Prevalence of styloid process elongation on digital panoramic radiography in South India population from Chengalpet district

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SUMMARY

The styloid process (SP) arises from the temporal bone in front of the stylomastoid foramen. Many nerves and vessels are adjacent to the SP. The length of the SP is usually 2-3 cm; if it is longer than 3 cm, it is considered elongated. The elongated SP may compress adjacent neurovascular structures, and cause neck and cervicofacial pain. This study aims to determine the prevalence of SP elongation detected on digital panoramic radiographs in the south Indian population from the Chengalpet region and its relation to gender, age, sides and types. Digital panoramic radiographs of 1000 patients with an age ranging from 10 to 80 years were retrospectively obtained from a private dental college. The subjects were divided into six age subgroups: 10-19, 20-29, 30-39, 40-49, 50-59, and 60 years and older. The apparent length of the SP was measured from the point where it left the temporal bone to its tip. SP measuring more than 3 cm were considered to be elongated. The data were analyzed by using Student's t-test and Chi-square test with a P value less than 0.05. The study findings reported that SP elongation was present in sixty-two (6.2%) patients. The prevalence of SP elongation in males was slightly higher than in females. In males, there was a statistically significant difference found between age groups. The prevalence of SP elongation was increased as the age increased. The most frequently observed type of elongation was the type I elongation. The digital panoramic radiographs are an economical, easily accessible and useful diagnostic tool for early detection of SP elongation. It was found that the elongated SP is an anatomical variation, which must be taken into account by practitioners while treating the patients with head and neck pain.

Key words: Eagle's syndrome – Elongated styloid process – Panoramic radiographs – South Indian population

INTRODUCTION

Styloid Process (SP) is derived from the Greek word *stylos*, meaning a pillar (AlZarea, 2017). The

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SP is a cylindrical, slender, needle-like projection from the inferior part of the temporal bone in front of the stylomastoid foramen (Chaurasia, 2019). The tip of the SP is attached to the stylohyoid ligament and is flanked on laterally and medially by external and internal carotid arteries (Iannucci and Howerton, 2017). Many important nerves such as the facial, glosssopharyngeal, vagus, hypoglossal nerve, and internal jugular vein are medially related to the SP (Eagle, 1937). The length of the SP may vary, but the mean radiographic length of the SP is usually 2-3 cm (Bozkir et al., 1999). The SP length which is longer than 3 cm is considered to be elongated (Keur, 1986). Eagle, an otorhinolaryngologist, first described in 1937 the term Eagle's syndrome, distinguished by the elongated SP and causing clinical symptoms such as neck and cervicofacial pain (Eagle, 1948). It has also received other names: stylohyoid syndrome (Steinman, 1968; Ettinger and Hanson, 1975; Messer and Abramson, 1975; Gossman and Tarsitano, 1977), stylalgia (Patni et al., 1986), SP neuralgia (Langland et al., 1982), cervicopharyngeal pain syndrome (Camarda et al., 1989a, b; Kay et al., 2001).

Several theories have been proposed to explain the etiology of SP elongation. It was suggested that a calcified stylohyoid and stylomandibular ligament are accountable for its elongation (Camarda et al., 1989a, b). The elongated SP exerts pressure on cranial nerves VII, IX, X, XI and XII, causing symptoms such as dysphagia, foreign body sensation in the throat, vertigo, cervicofacial pain, tinnitus (Warrier, 2019). Impingement of internal or external carotid artery by medially or laterally deviated elongated SP produces pain due to stimulation of sympathetic plexus associated with the artery (Chung et al., 2007). Internal carotid artery impingement leads to pain along the course of the artery, and may be accompanied by pain in the eye and parietal cephalgia, whereas external carotid impingement causes pain in the face below the eye (Dao et al., 2011). It may also cause cerebral stroke due to the compression of carotid arteries (Asutay, 2019). Eagle's syndrome is diagnosed by both radiographical and physical examination. More commonly, a panoramic radiograph is used to determine SP elongation.

The present study aims to investigate the prevalence of SP elongation by digital panoramic radiography, and to analyze this prevalence in relation to gender and age subgroups in the South Indian population living in the Chengalpet District. According to the literature, this was the first study investigating the prevalence of SP elongation in this region.

