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Research Article

Morphometric study of styloid process of temporal bone in Indian adult dry skull

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ABSTRACT

Background: Styloid Process (SP) of temporal bone is a spike like process which is usually straight but it can show curvature and concavity. Many important neurovascular structures are adjacent to it. These structures may be compressed due to morphological variations of styloid process when SP abnormally elongated it may pose threat to anesthetist while performing intubation.
Methods: Study was carried out on 70 (50 males, 20 females) adult dry skulls. All measurements such as length, direction, thickness at base of styloid process, distance between of two processes, and distance between it and stylomastoid foramen were taken with the help of vernier caliper in millimeters.
Results: We found mean length of styloid process in males on right side 17.8 mm and on left 15.4 mm. In females, it was 13 mm on right and 16.8 mm on left side. Average distance between of two styloid processes at base was 68.13 mm in males and 67.42 mm in females. Thickness at the base of styloid process, in males on right 4.53 mm and on left side it was 4.83 mm while in females on right 4.33 mm and on left side it was 5 mm.
Conclusions: Neurovascular structures which lie within the territory of styloid process may be compressed due to its anatomical variation. This data may be useful for clinicians, surgeons, radiologists, anesthetists and anatomists as an academic interest.

Keywords: Styloid process, Morphometry, Dry skull, Length, Variation

INTRODUCTION

The Styloid Process (SP) of temporal bone is slender, pointed and projects anteroinferiorly from inferior aspect of temporal bone. Often almost, it can show a curvature, an anteromedial-concavity being most common. Its length varies from a few millimeters to an average of 2.5 cm,[1] sometimes as long as 8 cm.[2] The styloid process is situated immediately anterior to the stylomastoid foramen.[3]

Relations of styloid process are very important. Laterally, it is covered by parotid gland, facial nerve crosses its base, external carotid artery crosses its tip and medially, it is separated from beginning of internal jugular vein by stylopharyngeus.[1] Lateral to the stylomastoid foramen, tympanomastoid suture lies which accommodates auricular branch of vagus nerve.[4] Internal carotid artery, internal jugular vein and 10th, 11th, and 12th cranial nerves lie on its medial side. In close proximity is the glossopharyngeal nerve lying in the posterolateral wall of tonsillar fossa.[5] Embryologically, the styloid process

ossifies from two centers i.e. tympanohyal proximal part and stylohyal distal part. Tympanohyal part ossifies before birth and stylohyal after birth.[6]

In 1937, Eagle was the first to present two cases of pharyngeal discomfort associated with elongated styloid process. He pointed out that the normal SP does not reach the tonsillar fossa but in about 4% of individuals, the process is elongated. In such cases, he reported the tip may be so deviated as to impinge up to either the internal or external carotid artery, but more frequently, it impinges upon the tonsillar region to produce pharyngeal pain, perhaps with extension to the ear.[7,8] Potgieter reported difficulty during intubation procedure due to elongated styloid process.[9] Considering the various relations of SP with important neurovascular structures and its morphological variations, we decided to work on this topic.

METHODS

Seventy adult dry skulls (50 males and 20 females) of known sex were taken for this study. Skulls with broken SP were excluded. Following parameters were measured in millimeters with the help of sliding vernier caliper-

1. Length of styloid process,
2. Distance between of 2 styloid processes at base,
3. Thickness at base styloid process,
4. Distance between the SP and stylomastoid foramen,
5. Direction of styloid process (Figure 1).

Data was analysed statistically by using SPSS computer program. Unpaired 't' test is applied for all parameters except direction of SP.

Figure 1: Showing styloid process (SP) of temporal bone in adult dry human skull.

RESULTS

Out of 70 adult dry skulls of known sex, mean length of SP in males was 17.89 mm on right side and 15.43 mm on left side while in females it was 13 mm on right side and 16.83 mm on left side. Distance between two SP at the base was 68.13 mm in males and 67.42 mm in females. Thickness at the base of SP in males, on right side was 4.53 mm and on left side 4.83 mm. In females, it was 4.33 mm on right and 5 mm on left side. The distance between SP and stylomastoid foramen was 4.13 mm and 4.21 mm on right side and left side respectively in males and in females, it was 2.06 mm on right side and 2.1 mm on left side (Table 1).

Table 1: Showing statistical analysis of the parameters of SP measured in millimeters.

Parameters		Males		Females	
		Right	Left	Right	Left
Length of SP	Number	35	40	13	18
	Range	5-46	4-32	5-25	0.8-2.8
	Mean	17.89	15.43	13	16.83
	'P' value	0.1462		0.9821	
Distance between two SP at the base	Number	23		12	
	Range	25-85		50-80	
	Mean	68.13		67.42	
	'P' value	0.4617			
Thickness at the base of SP	Number	38	41	15	20
	Range	2-8	2-7	3-6	0.2-0.8
	Mean	4.53	4.83	4.33	5
	'P' value	0.7645		0.0648	
Distance between SP and stylomastoid foramen	Number	24	33	17	20
	Range	1-9	1-13	1-5	0.1-0.4
	Mean	4.13	4.21	2.06	2.1
	'P' value	0.6421		0.5862	

Directions of SP were also reported as straight, curved, lateral, medial and anterior. Out of these, straight (Right-37.5% and left-41.9%) and anterior (Right-27.5% and left-32.55%) were more common in both sexes (Table 2).

