Original Article

HEALTH SCIENCES
MEDICINE

DOI: 10.32322/jhsm.1409589
J Health Sci Med. 2024;7(2):180-184

Evaluation of styloid process elongation: a cross-sectional study

Berkan Altay[1], Elif Çoban[2], Şeyma Kale[2], Özlem Arık[3]

[1]Department of Oral and Maxillofacial Surgery, Faculty of Dentistry, Kırıkkale University, Kırıkkale, Turkiye
[2]Department of Oral and Maxillofacial Surgery, Faculty of Dentistry, Kütahya Health Sciences University, Kütahya, Turkiye
[3]Department of Biostatistics, Faculty of Medicine, Kütahya Health Sciences University, Kütahya, Turkiye

Cite this article as: Altay B, Çoban E, Kale Ş, Arık Ö. Evaluation of styloid process elongation: a cross-sectional study. *J Health Sci Med.* 2024;7(2):180-184.

Received: 25.12.2023 ◆ **Accepted**: 02.03.2024 ◆ **Published**: 25.03.2024

ABSTRACT

Aims: The styloid process is a cylindrical projection of the temporal bone. When the length of the styloid process exceeds 30 mm, it is considered elongated. The aim of this study was to investigate the length, thickness and morphological pattern of the styloid process of patients using panoramic radiography and to evaluate the relationship with age and gender.

Methods: The study is designed retrospective cross-sectional and consisted of 3012 panoramic radiographs from patients routinely referred within the last six months, in which the borders of the styloid process region were clearly visualised on radiographs. Age and gender data of the patients were recorded. Styloid process was evaluated in terms of length, thickness and Langeais classification.

Results: The mean age of the patients was 38.32 years. 34.4% (n:1156) were male and 61.6% (n:1856) were female. The mean styloid process length was >30 for 32% of the patients. The thickness of the right styloid process was 2.73±1.56 and that of the left styloid process was 2.69±1.5. The length of the styloid process ranged between 0-79.98 mm with a mean of 26.12±10.78 mm. Most of the patients were in Langeais Type 1 class in right and left styloid process. There was a statistically significant correlation between the length, thickness and Langeais classification of right and left styloid process ($p<0.01$). There was a statistically significant correlation between age and styloid process length and thickness. Also, styloid process length and thickness were statistically greater in males than females ($p<0.01$).

Conclusion: In this study, the highest prevalence of elongation styloid process in Türkiye evaluated with panoramic radiographs is reported. Although styloid process elongation is mostly asymptomatic, more multicenter studies are needed to investigate the reasons for such a high prevalence.

Keywords: Styloid process, styloid process elongation, prevalence

INTRODUCTION

Styloid process (SP) is a cylindrical projection of the temporal bone located anterior to the stylo-mastoid foramen.[1] SP apex lies between the internal and external carotid arteries anteriorly and inferiorly. This anatomical location is a clinically important formation because it extends lateral to the pharyngeal wall and tonsillar fossa, and the ligaments to which it originates have functions such as mastication and swallowing.[2-5] The length of the SP is between 20-30 mm in the general population, and the SP is considered elongated when it is longer than 30 mm.[1] Panoramic radiographs can be used to determine SP elongation and elongated SP can be classified according to its morphology.[6,7] Langlais et al.[7] classified elongated SP as Type I (Elongated), Type II (Pseudo-articular), Type III (Segmented) based on its morphology.

Typically, an elongated SP is not associated with any pathology. However, in some cases, an elongated SP may be linked to various symptoms such as a sensation of a foreign body in the throat, pain when moving the head, dizziness, dysphagia, facial pain, tinnitus, and trismus. This cluster of symptoms associated with an elongated SP is referred to as Eagle syndrome.[8]

The aim of this study is to investigate the length, thickness, and morphological pattern of the SP using panoramic radiography in patients residing in the Kütahya province of Türkiye, and to evaluate its association with age and gender.