MATERIALS AND METHODS

The study was based on 1072 digital panoramic radiographs, which were retrospectively retrieved from the archival records of Tagore Dental College and Hospital, Department of Oral Diagnosis and Radiology. The study was approved by the institutional ethical committee (IEC/TDCH/054/2021). All the digital panoramic radiographs were taken between 2019 to 2021 using Rotograph EVO D (Villa SistemiMedicalai, Buccinasco) under standard exposure factors, as recommended by the manufacturer. The panoramic radiographs of all patients between 10 and 80 years old were included, provided that the radiograph was of good quality and showed the SP bilaterally. When the panoramic radiographs' quality was not good enough, the stylohyoid complex was not clearly identified, and SP superimposed on the temporal bone, then they were excluded from this study.

The subjects were divided into six age subgroups: 10-19, 20-29, 30-39, 40-49, 50-59, 60 years and above. The mineralized stylohyoid complexes and lengths of bilateral SPs were evaluated by using Digimizer image analysis software. The apparent length of the SP was measured from the point where it originates in the temporal bone to its tip. If the length of SP is more than 3 cm, it is considered elongated. The types and calcification pattern of elongation were determined for both right and left SPs, based on the classification proposed by Langlais et al. (1986). Their classification is shown in Fig. 1a and Fig. 1b. The collected data were entered into Microsoft Excel and analyzed by using SPSS 20.0 software. Student *t-test* and Chi-square test were used for statistical analysis. *P* values less than 0.05 were accepted as statistically significant.

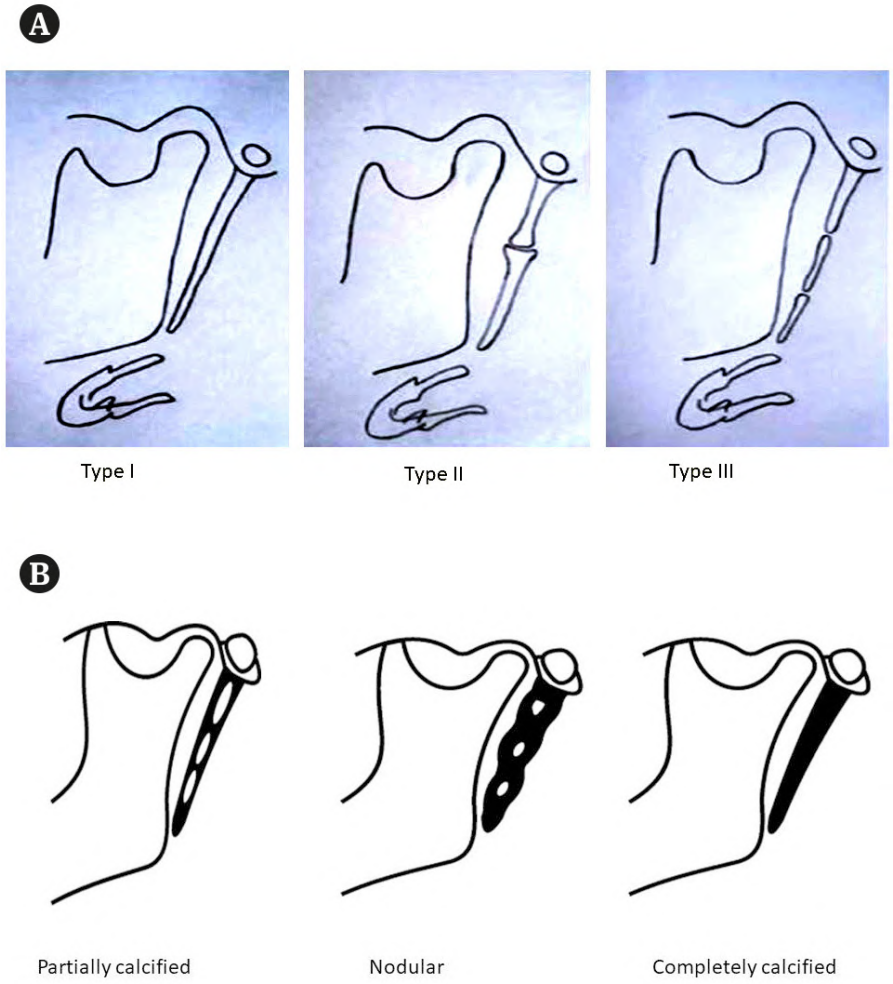

Fig.1 A- Classification of elongated styloid process (Langlais et al., 1986). Type I: uninterrupted elongation. Type II: pseudoarticulated. Type III: segmented elongation. **B-** Calcification pattern of elongated styloid process (Langlais et al., 1986).