Table 2: Showing direction of SP.

Direction of SP	Males		Females	
	Right (n=40)	Left (n=43)	Right (n=20)	Left (n=20)
Straight	15 (37.5%)	18 (41.9%)	6 (30%)	5 (25%)
Curved	3 (7.5%)	1 (2.30%)	6 (30%)	3 (15%)
Laterally	1 (2.5%)	0 (0%)	0 (0%)	0 (0%)
Medially	10 (25%)	10 (23.25%)	3 (15%)	4 (20%)
Anteriorly	11 (27.5%)	14 (32.55%)	5 (25%)	8 (40%)

DISCUSSION

Styloid process of temporal bone in Greek means 'Standing Pillar'. It is a slender projection attached to the base of the skull extending downward, forward and medially.[10] SP ossifies in cartilage and from its tip styloid ligament passes to the lesser cornu of hyoid bone. Embryologically, the styloid process, stylohyoid ligament and the lesser cornu of the hyoid bone are developed from the second pharyngeal arch called as the Reichert's cartilage because it is of cartilaginous origin. Stylohyoid ligament has the potential to mineralize.[11] So, length of SP is very variable[3]. Length of the SP may vary greatly on the right and left sides in the same individual.[12]

Eagle[7] defined the length of a normal styloid process is 2.5-3 cm. The normal length of the styloid process varies greatly as follows:

1. From 1.52 cm to 4.77 cm, according to Moffat et al. (1977)[13]

2. Less than 3 cm, according to Kaufman et al. (1970)[14]

3. From 2 cm to 3 cm, according to Lindeman (1985)[15]

Styloid process is considered normal when it is shorter than 2.5 cm and elongated when it is longer than 4 cm. Several theories have been proposed to explain the elongation of the SP in Eagle's syndrome.[16] An elongated SP occurs in about 4% of the general population. Only a small percentage (between 4% and 10.3%) of these patients is symptomatic with a female to male predominance of 3:1.[17] Incidence seems to range from 1.4 to 84.4% of population, that or anatomic (cadaveric or dry) specimen, ethnic variability and predominance of unilateral to bilateral occurrence.[18,19] The elongated SP syndrome is often observed in third and fourth decades of life and in women more frequently than in men.[20]

In our study, we found length of SP in males is 17.89 mm on right and 15.43 mm on left side while in females, it is 13 mm on right and 16.83 mm on left side. Present study results are going in favor of That B et al.[21] (Table 3). We reported 3 cases (2 right and 1 left) in males of which length of SP was exceeding 30 mm but in females, we did not found any SP more than 30 mm. Our findings differed from those of some other researches, who found an increased incidence of elongated SP in females[19], but our results are similar to those obtained by More et al.[22] (Table 3).

There are very few research reports on the interstyloid distance and direction of SP. We reported interstyloid distance in males was 68 mm and in females it was 67.4 mm. When we compared this result with other researcher's data, it is having similar results as Patil et al.[5] (Table 3). Several studies reported that the direction and angulations of the elongated SP probably were responsible for the irritation of a number of anatomical structures.[23] Anterior angulations might result in mucosal irritation and pressure over vital structures in tonsillar fossa.[24] We reported higher percentage for straight and anterior direction of SP in both sexes and this result is similar to those obtained by Bilodi and Shivareddy.[25] We noted the distance between SP and stylomastoid foramen, our results goes in favor of standard textbook of anatomy.[1,10,11] In 24 males and 13 females, it was very close to SP. We recorded thickness at the base of SP which was almost similar in both sexes. If the thickness at the base increases it may compress the facial nerve. There is paucity of information on different parameters of SP which is clinically important.

Taken together these findings may help surgeons to consider the SP whether its length and direction could be the factors that obstruct the surgical approach through the entrance of the infratemporal fossa.[24] Our study is an attempt to provide some data about different parameters of SP in Indian population. Detail study of the morphology of SP and its relations with adjacent neurovascular structures should be performed by using new imaging techniques which will throw light on this subject.

Table 3: Comparison between different studies for length of SP and Distance between two SP.

Authors	Length	Distance between two SP
Eagle[7] (1937)	20-30 mm	-
Moffat et al.[13] (1977)	15.2-47.7 mm	-
That B et al.[21](2000)	Right-15.9 mm and Left-15.2 mm	-
More CB, Asrani MK[22] (2010)	Males: Right-25.9 mm, Left-26.18 mm Females: Right-25.17 mm , Left-24.69 mm	-
Patil S, Ghosh S, Vasudeva N[5] (2014)	Right-13.9 mm and Left-12.9 mm	Base: 6.9 cm Tip: 6.4 cm
Present Study (2015)	Males: Right-17.89 mm, Left-15.43 mm Females: Right 13 mm, Left- 16.83 mm	At base, Males: 6.813 cm Females: 6.74 cm

CONCLUSION

Many important anatomical structures are in close proximity with the SP. These structures may be compressed or irritated because of variations in the morphology of SP. Our study may be helpful for maxillofacial surgeons, dentists, radiologists, and anesthetists to reach the proper diagnosis by doing pre-operative evaluation.

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