

## Radiological Evaluation of the Styloid Process Length Using 64-row Multidetector Computed Tomography Scan

### Abstract

**Background:** As elongated styloid process is one of the causes of recurrent oropharyngeal pain and carotid nerve plexus compression called Eagle's syndrome and this length is not similar in different communities, the aim of the current study is to determine average length of styloid process by paranasal multidetector computed tomography. **Materials and Methods:** This is a retrospective cross-sectional study about 393 patients who underwent paranasal MDCT scan for trauma in Radiology Department without pathologic finding. Styloid length from temporal bone junction to tip of the process was measured using Workstation software. Demographic data including age, sex, and height were gathered from the patients' records, and patients were questioned about symptoms of Eagle's syndrome before trauma. Data were analyzed using SPSS version 20 with the methods of *t*-test, Chi-square, and ANOVA.  $P < 0.05$  was considered statistically significant. **Results:** Two-hundred and sixteen males and 177 females underwent MDCT. The length of right, left, and mean length of both sides were  $25.4 \pm 7.3$ ,  $25.2 \pm 7.8$ ,  $25.3 \pm 7.1$ , respectively. The mean length of both sides' process was more among male that was statistically significant ( $P = 0.025$  and  $0.043$ , respectively). Right and left side styloid process' higher length was in correlation with patient's height ( $P = 0.002$ ,  $r = 0.153$ ,  $P = 0.029$ ,  $r = 0.110$ , respectively) and number of symptoms ( $P < 0.001$ ,  $r = 0.300$ ,  $P < 0.001$ ,  $r = 0.334$ , respectively). **Conclusion:** The mean length of styloid process was  $25.3 \pm 7.1$  that was in accordance with some studies and different from others. Styloid process length is higher in males. The length of styloid process is in association with height and number of symptoms as well.

**Keywords:** Iran, MDCT, paranasal sinus

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### Introduction

Elongated styloid process can cause Eagle's syndrome which is characterized by recurrent head and neck pain. The oropharyngeal symptoms may be due to mass and compression effect as this process is in vicinity of cranial nerves, carotid nerve plexus, carotid artery, and jugular vein.<sup>[1,2]</sup> Vague long-term pharyngeal pain that sometimes radiates to ear or foreign body sensation in throat, odynophagia, dysphagia, dysphonia, increased salivation, headache, and ringing or buzzing in ears are common symptoms of this syndrome. In vascular form of this syndrome, close contact of process with carotid artery can cause vascular compression or even tearing which may lead to stroke or transient ischemic attack.<sup>[1]</sup>

There are different studies about elongated styloid process. Most of the reports have shown the prevalence of 4% for elongated

styloid process in general population while just 4%–10.3% of these patients are symptomatic.<sup>[3]</sup>

There is no agreement about the normal length of this process. Some researchers mentioned 15.2–47.7 mm as normal length<sup>[4]</sup> whereas some other reports mentioned cutoff point of 30 or 20–30 mm as normal.<sup>[5,6]</sup>

Elongated styloid process may be ipsilateral or bilateral, and results are controversial about this matter.<sup>[7]</sup>

Results of the studies about sex predominance are controversial. While most of the studies have reported similar prevalence among male and female population, some others presented different predominance of elongated styloid process.<sup>[8]</sup>

Elongated styloid process can be diagnosed by examination of tonsillar fossa, panoramic radiographic studies, and

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computed tomography (CT) scan. In comparison to simple radiography, CT scan provides detailed information about anatomy of this process, so in conditions that the presence of pain or other symptoms of head and neck would suspect you about elongated styloid, multislice CT scan of the neck and skull base is the choice of modality. However, three-dimensional reconstruction of CT is the gold standard diagnostic modality for Eagle's syndrome.<sup>[9,10]</sup>

By consideration of these differences and lacking of enough native studies about styloid process anatomy, this study was designed. The aim of the current study was to determine the average length of styloid process bilaterally by paranasal multislice CT scanning among population referred to the Radiology Department of Al-Zahra Hospital, Isfahan, Iran.

## Materials and Methods

This is a retrospective, cross-sectional study about 393 patients who underwent paranasal multislice CT scan, followed by trauma in the Radiology Department of Al-Zahra Hospital, Isfahan, Iran, from 2014 to 2016. This study was approved by the Vice Chancellor for Research in Isfahan University of Medical Sciences under the research project number 394315.

All the traumatic patients who were candidate for undergoing multidirectional CT (MDCT) of paranasal sinus and had normal CT scan were included in the study.

All CT examinations were performed using a 64-slice MDCT scanner (Medical Health Care GE Workstation RDW 4.3, GE, USA). Technical features of MDCT were as follows:  $64 \times 0.625$  collimation, minimum slice thickness of 0.67, 0.641 pitch, kV of 120, and mAs of 200 by Philips scanner.

CT scanning of patients was done in the supine position and measuring of styloid process was performed in reconstructed images of coronal plane.

