value is of special interest for clinicians when managing atypical pain

in the head and neck area as well as for forensic medicine and medico legal cases. We believe that this study provides additional information about the frequency of elongated styloid process in the Jaipur population. Nevertheless, the actual research would be more accurate with a larger number of samples. Another limitation of the present study is the lack of gender-related variation which was not taken into consideration.

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