



## Original article

### **Styloid Process Elongation, Shape and Calcification Pattern According to Age and Gender**

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#### **ABSTRACT**

**Background:** Styloid process (SP) is a slender pointed part of the temporal bone, which is closely related to the stylomastoid foramen. As many important neurovascular structures located near the tip of SP, the elongation or ossification of stylohyoid ligament may be associated with pain related to orofacial region known as Eagle's syndrome.

**Aim** of this study was to assess the prevalence of elongated SP, its morphology and calcification pattern on digital panoramic radiographs in patients attending the dental clinic of the University of Benghazi.

**Material and Methods:** The digital panoramic radiographs with visible styloid processes of the studied group of patients were studied for their visibility, length and pattern of calcification. The length of styloid processes was measured in the radiograph and was considered elongated if that length exceeded 30 mm. The prevalence and pattern of elongation and calcification were determined according to Langlais classification.

**Results:** Out of the 304 patients (164 are males and 140 are females) examined radiographically, the elongation of SP was detected in 156 (51.31%) of the patients. It was bilateral in 151 (96.79%) cases. There were no significant differences between males and females in regard to the length and shape of SP between in all age groups in both sexes, but the calcification pattern was significantly different between the age groups in both sexes. The outlined pattern of calcification of SP was the most prevalent especially in the younger age group (10-19 years), while the complete calcification pattern was most commonly detected in the older age group ( $\geq 60$  years).

**Conclusion:** elongated SP whether it is accompanied by pain symptoms or asymptomatic, can easily be detected on a digital panoramic radiograph and should be considered in the differential diagnosis of orofacial pain.

**Keywords:** Styloid Process, Elongation, Calcification Pattern, Libyan patients.

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#### **INTRODUCTION**

Styloid process is derived from the Greek word 'Stylos' which means a pillar. It is a long osseous projection of petrous part of the temporal bone in front of stylomastoid foramen projecting from it forward, downward and slightly medial. Styloid apparatus is a functional unit composed of three muscles (styloglossus, stylohyoid and stylopharyngeus) and two ligaments (stylohyoid and stylomandibular) all attached

to it. <sup>1</sup> The normal length of SP is 25 to 30 mm in adults <sup>2</sup> It considered elongated if it exceeds 30 mm <sup>3</sup>. The tip of the process is situated lateral to the pharyngeal wall and immediately behind the tonsil fossa, and critically between the internal and external carotid arteries. Medially many important neurovascular structures are located in close proximity to this tip such as internal jugular vein and accessory, hypoglossal, glossopharyngeal, and vagus nerves. <sup>4-6</sup>

A wide variety of clinical symptoms have been attributed to the extraordinarily elongated styloid process, including unpleasant sensation in the throat similar to cervicofacial pain, described as by "Watt Eagle".<sup>7,8</sup> Multiple theories have been proposed the ossification of the stylohyoid "Eagle's syndrome" such as trauma activating the remnants of fibrocartilaginous cells or an abnormal healing following trauma that initiates calcification of the ligament<sup>9</sup>.

Although the exact etiology of SP elongation and ossification are still unknown, it is thought to be due to persistence of cartilaginous precursor<sup>10,11</sup> or due to systemic conditions altering calcium, phosphorus and vitamin D metabolism such as secondary hyperparathyroidism. The elongation of SP is diagnosed by both physical examination and radiological. Ortho Panoramic Radiograph (OPG) is the most widely used radiograph to determine SP elongation, while other projections such as the lateral skull, Towne's, lateral-oblique and anteroposterior head radiographs and computed tomography are also used as well.<sup>12</sup> Clinically, SP palpation in the tonsillar fossa (which is not normally palpable) is indicative of elongation. Palpation exacerbating pain symptoms which can be relieved by local anesthetic injection into the tonsillar fossa is considered diagnostic.

Langlais et al had proposed classification system for of the elongated SP pattern and its ossification based on the radiographic appearance of stylohyoid ligament depending upon the morphology of elongation. type I represent an elongated SP which is uninterrupted; while type II, is a pseudoarticulated where styloid process joined to the stylohyoid ligament by single pseudoarticulation; type III is segmented (Figure 1) depending on the pattern of calcification as: calcified outline, partially calcified, nodular, or completely calcified<sup>13</sup>.

## MATERIALS AND METHODS

In this retrospective, cross sectional study measurements of SP length, calcification pattern and shape were done on archived panoramic radiographic images of routine patients who had visited the dental clinic at Benghazi University dental clinic during the years 2009-2010. The study was conducted according to the human ethics guidelines set by this institution, in which an OPG was only taken for diagnostic purposes and needs.

