

A Study of Styloid Process: Anatomical Variation in Length and Angulation

Kiran Kumar S.¹, G. S. Malipatil²

¹Assistant Professor, Department of Anatomy, Chalmeda Anand Rao Institute of Medical Sciences, Karimnagar, Telangana State.

²Professor and HOD, Department of Anatomy, Pacific Institute of Medical Sciences, Umarda Udaipur, Rajasthan

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Corresponding author: Dr. G. S. Malipatil

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Abstract

Background: The styloid process is a slender, pointed about 2.5cm in length projects from the inferior aspect of the temporal bone. Length of Styloid Process (SP) varies widely. It can be very short and hidden by vaginal process or it can be elongated to reach hyoid bone. As many studies have not been reported in the literature regarding the anatomical and anthropometric variations of styloid process like length and angulation.

Aim & Objectives: To know anatomical variation in length and angulation in styloid process.

Material and Method: This is an observational descriptive study conducted in department of Anatomy KIMS, Bangalore and other Medical Colleges in and around Bangalore. Study Includes 121 Adult Human skulls with intact styloid Process. The length and angulation of the styloid process were measured directly from the digital images by the image analysis using Adobe Photoshop 7.0 and Image Tool 3.0 Program. Qualitative data were presented in frequency and proportion while quantitative data were presented in mean and standard deviation.

Observation and Results: 68 had both intact Styloid process and 53 had unilateral Styloid process. The mean length and standard deviation of combined right and left side of 121 skulls is 1.47 ± 0.72 cm respectively, There was no significant difference between the groups with medial and anterior angulation of 60-69, 70-79 and 80-89 and the side of the Styloid process.

Conclusion: From overall observation and discussion with the studies we can conclude that elongated SP (length > 30 mm) was seen more frequently as compared to bilateral. When bilateral, it was more on right side as compared to the left side. Whether normal or elongated, the length of SP was more on right side as compared to the left side.

Keywords: Styloid Process, Medial Angulation, Anterior Angulation, Unilateral And Bilateral Styloid Process.

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Introduction

The styloid process is a slender, pointed about 2.5cm in length projects from the inferior aspect of the temporal bone. Normally the length varies from few

millimetres to 30mm. The styloid process measuring more than 30mm is considered as elongated styloid process. The styloid process give attachments to 3 muscles and

2 ligaments. The muscles and ligaments arising from the styloid process stabilize the hyoid bone during normal oropharyngeal functions. One of the ligaments attached to styloid process is stylohyoid ligament, which arises from the tip of the styloid process and attached to lesser cornu of the hyoid bone. The styloid process with stylohyoid is an anatomic complex collectively termed as stylohyoid chain. The styloid process is developed from two segments i.e./tympanohyal and stylohyal segments derived from Reicherts cartilage (Second branchial arch).

In 4 to 7% of population it is noted that the styloid process is longer measuring more than 3cms. In such cases it can compress the surrounding vital neurovascular structures. The elongated styloid process can compress the carotid vessels, nerves, or it may cause irritation to the pharyngeal muscles resulting in various symptoms like chronic pain in pharyngeal region, referred otalgia, phantom foreign body sensation. These symptoms are named as eagle syndrome, elongated styloid process syndrome, carotid artery syndrome, stilalgia and pseudohyoid syndrome by different authors. All the symptoms provoked by elongated styloid process are not due to the elongation of styloid process but also depends on angulation of the styloid process.

As many studies have not been reported in the literature regarding the anatomical and anthropometric variations of styloid process like length and angulation of Styloid Process, thus we have undertaken this study to know anatomical variation of length and angulation in styloid process.

Materials and Method

Study Design: This is an observational descriptive study conducted in department of Anatomy KIMS, Bangalore and other Medical Colleges in and around Bangalore.

Place of study: Department of Anatomy, Kempegowda Institute of medical Sciences, Bangalore.

Sample Size: 121 Human Skulls

Inclusion Criteria: Adult Human skulls with intact styloid Process.

Exclusion Criteria: Fetal skull and skulls with broken styloid process.