Corresponding Author: Şeyma KALE, seyma.kale@ksbu.edu.tr

METHODS

Ethics

The study, structured as a retrospective cross-sectional analysis, involved patients who regularly sought treatment at the Kütahya Health Sciences University Faculty of Dentistry, Department of Oral and Maxillofacial Surgery. Obtaining approval from the Kütahya Health Sciences University Non-interventional Clinical Researches Ethics Committee, permission with decision number 2022/06-22 was secured. Conducted in accordance with the guidelines outlined in the Helsinki Declaration of Human Rights, the study obtained written consent from each patient.

Sample Size

While power analysis was performed; Since it was a prevalence (%, prevalence) study, the incidence of any event (prevalence of SP prolongation for this study) was taken into account. Referencing the study by Şişman et al.[20] a tolerance level (acceptable error) of d=0.05, and a significance level of 0.05 (95% confidence level) were employed for a prevalence of 15. The sample size was calculated with a power value of 80% and the study was planned to include at least 265 patients.

Study Design

During the last six months (January 2022 to July 2022), the study involved the examination of 4151 panoramic radiographs from patients who regularly visited the Kütahya Health Sciences University Faculty of Dentistry, specifically the Department of Oral and Maxillofacial Surgery. 1139 patients in whom the borders of the SP region could not be seen on panoramic radiograph were excluded from the present study. The study was conducted with 3012 panoramic radiographs. Age and gender data of the patients were recorded. SP were evaluated in terms of length, thickness and Langeais classification. The length of the SP was assessed from the tympanic cavity to its endpoint, categorizing those surpassing 30 mm as elongated. The thickness of the SP was measured at its thickest part. The classification of the SP morphology into Type 1, Type 2, and Type 3 was based on the Langeais criteria (Figure 1).

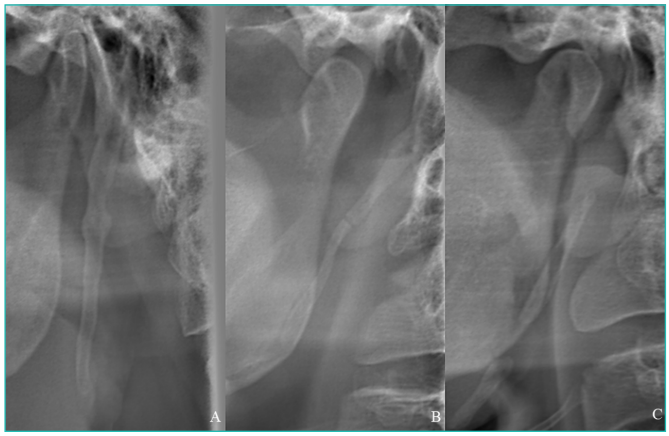

Figure 1. A. Type I SP, B. Type II SP, C. Type III SP

Statistical Analysis

Statistical analyses were performed using IBM SPSS 20 program. Descriptive statistics including minimum, maximum, mean and standard deviation values were used for numerical data. Frequency tables including frequency and percentage values were used for categorical data. Kolmogorov-Smirnov and Shapiro-Wilk tests were evaluated for the suitability of the distribution of the data of numerical variables to normal distribution. Kolmogorov-Smirnov and Shapiro-Wilk tests were evaluated for the suitability of the distribution of the data of numerical variables to normal distribution. Since the sample size was large enough, parametric hypothesis tests were used on data suitable for normal distribution. Independent-Samples T Test was used to show the difference between the two groups in terms of the mean of the numerical variable analyzed. Chi-square test was used to examine the variation and differences between two categorical variables. Pearson Correlation coefficient was calculated to express the direction and level of the relationship between two numerical variables. Phi and Cramer V correlation coefficients were used to calculate the degree and direction of the relationship between two categorical variables. In addition, histograms and bar graphs were used to obtain information about the distribution of the data of the variables. $p<0.05$ and $p<0.01$ were considered statistically significant.

RESULTS

The ages of the patients ranged between 12-90 years with a mean age of 38.32 years. 34.4% (n:1156) of the patients were male and 61.6% (n:1856) were female. The length of the SP ranged between 0-79.98 mm with a mean length of 26.12±10.78 mm. For the mean SP length, the proportion of >30 was calculated as 32%. There were 192 (6.4%) patients with 0 for the length of the right SP and 0 for the thickness of the right SP. There were 203 (6.7%) patients with 0 length of the left SP and 0 thickness of the left SP.