RESULTS

Out of a total number of 1,072 digital panoramic radiographs were examined. 1,000 radiographs met our criteria and were included in this study. There were 521 male (52.1%) and 479 female (47.9%). In the study sample out of 1000 panoramic radiographs, 62 radiographs showed an elongated SP of which, 36 (6.9%) elongated SP were observed in males and 26 (5.4%) were observed in females.

Prevalence of SP elongation in relation to age in males was shown in Table 1(a). For what concerns the age groups in males, 4 out 115 (3.5%) patients between 10 and19 years old, 9 out 168 (5.4%) patients between 20 and29 years old, 2 out 81 (2.5%) patients between 30 and39 years old, 6 out 70 (8.6%) patients between 40 and 49 years old, 10 out 56 (17.9%) patients and 5 out 31 (16.1%) patients, respectively, between 50 and59 and over 60 years old showed an elongated SP. We found a statistically significant difference in the prevalence of the elongated SP in males among the age groups with a p-value lower than 0.05 (p-value<0.001). Compared to other age groups, the percentage of prevalence of SP elongation was increased in the 50-59 and above-60 age groups.

Prevalence of SP elongation in relation to age in females was shown in Table 1(b). In the case of females, 4 out 138 (2.9%) patients between 10 and 19 years old, 8 out 132 (6.0%) patients between 20 and 29 years old, 7 out 78 (8.9%) patients between 30 and 39 years old, 3 out 57 (5.3%) patients between 40 and 49 years old, 2 out 48 (4.2%) patients and 2 out 26 (5.4%) patients, respectively, between 50 and59 and over 60 years old have SP elongation. The p-value was higher than 0.05 (p-value<0.529), and showed that there

Table 1a. Styloid process elongation in relation to age in males.

	Age groups (years)	Normal	Elongated SP (%)	Total (%)	Chi-Square Value	P-value
Male	Age 10-19	111	4 (3.5%)	115(22.0%)	20.048	0.001***S
	Age 20-29	159	9 (5.4%)	168(32.2%)		
	Age 30-39	79	2 (2.5%)	81(15.5%)		
	Age 40-49	64	6 (8.6%)	70(13.4%)		
	Age 50-59	46	10(17.9%)	56(10.7%)		
	Age >60	26	5 (16.1%)	31(5.9%)		
	Total	**485**	**36 (6.9%)**	**521(52.1%)**		

Table 1b. Styloid process elongation in relation to age in females.

	Age groups (years)	Normal	Elongated SP (%)	Total (%)	Chi-Square Value	P-Value
Female	Age 10-19	134	4(2.9%)	138(28.8%)	4.145	0.529***NS
	Age 20-29	124	8(6.0%)	132(27.5%)		
	Age 30-39	71	7(8.9%)	78(16.3%)		
	Age 40-49	54	3(5.3%)	57(11.9%)		
	Age 50-59	46	2(4.2%)	48(10.0%)		
	Age >60	24	2(7.7%)	26(5.4%)		
	Total	**453**	**26(5.4%)**	**479(47.9%)**		

was no statistically significant difference in the prevalence of SP elongation in females among the age groups.

The prevalence of elongated SP in males and females according to side distribution was presented in Table 2. Out of the 26 females, 14 showed unilateral and 12 showed bilateral elongated SP, and out of 36 males 19 unilateral and 17 bilateral SP elongation were present. The percentage of the unilateral and bilateral SP elongation in males and females were almost equal. However, the percentage of unilateral is higher than that of bilateral in both male and female. But there was no statistically significant difference (*P*= 0.934) found between males and females, or betweenunilateral and bilateral distribution of elongated SP.

The Digital panoramic radiographs showing Langlais types of elongated SPs was shown in Fig. 2A to C. The distribution of types of SP elongation in both right and left side was shown in Table 3(a). The most common type of elongation observed on the right side was type I (78%). The prevalence of type II was 17%, and of type III was 5%. In the case of left side, type I was 64%, type II was 22%, and type III was 14%. The distribution of calcification pattern of SP elongation on right and left side was shown in Table 3(b). On both right and left sides, the completely calcified pattern (52% and 53%) was the most common pattern of calcification followed by partial calcification (41%and 40%) and nodular (7%) pattern, respectively.

Table 2. Distribution of elongated styloid process in males & females according to sides.

