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MORPHOMETRIC STUDY OF THE STYLOID PROCESS AND ITS CLINICAL IMPLICATIONS

Anatomy

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ABSTRACT

Background: Styloid process is a slender, cylindrical spur of bone fused with the inferior aspect of the temporal bone in front of the stylomastoid foramen. Present study aimed to evaluate the length, angulation, interstyloid distance and styloid ratio to highlight their possible etiological importance in clinical and surgical conditions. Interstyloid distance is used for sexual dimorphism. Excessive length and angulation of styloid process is clinically important, as it may cause Eagle's syndrome.

Material And Methods: The study was done on both sides of 52 dry human skulls of unknown age and sex without any obvious deformity. Each skull was carefully examined for the presence of elongated styloid process (length>30 mm). The length was measured using Vernier caliper and interstyloid distance was measured using divider. Angle of styloid process with the Reid's baseline and styloid ratio was also calculated.

Results: Out of 52 skulls, elongated styloid process was observed in thirteen skulls, amongst them eight skulls (15.38%) with unilateral and five (9.62%) with bilateral elongation. Rest of the skulls (n=39) had lengths varying from 20-30 mm. Mean angle between styloid process and Reid's baseline was 51.13°. Average interstyloid distance was 75.42 mm while 70-80 mm was the most common range. Styloid ratio varied from 3-4.

Conclusions: Unilateral elongated styloid process was found more frequently as compared to bilateral. The results can be used as a baseline data for identification of male and female skull by calculating the interstyloid distance. The findings of the present study may be of utmost importance in the examination of styloid process in patients with symptoms of stylalgia.

KEYWORDS

Skull, Styloid Process, Length, Angulation, Interstyloid Distance, Styloid Ratio.

INTRODUCTION

Styloid process (SP) is a slender, cylindrical spur of bone fused with the inferior aspect of the temporal bone (1). The location of the apex of the styloid process is clinically important because it is related to important neurovascular structures. Its base lies just in front of the stylomastoid foramen and its tip projects in antero-inferior direction lying in between internal and external carotid arteries and in relation to the lateral pharyngeal wall and tonsillar fossa (2). The normal adult styloid process is 20-30 mm in length. It is regarded as elongated when it is longer than 30 mm. Elongation of the SP can trigger a series of clinical symptoms such as odynophagia, dysphagia, pain in cervicofacial region, tinnitus and trismus. It is known as styalgia or "Eagle's syndrome". Eagle's syndrome was first documented by Watt W. Eagle in the year 1937.

The presence of an elongated styloid process is not usually a pathognomonic finding for Eagle's syndrome. Previous studies report that the abnormal angulation rather than the elongated styloid process may be responsible for irritation of surrounding structures leading to Eagle's syndrome (3, 4). Present study aimed to evaluate the length, angulation, interstyloid distance and styloid ratio to highlight their possible etiological importance in clinical and surgical conditions.

MATERIAL AND METHODS

The study was done on both sides of 52 dry human skulls of unknown age and sex without any obvious deformity. Skulls were procured from Department of Anatomy, Career Post Graduate Institute of Dental Sciences & Hospital, Lucknow, India. Each skull was carefully examined for the presence of elongated styloid process (length>30 mm). The length was measured using Vernier caliper and interstyloid distance was measured using divider. Angle of styloid process with the Reid's baseline was also calculated.

Length of styloid process was measured from the base to the tip of styloid process using Vernier caliper (Fig. 1). Angulation of styloid process is the angle between the line of styloid process and Reid's baseline (Fig. 2). Reid's baseline is the line joining the infraorbital margin to the middle of external acoustic meatus.

The angle was measured using protractor and recorded in degree. Interstyloid distance is the distance between the bases of two styloid process. It was calculated using the divider and recorded in mm (Fig. 3). Styloid ratio is the ratio between the interstyloid distance and the mean length of the styloid process:

Styloid ratio = Interstyloid distance / Mean length of styloid process

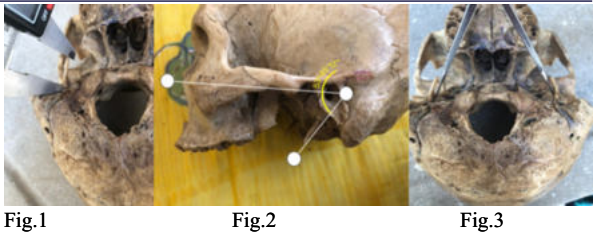


Fig.1 Fig.2 Fig.3

Fig. 1: Measurement Of Length Of Styloid Process By Digital Vernier Calipers
Fig. 2: Measurement Of Angulation Of Styloid Process

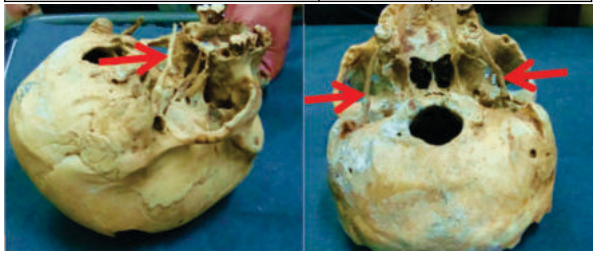
Fig. 3: Measurement Of Interstyloid Distance By Divider

OBSERVATIONS AND RESULTS

Out of 52 skulls, elongated styloid process i.e. length more than 30 mm was observed in thirteen skulls, amongst them eight skulls (15.38%) with unilateral and five (9.62%) with bilateral elongation. Rest of the skulls (n=39) had lengths varying from 20-30 mm (Table 1).