Methods

The length and angulation of the styloid process were measured directly from the digital images by the image analysis using Adobe Photoshop 7.0 and Image Tool 3.0 Program. The length were measured corresponds to the free part of the styloid process situated on its frontal side and the distance were measured between the bases, midpoints and the tips of the styloid processes. The measurements of elongated and angulated styloid process of dry skull were done by Towne's X-ray view. Medial angulation was measured on Towne's X-ray. A vertical line passed from the cranial base of the process which was vertical to the line connecting the bases of both the styloid processes. Medial angulation was measured as the angle between the vertical line and the body of the process. Anterior angulation was measured on lateral skull X-ray. A vertical line passed from the cranial base of the process, which was vertical to the Frankfort plane (a line passing horizontally from the superior border of external acoustic meatus to the inferior border of orbital rim). Anterior angulation was measured as the angle between this vertical line on lateral skull X-ray and the body of the process.

Results and Observation

For the present study, 400 dry adult human skulls were collected; out of which only 121 fulfilled the study criteria of at least one styloid process intact. This study was conducted on these 121 skulls. They were examined for variations that exist in morphology and morphometric parameters

of Styloid process. The results are as follows:

Table 1: Classification of the skull based on intact Styloid process

Direction of the Styloid process	Number	Percentage
Total number with bilateral intact Styloid process	68	56.2
Total number with unilateral intact Styloid process	53	43.8
Total number of skulls	121	100

Among the 121 skulls, it was observed that 68 had both intact Styloid process and 53 had unilateral Styloid process.

Table 2 : Classification of Styloid process based on the length and side

Length of styloid process (in cm)	Side of the styloid process		
	Right	Left	Total
0.4 – 1.0	41(41%)	33(37.08%)	74 (39.15)
1.1 – 2.0	37(37%)	39(43.82%)	76 (40.21)
2.1 – 3.0	18(18%)	15(16.85%)	33 (17.46)
3.1 – 4.0	4(4%)	2(2.25%)	06 (03.17)
Total	100	89(100%)	189 (100)
Mean \pm SD	1.47 \pm 0.72	1.54 \pm 0.71	1.469 \pm 0.717

Of the 189 Styloid processes, 76 (40.21%) had length within 1.1 - 2.0 cm, 74 (39.15%) had length within 0.4 - 1.0 cm and 39 (20.63%) had length within 2.1 – 4.0 cm. The mean length and standard deviation of combined right and left side

of 121 skulls is 1.47 \pm 0.72 cm respectively, mean length and standard deviation of right side of 121 skulls was 1.54 \pm 0.71cm and that of left side was 1.469 \pm 0.717 cm

Table 3: Medial angulation of Styloid process

Medial Angulation	Side of the Styloid process			Chi-Square	P-value
	Right	Left	Total		
60 ⁰ – 69 ⁰	15(15.31%)	12(13.33%)	27(14.29%)	4.09	0.1295
70 ⁰ – 79 ⁰	58(58.16%)	42(46.67%)	100(52.91%)		
80 ⁰ – 89 ⁰	26(26.53%)	36(40%)	62(32.8%)		
Total	99(100%)	90(100%)	189(100%)		
Mean \pm sd	72.32 \pm 6.52	73.39 \pm 6.78	72.83 \pm 6.65		

Out of 189 styloid processes, 100 (52.91%) styloid process had medial angulation in the range of 70⁰-79⁰, 62(32.80%) styloid process had medial angulation in the range of 80⁰-89⁰ and 27(14.29%) styloid process had medial angulation in the range of 60⁰-69⁰ respectively. Out of 99 styloid processes on the right side 58(58.16%) had medial angulation in the range of 70⁰-79⁰, 26(26.53%) had medial angulation in the range of 80⁰-89⁰ and 15(15.31%) styloid process had medial angulation in the range

of 60⁰-69⁰. Out of 90 styloid processes on the left side 42 (46.67%) styloid process had medial angulation in the range of 70⁰-79⁰, 36 (40%) had medial angulation in the range of 80⁰-89⁰ and 12(13.33%) had medial angulation in the range of 60⁰-69⁰ and there was no significant difference between the groups with medial angulation of 60-69, 70-79 and 80-89 and the side of the Styloid process.