A total of 304 digital panoramic radiographs were selected for this study. The radiographs taken by Vatech PaX-i Panoramic X Ray machine under standard exposure factors as recommended by the manufacturer. Only diagnostically acceptable images were included in the study.

SP Type and Pattern of Calcification of both the left and right side were analyzed independently and the length was measured using the IC software. The start point of measurement of the length of Sp was initiated was the base of temporal bone and downward to the tip of the process. An SP measuring more than 30 mm were considered as elongated. The ossified stylohyoid ligament that joined to SP was included of the measurements.

Data regarding all 304 panoramic radiographs were analyzed using IBM SPSS 23.0 (statistical package for social science Inc. Chicago, USA) software. Student t-test, One-way ANOVA, Chi-square and Fisher's exact tests were used for statistical analysis. P values less than 0.05 was accepted as statistically significant.

## RESULTS

There was no statistically significant difference between the number of patients with elongated SP when they were subdivided into age groups. SP was elongated in 156 patients (80 males and 67 females). In 151 patients the elongation was bilateral representing (96.79 %) of the cases with an elongated SP. This difference between the sexes is not statistically significant. Similarly there was no significant difference between the two genders in the SP length. The mean length of styloid process was ( $42.43 \pm 10.87$ ) on the right side and ( $42.41 \pm 10.89$ ) on the left side. There is no significant difference between males and females regarding the mean process length or the shape or calcification pattern (Table 1) while the partial calcification pattern was the most common calcification pattern observed in both sides (Tables 2 & 3).

According to age groups, there is no statistically significant differences in the mean length of right and left styloid processes (p-value: 0.73 and 0.51 respectively). However in the age group (40-49 years) the left styloid process was significantly longer in females ( $51.60 \pm 17.38$  vs  $37.94 \pm 7.75$ , p-value=0.02), while in the age group (50-59 years), the left styloid was significantly longer in males ( $31.57 \pm 2.5$  vs  $38.46 \pm 11.23$ , p value = 0.03).

There was no significant differences in the morphology of the elongated styloid processes between the age groups of both genders.

## DISCUSSION

Elongation of styloid process and ossification of stylohyoid ligament has been reported by many investigators, the majority of individuals exhibiting this anatomical anomaly experience no symptoms. There is no agreed pathogenesis of this condition. The occurrence of styloid process elongation varies greatly in different populations. In the present study the prevalence of SP elongation is detected in more than half of the patients, all of them were asymptomatic, while other studies reported wide range of prevalence between 3.7 to 93%.<sup>14-19</sup>, this figure may had been resulted from differences in population or due to genetic factor.

It has been estimated that 4% of the general population have radiographic evidence of an elongated SP, the majority are asymptomatic, out of these only 4%-10.3% of the patients are having symptoms<sup>28</sup>. Elongation of SP appears bilaterally in most of the cases, even so the symptoms generally presents with unilateral orofacial pain<sup>29</sup>.

In the present study the percentage of SP elongation was almost the same in both genders in consistent with some other studies<sup>20,21</sup>, and contradicting the findings of other studies<sup>22,23</sup>. Although elongated styloid process is noticed more in females than males in both sides there was no significant difference between age groups, while other studies reported significant relationship between age and elongation<sup>24</sup>.

Bilateral elongation is the norm in this study and was seen in almost all the cases which is in consistent with most of other studies, that reported a bilaterally elongation of SP<sup>25,26</sup> and showed an increased length of the styloid process with the increased age<sup>23,26,27</sup>.

According to Langlais classification, more than 72 % of the elongated SP in this study was type I elongation, while type II and type III elongation were less frequently encountered in all age groups. However when it comes to the calcification pattern there was significant difference between all age groups in both sex-

es; as the outline calcification pattern being the most predominant pattern in the younger age group, while the complete calcification pattern was the most common pattern in older age group in consistence with other studies which found that the type I elongation pattern and the outline calcification pattern were the common<sup>24</sup>.

SP's clinical symptoms are not only related to elongation alone, but also related to the medial inclination of SP and its proximity to the neurovascular structures. This may explain the lack of symptoms in the majority of cases with an elongated SP in this study. However, Eagle's syndrome should always be considered in the differential diagnosis of head and neck pain such as facial neuralgias such as glossopharyngeal neuralgia, tonsillitis, dental infections and TMJ disorders.

The precise cause of SP elongation and ossification of stylohyoid ligament is not fully understood, however many theories have been proposed to explain that. Eagle considered the scar formation followed tonsillectomy or local chronic irritation could cause periostitis, osteitis or tendonitis leading to this syndrome<sup>7</sup>.