Table 1: Percentage Of Skulls Showing Normal Length And Elongation Of Styloid Process

Length	Number	Percentage
Normal (20-30 mm)	39	75%
Unilateral Elongation (>30 mm)	8	15.38%
Bilateral Elongation (>30 mm)	5	9.62%



A B

Fig. 4: Skull Showing Elongation Of Styloid Process (a) Unilateral (b) Bilateral

The angulation of styloid process was divided into three range i.e. 40°-50°, 51°-60° and >60°. The mean angle between the line of styloid process and Reid's baseline was calculated to be 51.13°. Maximum angle was 61° and minimum was 43°. Maximum skulls (71.15%) had angulation that fall in the range of 51°-60° (Table 2).

Table 2: Percentage Of Skulls Showing Different Angulation Of Styloid Process

Angulation (in degree)	Number	Percentage
40-50	14	26.92%
51-60	37	71.15%
>60	1	1.92%

The mean interstyloid distance was calculated to be 75.42 mm. Maximum distance was 84 mm while minimum was 59.4 mm. Maximum number of skulls (63.46%) had distance ranging from 70-80 mm while only one skull had less than 60 mm, eleven skulls exhibited 60-70 mm and seven skulls showed more than 80 mm interstyloid distance (Table 3).

Table 3: Percentage Of Skulls Showing Different Interstyloid Distance

Interstyloid distance (mm)	Number	Percentage
<60	1	1.92%
60-70	11	21.15%
70-80	33	63.46%
>80	7	13.46%

The styloid ratio was calculated by dividing the interstyloid distance with the mean length of styloid process. The range of styloid ratio was divided as 3-4, 4-5 and >5. Maximum ratio was 5.21 while minimum was 3.16. Most of the skulls (71.15%) exhibited 3-4 styloid ratio (Table 4).

Table 4: Percentage Of Skulls Showing Various Styloid Ratio

Styloid Ratio	Number	Percentage
3-4	37	71.15%
4-5	9	17.31%
>5	6	11.54%

DISCUSSION

Several theories for variations in length and angulation of styloid process have been proposed. Excessive or abnormal ossification of stylohyoid complex components during development may result in abnormally elongated or angulated styloid process. Traumatic stimulus can also lead to multiple metaplastic alterations in the cells of the styloid ligament, which results in its total or partial ossification (5, 6). An elongated process has embryological basis and results from the complete or partial ossification of the stylohyoid ligament which links the styloid process to the lesser cornu of hyoid bone. If the structure solidify, it causes pain and suffering. The SP originates from Reichert's cartilage, which is from the second brachial arch. Reichert's cartilage consisted of four segments: tympanohyal, stylohyal, ceratohyal, and hypohyal. The tympanohyal is responsible for the formation of the proximal part and stylohyal for the formation of the distal part of the SP. The ceratohyal is responsible for the formation of the stylohyoid ligament and hypohyal for the formation of the lesser horn of the hyoid bone. The ceratohyal of Reichert's cartilage becomes the stylohyoid ligament; however, ossification occurs due to unknown causes (7).

Elongation of SP was seen more frequently unilaterally (15.38%) as compared to bilaterally (9.62%) in present study. This is parallel to the study done by Natsis et al. (2015) who reported it in Greek population (8). Some more studies also described the elongation of styloid process in different population (7, 9, 10).

According to study the anterior angulation and the length of the styloid process are responsible for the symptoms of Eagle's syndrome (11-13). Anterior angulation might result in mucosal irritation and pressure over vital structures in tonsillar fossa (13).Several studies reported that the direction and angulations of the elongated SP probably were responsible for the irritation of a number of anatomical structures (14, 15). We reported higher percentage of angulation in the range of 51-60 degree which is similar to those obtained by Bilodi & Reddy (16).

The interstyloid distance is used for sexual dimorphism. Interstyloid distance ranged 70-80 mm in maximum number of skulls (63.46%) which is in harmony with that of previous studies (17-20).

The length and direction of SP may help surgeons to consider whether these could be the factors that obstruct the surgical approach through the entrance of the infratemporal fossa (13). Present study is an attempt to provide some data about different parameters of SP in Indian population.

CONCLUSION

The study and knowledge of the anatomical variations of the SP in a population may help clinicians from various specialities to diagnose Eagle's syndrome. The surgical anatomy of the elongated styloid process is important to the neurosurgeons and radiologists while interpreting the computed tomogram scans and magnetic resonance images. The morphological knowledge of Eagle's syndrome is enlightening to all the health care professionals who are involved in the diagnosis and management of chronic head and neck pain. This study provides additional information about the frequency of elongated styloid process in Indian population. Apart from this the interstyloid distance as well as the styloid ratio can be used for sex determination.

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