Out of 189 styloid processes, 146 (77.25%) styloid process had Anterior angulation in the range of 60⁰-79⁰, 32

(16.93%) styloid process had Anterior angulation in the range of 80° - 89° and 11(5.82%) styloid process had Anterior angulation in the range of 40° - 59° respectively. Of the 99 right Styloid processes, 79 (79.80%) had anterior angle in the range of 60° - 79° , 14(14.14%) had anterior angle in the range of 80° - 99° and 6 (6.06%) had anterior angle in the range of 40° - 59° . Out of 90 styloid processes on

the left side 68 (75.56%) had anterior angle in the range of 60° - 79° , 18(20%) had anterior angle in the range of 80° - 99° and 4(4.44%) had anterior angle in the range of 40° - 59° . And There was no significant difference between the groups with Anterior angulation of 60-69, 70-79 and 80-89 and the side of the Styloid process shown in Table 4.

Table 4: Anterior angulation of Styloid process

Anterior Angulation	Side of the Styloid process			Chi-Square	P-value
	Right	Left	Total		
$40^{\circ} - 59^{\circ}$	6(6.06%)	4(4.44%)	11(5.82%)	1.15	0.562
$60^{\circ} - 79^{\circ}$	79(79.8%)	68(75.56%)	146(77.25%)		
$80^{\circ} - 99^{\circ}$	14(14.14%)	18(20%)	32(16.93%)		
Total	99(100%)	90(100%)	189(100%)		
Mean \pm SD	67.24 \pm 8.13	69.17 \pm 8.65	68.16 \pm 8.42		

Discussion

In daily practice a diagnosis of styloid process syndrome is usually made in the specialist clinic, and is most frequently made by an ENT specialist, a maxillofacial or oral surgeon. Much of the previous work on pain originating from the area of the styloid process has concentrated on elongated processes as the cause of the symptoms. [1-4] Pathogenic mechanisms for pain arising from an elongated styloid process usually involve impingement of pharyngeal mucosa as it is drawn against an elongated process during normal function or impingement of the carotid vessels and their associated sympathetic chain. Eagle argued that pain from an elongated styloid process was due to "constant mechanoreceptor discharge in the area of the fifth, seventh, ninth and tenth cranial nerve endings" initiated by a mechanical irritation from the styloid process. If a soft-tissue lesion at the styloid process results in an inflammatory response, any post-trauma inflammatory edema that may result from such a chronic lesion could be contained in the lateral pharyngeal space. It may be possible this could create an elevation in intercompartmental pressure which may

affect the neurovascular contents of this space [5].

In our study 121 skulls were included who were satisfied inclusion and exclusion criteria. They were examined for variations that exist in morphology and morphometric parameters of Styloid process. it was observed that 68 had both intact Styloid process and 53 had unilateral Styloid process. Styloid process elongation can occur unilaterally or bilaterally [6]. There are investigators claiming that the phenomenon is most common unilaterally but others are contrary to these claims. It has been suspected that an elongated styloid process could be caused by: congenital elongation of the styloid process due to persistence of the cartilaginous analogue of the Styloid, calcification of the stylohyoid ligament by unknown mechanism and growth of osseous tissue at the insertion of the stylohyoid ligament [7]. Ossification can take place during childhood and adolescence when the rate of bone growth is increased. After the age of 20 there is a rapid decrease in ossification formation [8]. However, other authors support that an inconsistent trend exists toward greater

ossification of the stylohyoid ligament with advanced age [9].