Elongated SP	Male	Female	Chi-square Value	Significance Level
Unilateral	19 (53%)	14 (54%)	0.007	0.934*** NS
Bilateral	17 (47%)	12 (46%)		
Total	36	26		

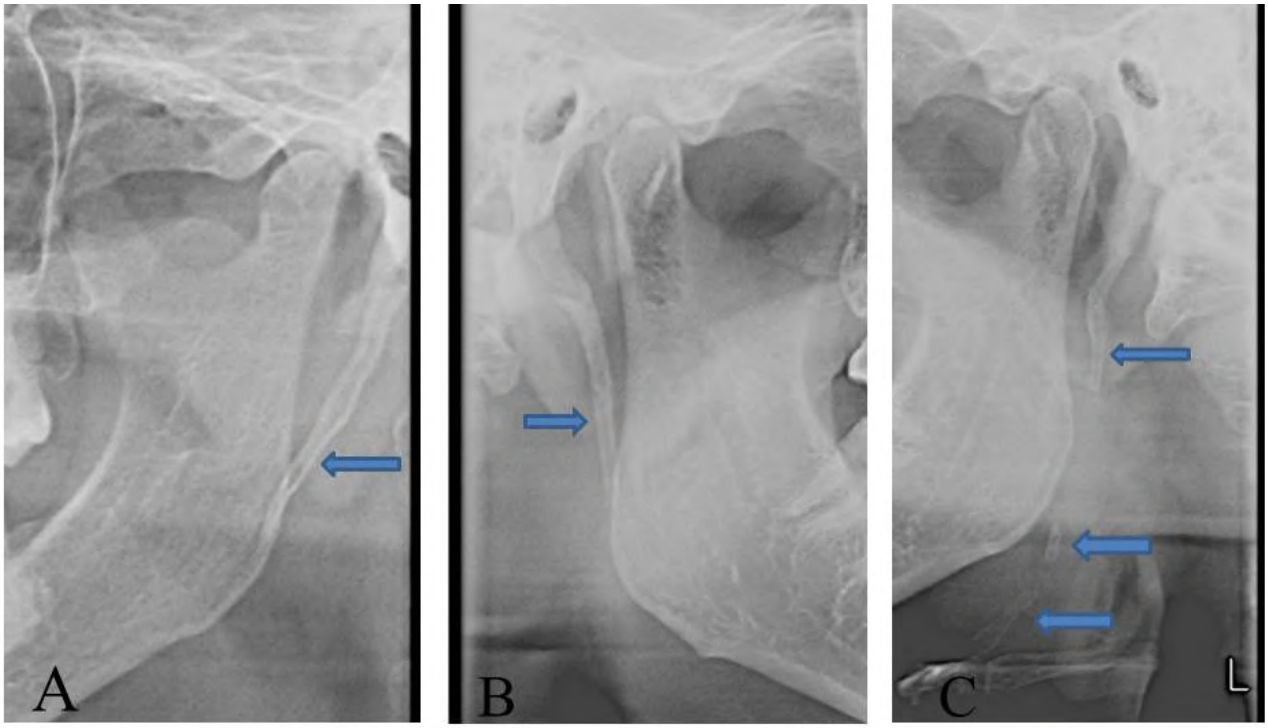

Fig. 2.- Digital panoramic radiograph showing Langlais type of elongated styloid process. **A**: Type I. **B**: Type II. **C**: Type III.

Table 3a. Distribution of types of elongated styloid process.

Elongated SP	Type I	Type II	Type III	Total
Right side	36 (78%)	8 (17%)	2 (5%)	46
Left side	29 (64%)	10 (22%)	6 (14%)	45

Table 3b. Distribution of calcification pattern of elongated styloid process.

Elongated SP	Partially calcified	Nodular	Completely calcified	Total
Right side	19 (41%)	3 (7%)	24(52%)	46
Left side	18 (40%)	3 (7%)	24 (53%)	45

DISCUSSION

The length of the SP varies from individual to individual, and from population to population. In the year 1937, Eagle, an otorhinolaryngologist, first reported that the SP that is over 3 cm was considered to be elongated, causing various clinical signs and symptoms related to the neck and cervicofacial region (Eagle 1948). Although the actual cause of SP elongation is not clear, mineralization and calcification of the tip of the SP may cause elongation. It could be due to the growth of osseous tissue at the insertion of stylohyoid ligament, or it could be due to calcification of stylohyoid ligament due to unknown processes or due to persistence of cartilaginous analog of stylohyal (Scavone et al., 2019). The resultant abnormal stylohyoid complex may irritate or exert pressure over adjacent neurovascular structures and cause clinical symptoms of Eagle Syndrome. The symptoms can be confused with some other disorders, including a wide variety of facial neuralgias, nasopharyngeal lesions, tonsillitis, otitis, oral, dental and temporomandibular diseases (Asutay et al., 2019). Hence, a detailed differential diagnosis for SP elongation should be done.