The mean length of the right SP was 26.04±11.46; the mean length of the left SP was 26.20±11.42. There was a positive correlation between the length of the right SP and the length of the left SP at the 77.6% level and it was statistically significant ($p<0.01$; Table 1). The proportion of patients with right SP length >30 was 32.8% and the proportion of patients with left SP length >30 was 33.5%. When the length of the right SP and the length of the left SP were divided into two categories as ≤30 and >30 and the relationship between them was examined; there was a relationship of 64.9% and it was statistically significant ($p<0.01$; Table 2). The rate of those with both right and left >30 is 77.4%. The rate of those with ≤30 in both right and left is 87.9%.

Table 1. Relationships between Length and Thickness of SP According to Regions

	Length of the right SP and length of the left SP	Thickness of the right SP and thickness of the left SP	Length of the right SP and thickness of the right SP	Length of the left SP and thickness of the left SP
Pearson correlation	0.776**	0.478**	0.335**	0.349**
p-value	0.000	0.000	0.000	0.000

**: Correlation is significant at the 0.01 level

Table 2. Relationships between length and classification types of SP

	Length of the right SP and the length of the left SP		Right and left SP classification type
Phi	0.649**	Cramer`s V	0.537**
χ^2	1270.432	χ^2	1588.546
p-value	0.000	p-value	0.000

**: Correlation is significant at the 0.01 level

The thickness of the right SP was 2.73±1.56; the thickness of the left SP was 2.69±1.50. There is a positive correlation between the thickness of the right SP and the thickness of the left SP at 47.8% level and it is statistically significant (p<0.01; Table 1). There is a positive correlation between the length of the right SP and the thickness of the right SP at the level of 33.5%; there is a positive correlation between the length of the left SP and the thickness of the left SP at the level of 34.9% and it is statistically significant (p<0.01; Table 1).

There is a low positive correlation between age and the length of the right SP, the length of the left SP, and the average SP length at approximately 9%, 11%, and 10%, respectively (p<0.01; Table 3). There is a low positive correlation between age and thickness of the right SP, thickness of the left SP, thickness of the average SP with approximately 13%, 14%, 16%, respectively (p<0.01; Table 3).

Table 3. Relationships between age and, length and thickness of SP

	Age	
	Pearson Correlation	p-value
Length of the Right SP	0.087**	0.000
Length of the Left SP	0.107**	0.000
Length of the Left SP	0.103**	0.000
Thickness of the Right SP	0.132**	0.000
Thickness of the Left SP	0.144**	0.000
Thickness of the Average SP	0.161**	0.000

**: Correlation is significant at the 0.01 level

There is a statistically significant difference in the mean age value between individuals with a length of the right SP of 30 and individuals with a length of >30 (p<0.01). The mean age of individuals with a right SP length of >30 was calculated as 39.93±15.30, which was older than the mean age of individuals with a right SP length of ≤30. There was a statistically significant difference in mean age between individuals with a left SP length ≤30 and individuals with a left SP length >30 (p<0.01). The mean age of individuals with a left SP length of >30 was calculated as 39.62±15.49, which was greater than the mean age of individuals with a left SP length of ≤30.

There is a statistically significant difference between female and male individuals in terms of mean right SP length, left SP length and mean SP length values (p<0.01). SP length values were found to be larger in males. There is a statistically significant difference between female and male individuals in terms of mean right SP thickness, left SP thickness and mean SP thickness values (p<0.01). SP thickness values were found to be larger in males.

When the Langeais classification of the right SP was analyzed; the majority of the patients were in Type 1 class. This was followed by Type 3 and Type 2 (Figure 2). 78.4% of the right SP were longer than 30 mm and were Type 1. 8.2% of the right SP were Type 2 and 13.4% were Type 3. When the Langeais classification of the left SP was analyzed; the majority of the patients were in Type 1 class. This was followed by Type 3 and Type 2 (Figure 3). 70.6% of left SP longer than 30 mm were Type 1, 8% were Type 2, and 12.4% were Type 3. There was a 53.7% correlation between right and left SP classification type and it was statistically significant (p<0.01; Table 2). In both right and left SP classification types, 91.9% had type 1, 51.1% had type 2, and 61.3% had type 3.