In our study we have observed 76 (40.21%) had length within 1.1 - 2.0 cm, 74 (39.15%) had length within 0.4 - 1.0 cm and 39 (20.63%) had length within 2.1 – 4.0 cm. Mean length of styloid process was 1.469 ± 0.717 cm, on the right side it was observed 1.47 ± 0.72 cm and on the left side it was 1.54 ± 0.71 cm. A normal range of the length of the styloid process differs among the studies in the literature. Eagle *et al* reported the normal length of the styloid process as 2.5 cm. other authors measured the length as 3 cm. It has been reported that it is probably symptomatic when the length exceeds 4cm [10]. Some authors say that length of styloid process ranges between 15.2 mm & 47.7mm considered being normal. Studies of other authors consider length of styloid process over 30 mm. As elongated styloid process [11]. Few have considered 40mm of length of styloid process. In some rare cases there is very long styloid process measuring 73mm [12,11]. R Vadgaonkar *et al*[13] observed that the mean length of the styloid process was 17.8 ± 9.3 mm and 18.2 ± 5.6 mm for the right and left sides, respectively. This data is smaller in comparison to the data from North Indian population reported by Rathva *et al* [14] reported that the length of styloid process was 43.8 ± 11.1 mm and 43.5 ± 10.4 mm for the right and left sides in their specimens. This variation in the data from Indian samples may be because the difference in the method which was used to measure the parameter as they performed the measurements by using digital image analysis using the adobe photoshop.

Our study found that 100 (52.91%) styloid process had medial angulation in the range of 70° - 79° , 62(32.80%) styloid process had medial angulation in the range of 80° - 89° and 27(14.29%) styloid process had medial angulation in the range of 60° - 69° respectively. and there was no significant difference between the groups with medial

angulation of 60° - 69° , 70° - 79° and 80° - 89° and the side of the Styloid process. Also 146 (77.25%) styloid process had Anterior angulation in the range of 60° - 79° , 32 (16.93%) styloid process had Anterior angulation in the range of 80° - 89° and 11(5.82%) styloid process had Anterior angulation in the range of 40° - 59° respectively and there was no significant difference between the groups with Anterior angulation of 60° - 69° , 70° - 79° and 80° - 89° and the side of the Styloid process.

Several studies reported that the direction and angulation of the elongated styloid process probably were responsible for the irritation of a number of anatomical structures traversing the parapharyngeal space. For example, medial deviation could impinge the tonsillar fossa and anterior angulation might result in mucosal irritation and pressure over vital structures in the tonsillar fossa[15]. Jackson *et al* also reported that an elongated styloid process deviating slightly from its normal direction could impinge the internal or external carotid artery, and causes pain during artery's palpation because it stimulates the sympathetic nerve plexus accompanying the artery and that correlates hypertension in elongated styloid process[16,17]. The elongation of styloid process is considered an anomaly which can be accompanied by a series of symptoms such as dysphasia, odynophagia, facial pain, ear pain, headache, tinnitus and trismus. This set of symptoms associated with the elongated styloid process is called Eagle's syndrome (Lages *et al.*, 2006) [18]. The mean medial angulation (MA) and anterior angulation (AA) on the right and left sides were determined. [19-22] The MA and AA were compared on the right and left sides according to gender. The MA was found to be statistically significantly higher in male patients on both sides ($p=0.029$ on the right side and $p<0.001$ on the left side). [23] The AA was also higher in male patients on both sides. However, it was not statistically significant. The MA and AA

on the right and left sides were compared regardless of gender. Only the AA was found to be statistically significantly

higher on the left side ($p < 0.001$). comparison of angulation was showed in bellow table.

Study	Years	Population	Medial Anglulation (Degree)	Anterior Angulation(Degree)
Yavuz et al[19]	2008	Turkish	16.4	19.9
Mazzeto et al[20]	2013	Brazilian	19.1(R), 19.04(L)	20.89
Patil et al[21]	2014	Indian	74.15	62.45
Apurba Patra et al[22]	2017	Indian	65.48(R), 63.80(L)	57.5(R), 59.30(L)
Present study	2022	Indian	72.32(R), 73.39(L)	67.24(R), 69.17(L)

Conclusion

From overall observation and discussion with the studies we can conclude that elongated SP (length > 30 mm) was seen more frequently as compared to bilateral. When bilateral, it was more on right side as compared to the left side. Whether normal or elongated, the length of SP was more on right side as compared to the left side. An elongated SP is important not only clinically but also academically and ontogenically.

Limitation

- We have not consider gender of the samples
- And sample size was less

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