Styloid length from temporal bone junction to tip of the process was measured using CT image analysis workstation (Advantage Workstation, GE, healthcare, USA). In the case of ossification in stylohyoid ligament, this length was added to length of the process. For bias prevention, all of the measurements were done by an expert radiologist.

Exclusion criteria were (1) age of  $<11$  or  $>75$  years, (2) technical problem and/or any problem in multislice CT scan processing (in cases that styloid process cannot be evaluated), and (3) pathologic findings. Cutoff point for this process length was 30 mm as mentioned in notable number of previous studies,<sup>[6,11]</sup> so we use this cutoff point to measure the prevalence of elongated styloid process in both male and female population.

Demographics including age, sex, and height were gathered from patients' records, and patients were questioned about

symptoms of Eagle's syndrome before trauma including (1) facial pain, (2) periauricular pain, (3) foreign body sensation, (4) sore throat, (5) chronic headache, and (6) neck pain.

Patients were divided into three groups: under 40 years, 40–60 years, and above 60 years.

The right and left styloid process' length was measured separately among male and female population.

Data were analyzed using IBM SPSS statistics 20 software (SPSS Inc., Chicago, IL, USA). Test methods were *t*-test, Chi-square test, and ANOVA. For evaluating the correlation between demographic data and the process length, Pearson correlation test is used, and in case of necessity, regression test is administered.  $P < 0.05$  was considered statistically significant.

## Results

Multislice CT scan of styloid process in 393 patients including 216 males (55%) and 177 females (45%) was evaluated in this study. Patients ranged from 12 to 75 years ( $41.3 \pm 16.7$ ) and were 148–182 cm height ( $166.8 \pm 7.9$ ).

The length of right, left and mean length of both sides were  $25.4 \pm 7.3$  (range: 4.1–57),  $25.2 \pm 7.8$  (range: 7–62), and  $25.3 \pm 7.1$  (range: 5.8–59.5), respectively.

Based on symptoms, patients were divided into seven subtypes including symptom-free and 1, 2, 3, 4, 5, and 6 with symptoms of facial pain, periauricular pain, foreign body sensation, sore throat, chronic headache, and neck pain, respectively. Totally, 228 (58%) and 93 (23.7%), 38 (9.7%), 21 (5.3%), 8 (2%), 3 (0.8%), and 2 (0.5%) patients were symptom-free and had 1–6 symptoms, respectively.

Comparison of right, left, and mean of both sides' process length among male and female is shown in Table 1. The mean length of both processes was significantly higher among males than that of females ( $P = 0.043$ ).

Higher length of styloid processes even in the left or right sides correlated with patients height positively ( $P = 0.002$ ,  $r = 0.153$  and  $P = 0.029$ ,  $r = 0.110$ , respectively), and number of symptoms was in association with right and left side styloid process higher length too ( $P < 0.001$ ,  $r = 0.300$  and  $P < 0.001$ ,  $r = 0.334$ , respectively); these are summarized in Figures 1 and 2, respectively.

Table 2 shows the different styloid process lengths in age subtypes of  $<40$  years, 40–60 years, and  $>60$  years, and styloid length was not in correlation with age ( $P > 0.05$ ).

Information about length of styloid process with consideration of 30 mm as cutoff point is reported in Table 3. Patients with longer right/left styloid process had longer left/right process; however, this relation was not

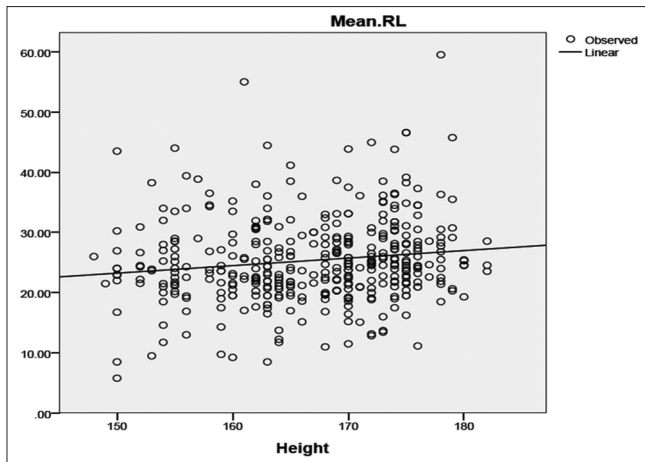


Figure 1: Association of height with mean length of both right and left styloid process