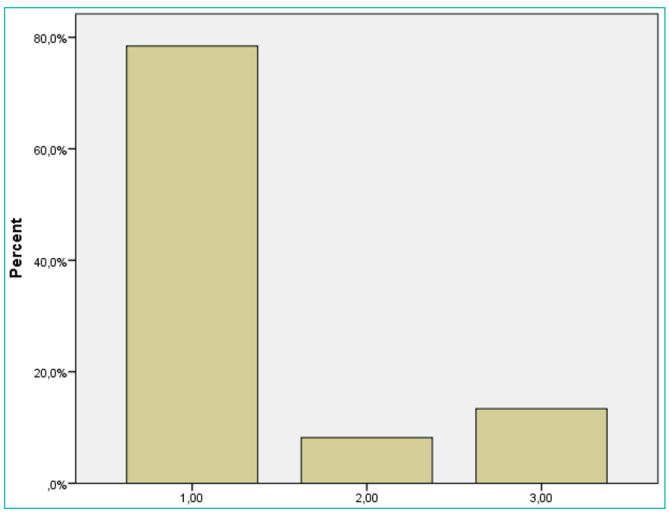

Figure 2. Rates of right SP langeais classification

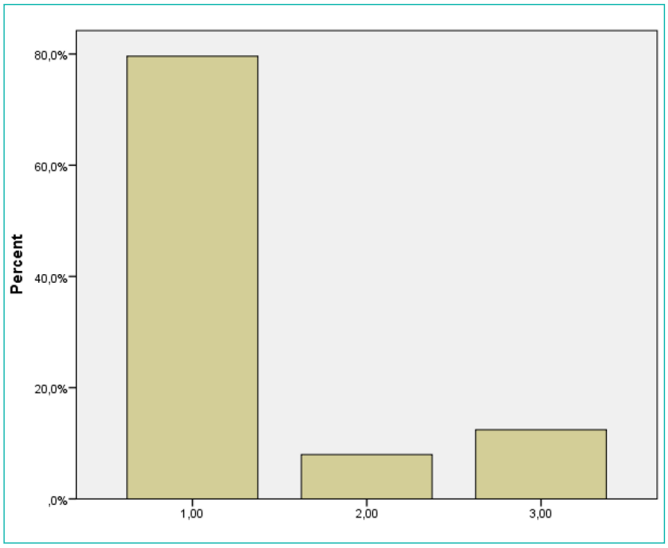

Figure 3. Rates of left SP langeais classification

DISCUSSION

According to the results obtained from present study, the prevalence of SP elongation was found to be 32% in Kütahya, Türkiye. It was observed that the length and thickness of SP increased with increasing age, and this increase was higher in males. Right and left SP length, thickness, and calcification type were related to each other. This study is one of the rare studies evaluating the SP thickness and the relationship between right and left SP length, thickness and morphological type. To the best of our knowledge, it is also the first study that evaluated the highest number of patients, reported the highest prevalence rate, and evaluated SP thickness using panoramic radiographs in Türkiye.

Although elongated SP is usually asymptomatic, various theories have been proposed to clarify its cause.[4,9-11] Studies have reported that congenital etiology is the cause of elongated SP. However, traumatic events in the pharyngeal region such as tonsillectomy, ageing, endocrine disorders, local chronic irritation or inflammation have also been reported to be factors.[4,9,10] Systemic factors related to abnormal serum calcium and phosphorus levels may also be associated with elongated SP.[11] A recent study reported that intraoral inflammatory events associated with root canal treatments may have an association with SP.[12] Renal transplant patients on haemodialysis may also experience elongated SP due to changes in phosphate balance and PTH levels.[13] The exact aetiology of elongated SP is unknown, although many hypotheses have been proposed.[14] According to some authors, SP elongation may be considered a physiological phenomenon.[15] The finding that the right and left SP were morphologically related in this study may indicate that the elongation of SP is influenced by systemic conditions.