Palpation of the tip of the SP in the tonsillar fossa is indicative of SP elongation which is not normally palpable and confirmation can be done by radiographical imaging (Bagga et al., 2020). A variety of radiological approaches

are available to find out the elongated SP such as panoramic radiographs, lateral view of the skull, posterior-anterior view of the skull, and computed tomography (CT). Generally, panoramic radiography is used to detect SP elongation, because it is a simple technique and provides realistic images, allowing to replicate the SP length measurements (Chen et al., 2021).

The reported radiographic prevalence of the SP elongation varies from less than 2% to greater than 30% in the literature (Keur et al., 1986; Bozkir et al., 1999; Alpoz et al., 2014; Zaki et al., 1996). The present study exhibited that SP elongation was found in 62 out of 1000 patients, so the prevalence was 6.2%. This finding coincided with those by Austay et al. (2019), Swapna et al. (2021) and Scaf et al. (2003), who reported prevalence rates below 30%. However, this result was in contrast with the result of Chen et al. (2021) and Bagga et al. (2012), who reported that the prevalence of SP elongation was over 30%. This prevalence distribution difference in SP elongation might be due to geographical variation. The ligaments attached to the SP are more prone to ossification where the population has the habit of chewing hard foods, such as gutka and areca nut, and performing strenuous work (Bagga et al., 2012).

The prevalence percentage of elongated SP was lower in the younger age group (<19 years) compared to other age groups. This showed that the bone growth was not completed, and developmental calcification process increased as the age increased (Bruno et al., 2017). The findings by Chen et al. (2021) and Jamal et al. (2018) revealed that the length of the SP was increased with advancing age. They reported that age-related degeneration of the stylohyoid ligamentous complex and a general tendency of calcium salts deposition might be the reasons for SP elongation. Austay et al. (2019) and Gokce et al. (2008) stated that there was no correlation between the incidence of SP elongation and age. The results of the present study are also concurrent with their findings: in female, the prevalence of SP elongation was not related with age, and in the case of males, the prevalence percentage of SP elongation was higher in the groups above 50-59 years of age only.

The study results showed that the prevalence of SP elongation in males was slightly higher than in females, and this result coincides with the findings of Hettiarachchi et al. (2019) and AlZarea et al. (2017), who have reported a higher male incidence. The exact pathogenesis of SP elongation in male due to calcified and ossified bone and ligament is unclear. Explanations that have been put forward include local chronic irritation, surgical trauma, growth osseous tissue, mechanical stress or trauma during development of SP. However, this study's finding was in contrast with the findings by Ilguy et al. (2005), who observed a female-male ratio of 3:1, and Ferrario et al. (1990), who found a higher female incidence. It was suggested that endocrine disorders in women at menospause might be a reason for female predominance (Alpoz et al., 2014; Watanabe et al., 2010).

Bruno et al. (2017) and Gokce et al. (2008) reported that there was no statistically significant difference between the unilateral and bilateral distribution of SP elongation in relation to males and females. The present study's results also coincide with their findings. The most common type of elongation observed within this study was type I and the calcification pattern was the completely calcified pattern. These results were concurrent with the findings of Hettiarachchi et al. (2019) and Jamal et al. (2018). The regional factors like dietary factors might be responsible for different types and calcification patterns of elongated SP (Gokce et al., 2008).

CONCLUSION

Based on the findings of the present study, the prevalence of SP elongation in the south Indian population in the Chengalpet region was 6.2%. The prevalence rate was slightly higher in male than female. The commonest type of elongation and calcification pattern were type I and completely calcified pattern. As the age increased, the prevalence of SP elongation also increased only in males after 50 years of age. Elongated SP causes dysphagia, recurrent throat pain or foreign body sensation, facial pain and neck pain, radiating into the ear. The awareness about the prevalence rate, as well as the signs and symptoms related with elongated SP, will

be helpful for otolaryngologists, neurologists and dental surgeons. SP elongation might also include differential diagnosis in trigeminal neuralgias, migraine, myofacial dysfunctions and cervical arthritis. This knowledge will be useful for practitioners to avoid misinterpretation of the symptoms such as tonsillar pain, or pain of dental, muscular, or pharyngeal origin.

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