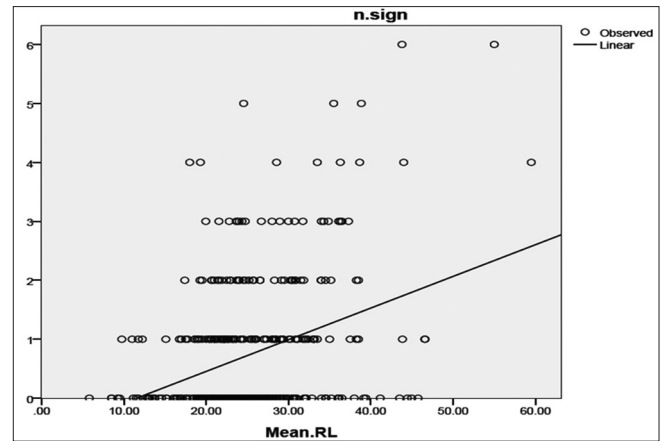


Figure 2: Association of number of signs (n.sign) with mean length of both right and left styloid processes

**Table 1: Right and left process length comparison in different sex**

Side of process	Sex (n)	Mean±SD
Right	Male (226)	26.2±7.4
	Female (177)	24.5±7.2
Left	Male (226)	25.8±7.9
	Female (177)	24.6±7.8
Both right and left	Male (226)	26.0±7.0
	Female (177)	24.5±7.0

SD: Standard deviation

**Table 2: Different styloid process length in different ages**

Side of process	Age, years (n)	Mean±SD	P
Right	<40 (187)	24.6±7.3	0.110
	40-60 (135)	26.4±7.3	
	>60 (71)	25.6±7.5	
Left	<40 (187)	24.3±7.3	0.06
	40-60 (135)	26.6±8.2	
	>60 (71)	25.0±7.7	

SD: Standard deviation

**Table 3: Prevalence of styloid process length above and under cutoff point**

Styloid process length	Right process, n (%)	Left process, n (%)	P
≥30 (mm)	88 (22.4)	91 (23.2)	0.514
<30 (mm)	305 (77.6)	302 (76.8)	

statistically significant ( $P > 0.05$ ). According to Table 3, the prevalence of elongated styloid process is 22.9%.

The prevalence of elongated styloid process ( $\geq 30$  mm) did not differ in male and female, either in the right or in the left ( $P = 0.171$  in right side and  $0.338$  in left side).

## Discussion

Eagle's syndrome symptoms were explained by Eagle, but Pietro Marchetti first. One of these symptoms is chronic

head and neck pain that can decrease quality of life. In addition, elongated process and stylohyoid ligament calcification can lead to higher risk of carotid artery dissection, transient ischemic attack, and stroke.<sup>[1,10]</sup>

Head and neck pain etiology diagnosis is not easy and is increasingly dependent on paraclinics. MDCT is an approved modality for measuring of styloid process length.<sup>[4,10]</sup> Considering mentioned risks that elongated styloid process may lead to, the importance of radiologist's attention to length of this process is clear. By diagnosing cases with elongated process, conservative or surgical prophylactic therapies can be considered for resolving patient sign and symptoms and decreasing the risk of carotid artery dissection and stroke. The length of right, left, and mean length of both sides were  $25.4 \pm 7.3$ ,  $25.2 \pm 7.8$ , and  $25.3 \pm 7.1$ , respectively. These means are less than that was reported in Cullu *et al.*'s study but not to that extent of Yavuz *et al.* about Turkish population.<sup>[10,12]</sup> Furthermore, our findings were in accordance with Balbuena Jr *et al.* presentation, and these differences may have occurred due to different races and environmental factors.<sup>[13]</sup>

The length of styloid process was associated with patient's height, that is, in accordance with other study that reported significant association with height and weight,<sup>[12]</sup> and another interesting finding is association of process length with a number of symptoms that in patients with more symptoms, longer styloid process was detected.

Another factor that was assessed in the current study was age relation and process length in which we found no correlation. Our subtypes were not similar to other studies, and one of the limitations of this study is dividing patients into nonequal ranges. The findings were somehow similar to Ekici *et al.*'s study but notably less than Yavuz *et al.*<sup>[12,14]</sup>

The mean length of both right and left side processes was significantly higher among males ( $P = 0.043$ ). The longer styloid process in males is presented in other studies.<sup>[10,14]</sup>

One of the limitations of the current study is lack of evaluating cutoff for the length of this process which was

due to not having approved cases of Eagle's syndrome, but the cutoff is important as it can affect the approach for prophylactic therapy. Based on previous studies, there are different cutoff points for styloid process length including 25, 40, and 45 mm, but most studies used 30 mm as cutoff point as we do. The prevalence of elongated process was 22.9% in the current presentation while other studies have reported diverse prevalence from 4% to 81.4%.<sup>[5,6,11,15,16]</sup>

### Conclusion

The mean length of styloid process was  $25.3 \pm 7.1$  that was in accordance with some studies and different from others.

Styloid process length is higher in males. The length of styloid process is in association with height and number of symptoms as well. Not having cases with a diagnosis of Eagle's syndrome was the reason of not having cutoff in this study; thus, further studies with consideration of cutoff in Iran's population are recommended.

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There was no financial support as we used existing data in Al-zahra.

### Conflicts of interest

There are no conflicts of interest.

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