The incidence of elongated SP varies in the population.[16] Studies have shown that the incidence of SP formation on panoramic radiographs varies between 4% and 33.4% and the majority of these patients are asymptomatic.[1,8,17,18] In studies conducted in Türkiye, the prevalence of elongated SP ranges from 3.7 % to 7.7%.[19,20] The present study presents a higher prevalence rate compared to studies evaluating patients in Türkiye using panoramic radiographs. In a study evaluating patients in Türkiye with cone beam computed tomography (CBCT), 13% had left, 8% right and 33% bilateral SP elongation.[21]

In a study of patients with temporomandibular disorder (TMD), it was reported that 76% of patients showed elongation of at least one of the SP and the incidence of SP may be high in patients with this disorder.[22] In a study of patients with torus palatinus, it was reported that 15% had SP on at least one side.[23] SP elongation may also be higher in edentulous patients.[24]

The relationship between SP elongation and age is controversial in the literature. SP elongation has been reported to be associated with age and to increase with age in studies.[6,20] However, there are also studies that suggest that it is not associated with age.[25,26] A recent systematic review reported that the length of the SP was longer in females than in males.[27] However, there are also studies that reported that it was similar between genders[3,20,21] or that it was greater in males.[6,28] In the present study, SP length was associated with age and male gender, similar to the results of Shaik MA et al.[6]

Limitations

The limitations of this study include the inability to clinically evaluate patients and the failure to exclude individuals with diseases that may affect bone metabolism. This circumstance prevented direct observation or assessment of clinical symptoms or signs of SP elongation. Moreover, the inclusion of individuals with conditions potentially influencing bone metabolism could impact the generalizability of the results. Hence, future study designs may focus on better controlling factors that may influence bone metabolism.

CONCLUSION

To the best of the authors' knowledge, this study reports the highest prevalence of elongated SP in Türkiye, with a rate of 32%. While elongated SP is predominantly asymptomatic, further research is warranted to explore the underlying reasons for this elevated prevalence. Given the potential involvement of various systemic and environmental factors in SP elongation, multicenter studies involving a larger patient cohort and comprehensive clinical evaluations, particularly focusing on maxillofacial symptoms, are warranted.

ETHICAL DECLARATIONS

Ethics Committee Approval

The study was carried out with the permission of Kütahya Health Sciences University Non-invasive Clinical Researches Ethics Committee (Date: 25.05.2022, Decision No: 2022/06-22).

Informed Consent

Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process

Externally peer reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Financial Disclosure

The authors declared that this study has received no financial support.