Panoramic radiographs have been commonly used until now by most of investigators to detect and study SP because it is economic, easily accessible and useful diagnostic aid for early detection of the elongated styloid process with or without symptoms, although CT is proved an effective means for evaluation of the SP length, angulation, and other morphological features<sup>28</sup>. However errors do occur by using panoramic radiographs which may lead to improper readings such as superimposition of SP with other skeletal structures, image magnification and angulation of SP.

**Conclusion:** Dentist should be aware of the styloid process elongation, which is often coincidental asymptomatic radiographic finding. OPG is still considered by many as an important tool for diagnosis of elongated styloid process. Further studies are still required to investigate the relationship between the type of styloid process and symptomatic presentation (Eagle's syndrome).

**Table 1: SP calcification in different age groups**

Gender	Age	Calcification (Right side)				P value	Calcification (Left side)				P value
		1	2	3	4		1	2	3	4	
Male	10-19	66.6%	0%	0%	33.3%	0.004	66.7%	0%	0%	33.3%	0.028
	20-29	11.1%	5.6%	77.8%	5.6%		11.1%	5.6%	77.8%	5.6%	
	30-39	42.1%	0%	36.8%	21.1%		42.1%	0%	38.9%	21.1%	
	40-49	40%	6.7%	26.7%	26.7%		40%	6.7%	26.7%	26.7%	
	50-59	23.1%	23.1%	46.2%	7.6%		23.1%	23.1%	46.2%	7.7%	
	≥60	0%	0%	100%	0%		0%	0%	100%	0%	
Female	10-19	60%	0%	20%	20%	0.000	50%	0%	25%	25%	0.000
	20-29	40.9%	13.6%	0.9%	36.4%		36.4%	22.7%	0%	40.9%	
	30-39	20%	0%	36%	44%		20.8%	0%	45.8%	33.3%	
	40-49	0%	20%	80%	0%		0%	20%	80%	0%	
	50-59	0%	28.6%	57.1%	14.3%		0%	28.6%	57.1%	14.3%	
	≥ 60	0%	22.2%	66.7%	11.1%		0%	22.2%	66.7%	11.1%	

**Table 2: SP morphology in different age groups in both genders**

Gender	Age	Morphology (Right side)			P value	Morphology (Left side)			P value
		1	2	3		1	2	3	
Male	10-19	50%	16.66%	33%	0.07	50%	16.66%	33%	0.25
	20-29	70%	15%	15%		65%	10%	25%	
	30-39	56%	12.5%	31.25%		66.66%	11.11%	22.22%	
	40-49	88.23%	5.88%	5.88%		77.5%	6.25%	6.25%	
	50-59	92.3%	7.7%	0%		84.61%	7.69%	7.69%	
	≥60	33.33%	66.66%	0%		33.33%	66.66%	0%	
Female	10-19	60%	20%	20%	0.52	33.33%	16.66%	50%5	0.52
	20-29	81.81%	9.09%	9.09%		71.42%	9.52%	19.04%	
	30-39	72%	12%	16%		70.83%	8.33%	20.83%	
	40-49	40%	0%	60%		40%	0%	60%	
	50-59	66.66%	16.66%	16.66%		66.66%	16.66%	16.66%	
	≥60	77.77%	11.11%	11.11%		77.77%	11.11%	11.11%	

**Table 3: Calcification pattern in both genders**

Right side	All	Male	Female	P value
Outline pattern	25.2%	27.1%	23.3%	0.27
Nodular pattern	8.4%	5.7%	11%	
Partial pattern	41.3%	47.1%	35.6%	
Complete pattern	25.2%	20%	30.1%	
Left side				
Outline pattern	25.4%	29.1%	21.1%	0.1
Nodular pattern	10.6%	7%	14.1%	
Partial pattern	24.3%	47.9%	36.6%	
Complete pattern	21.8%	15.5%	28.2%	