Author Contributions

All the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

REFERENCES

1. Bruno G, de Stefani A, Balasso P, Mazzoleni S, Gracco A. Elongated styloid process: an epidemiological study on digital panoramic radiographs. *J Clin Exp Dent.* 2017;9(12):e1446-e1452.
2. Rath G, Anand C. Abnormal styloid process in a human skull. *Surg Radiol Anat SRA.* 1991;13(3):227-229.
3. Scaf G, Freitas DQ de, Loffredo L de CM. Diagnostic reproducibility of the elongated styloid process. *J Appl Oral Sci.* 2003;11(2):120-124.
4. Camarda AJ, Deschamps C, Forest DI. Stylohyoid chain ossification: a discussion of etiology. *Oral Surg, Oral Med Oral Pathol.* 1989;67(5):508-514.
5. Koshy JM, Narayan M, Narayanan S, Priya BS, Sumathy G. Elongated styloid process: a study. *J Pharm Bioallied Sci.* 2015;7(Suppl 1):S131.
6. Shaik MA, Kaleem SM, Wahab A, Hameed S. Prevalence of elongated styloid process in Saudi population of Aseer region. *Eur J Dent.* 2013;7(4):449-454.
7. Langlais RP, Miles DA, Van Dis ML. Elongated and mineralized stylohyoid ligament complex: a proposed classification and report of a case of Eagle's syndrome. *Oral Surg Oral Med Oral Pathol.* 1986;61(5):527-532.
8. İlgüy D, İlgüy M, Fişekçioğlu E, Dölekoğlu S. Assessment of the stylohyoid complex with cone beam computed tomography. *Iran J Radiol.* 2013;10(1):21.
9. Jeyaraj P. Etio-histomorphogenesis of styloid enlargement—a novel and extensive light microscopic analysis of 10 cases of Eagle's syndrome. *Oral Surg.* 2022;15(3):224-233.
10. Fini G, Gasparini G, Filippini F, Becelli R, Marcotullio D. The long styloid process syndrome or Eagle's syndrome. *J Cranio-Maxillofac Surg.* 2000;28(2):123-127.
11. Gokce C, Sisman Y, Sipahioglu M. Styloid process elongation or eagle's syndrome: is there any role for ectopic calcification. *Eur J Dent.* 2008;2(03):224-228.
12. Al-Amad SH, Al Bayatti S, Alshamsi HA. Stylohyoid ligament calcification and its association with dental diseases. *Int Dent J.* 2023;73(1):151-156.
13. Costantinides F, Della Flora F, Tonni I, et al. Elongation of the styloid processes in kidney-transplanted patients: the role of ectopic calcification as possible cause of Eagle syndrome. *Cranio-J Craniomandib Pract.* 2021;39(4):321-325.
14. Reddy RS, Kiran CS, Madhavi NS, Raghavendra MN, Satish A. Prevalence of elongation and calcification patterns of elongated styloid process in south India. *J Clin Exp Dent.* 2013;5(1):e30.
15. Anbiaee N, Javadzadeh A. Elongated styloid process: Is it a pathologic condition. *Indian J Dent Res.* 2011;22(5):673-677.
16. Piagkou M, Anagnostopoulou S, Kouladouros K, Piagkos G. Eagle's syndrome: a review of the literature. *Clin Anat Off J Am Assoc Clin Anat Br Assoc Clin Anat.* 2009;22(5):545-558.
17. Guimarães SMR, Carvalho ACP, Guimarães JP, Gomes MB, Cardoso M de MM, Reis HN. Prevalence of morphological alterations of the styloid process in patients with temporomandibular joint disorder. *Radiol Bras.* 2006;39(6):407-411.
18. More CB, Asrani MK. Evaluation of the styloid process on digital panoramic radiographs. *Indian J Radiol Imaging.* 2010;20(04):261-265.
19. 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;33(1):96-102.
20. Şí şman Y, Gökçe C, Öztürk A, Akgunlu F, Tarım Ertaş E. Prevalence of styloid process elongation on panoramic radiography in the Turkiye population from Cappadocia region. *Eur J Dent.* 2007;2(01):18-22.
21. Öztunç H, Evlice B, Tatli U, Evlice A. Cone-beam computed tomographic evaluation of styloid process: a retrospective study of 208 patients with orofacial pain. *Head Face Med.* 2014;10(1):5.
22. de Andrade KM, Rodrigues CA, Watanabe PCA, Mazzetto MO. Styloid process elongation and calcification in subjects with TMD: clinical and radiographic aspects. *Braz Dent J.* 2012;23(4):443-450.
23. Sisman Y, Gokce C, Tarim Ertas E, Sipahioglu M, Akgunlu F. Investigation of elongated styloid process prevalence in patients with torus palatinus. *Clin Oral Investig.* 2009;13(3):269-272.
24. Akar GC, Alpoz E, Govsa F, Lomcali G. Does the state of dentition effect the type of stylohyoid chain calcification pattern? *Surg Radiol Anat.* 2016;38(7):817-823.
25. Bagga MB, Kumar CA, Yeluri G. Clinicoradiologic evaluation of styloid process calcification. *Imaging Sci Dent.* 2012;42(3):155-161.
26. Swapna LA, AlMegbil NT, Almutlaq AO, Koppolu P. Occurrence of the elongated styloid process on digital panoramic radiographs in the Riyadh population. *Radiol Res Pract.* 2021;2021:6097795.
27. Sridevi K, Mahesh N, Krishnaveni B, Deepika AN, Thejasri V, Leninson BD. Evaluation of styloid process and its anatomical variations: a digital panoramic study with systematic review. *J Int Soc Prev Community Dent.* 2019;9(3):256.
28. Shah SP, Praveen N, Syed V, Subhashini A. Elongated styloid process: a retrospective panoramic radiographic study. *World J Dent.* 2012;3(4):316-319.