**Figure 1: TypeIII (Segmented) styloid process**

## References

1. Standring S. Skull and Mandible. In Gray's Anatomy. The Anatomical basis of clinical practice. 39<sup>th</sup> edition. Elsevier, Edinburg; 2005:470.
2. Eagle W. Elongated styloid process: further observations and a new syndrome. Arch Otolaryngol. 1948;47(5):630-640.
3. Ilgüy M, Ilgüy D, Güler N, Bayirli G Incidence of the type and calcification patterns in patients with elongated styloid process. J Int Med Res. 2005 Jan-Feb;33(1):96-102.
4. Eagle WW. Symptomatic elongated styloid process: report of two cases of styloid process-carotid artery syndrome with operation. Arch Otolaryngol. 1949;49(5):490-503.
5. Fini G, Gasparini G, Filippini F, Becelli R, Marcotullio D. The long styloid process syndrome or Eagle's syndrome. J Craniomaxillofac Surg. 2000;28(2):123-127.
6. Moffat DA, Ramsden RT, Shaw HJ. The styloid syndrome: aetiological factors and surgical management. J Laryngol Otol 1977; 91:279-294.
7. Ilgüy D, Ilgüy M, Fls E, et al. Assessment of the stylohyoid complex with cone beam computed tomography. Iran J of Radiol 2013;10(1):21-26.
8. Moon CS, Lee BS, Kwon YD, et al. Eagle's syndrome: a case report. J Korean Assoc Oral Maxillofac Surg. 2014, 40:43-47.
9. Woolery WA. The diagnostic challenge of styloid elongation (Eagle's syndrome). J Am Osteopath Assoc.1990; 90: 88-89.
10. Anbiaee N, Javadzadeh A. Elongated styloid process: Is it a pathologic condition? Indian J of Dent Res 2011;22:673-7.
11. Erol B. Radiological assessment of elongated styloid process and ossified stylohyoid ligament. J of Marmara Univers Dent Facul 1996;2:554-556.
12. Steinmann EP. Styloid syndrome in absence of an elongated process. Acta Otolaryngol. 1968;66:347-356.
13. Gokce C, Sisman Y, Ertas ET, et al. Prevalence of styloid process elongation on panoramic radiography in the Turkey population from cappadocia region. Eur J Dent. 2008;2:18-22.
14. Erol B. Radiological assessment of elongated styloid process and ossified stylohyoid ligament. J of Marmara Univer Dent Facul. 1996;2:554-556.
15. Sudhakara Reddy R, et al. A. Prevalence of elongation and calcification patterns of elongated styloid process in south India. J Clin Exp Dent. 2013 Feb; 5(1): e30-e35.
16. Alpoz E, Akar GC, Celik S, Govsa F, Lomcali G. Prevalence and pattern of stylohyoid chain complex patterns detected by panoramic radiographs among Turkish population. SurgRadiol Anat. 2014 Jan;36(1):39-46



17. Mirshekar A, Abesi F, Mehdizadeh M, Khanbabapour M, Khafri S. Radiological Assessment of the Length of Styloid Process on Panoramic Radiography. *J Mazand Univ Med Sci*; 24(112):123-6.
18. Guimaraes A., et al. Prevalence of elongated styloid process and/or ossified stylohyoid ligament in panoramic radiographs. *Revista Gaúcha de Odontologia*, 2010;58,(4):481-485.
19. de Paula M, Carraretto F. Prevalence of elongation of the styloid process in patients with temporomandibular disorders. *Revista da Imagem*, 2008;30(1):1-5.
20. Scaf G, Freitas DQ, LoffredoLde C. Diagnostic reproducibility of the elongated styloid process. *J Appl Oral Sci* 2003;11:120-4.
21. Shah SP, Praveen NB, Syed V, Subhashini AR. Elongated styloid process: A retrospective panoramic radiograph study. *World J Dent* 2012;3:316-9.
22. Okabe S, Morimoto Y, Ansai T, Yamada K, Tanaka T, Awano S, et al. Clinical significance and variation of the advanced calcified stylohyoid complex detected by panoramic radiographs among 80-year-old subjects. *Dentomaxillofac Radiol* 2006;5:191-9.
23. Ferrario VF, Sigurtá D, Daddona A, et al. Calcification of the stylohyoid ligament: incidence and morphoquantitative evaluations. *Oral Surg Oral Med Oral Pathol*. 1990; 69(4): 524-529.
24. Zaki HS, Greco CM, Rudy TE, et al. Elongated styloid process in a temporomandibular disorder sample: prevalence and treatment outcome. *J Prosthet Dent*. 1996;75(4):399-405.
25. Balcioglu HA, Kilic C, Akyol M, Ozan H, Kokten G. Length of the styloid process and anatomical implications for Eagle's syndrome. *Folia Morphol (Warsz)* 2009;68:265- 70.
26. Basekim CC, Mutlu H, Güngör A, Silit E, Pekkaflali Z, Kutlay M, Colak A, Oztürk E, Kizilkaya E. Evaluation of styloid process by three-dimensional computed tomography. *Eur Radiol*, 2005; 15: 134-139.
27. Joshi V, Iyengar AR, Nagesh KS, Gupta J (2007) Elongated styloid process: A radiographic study. *J Indian Acad Oral Med Radiol*, 2005;19: 498-502.
28. Murtagh RD, Caracciolo JT, Fernandez G. CT findings associated with eagle syndrome. *Am J Neuroradiol*. 2001;22:1401-1402.
- 29.