

EVALUATION OF STYLOHYOID LIGAMENT CALCIFICATIONS IN THE CENTRAL ANATOLIAN REGION

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ABSTRACT

This study aims to determine the prevalence of the elongated styloid process (ESP) on panoramic radiographs in a Turkish subpopulation and to investigate the relationship between SP lengths and the age and gender of individuals. Digital panoramic radiographs of 1000 patients who applied to Necmettin Erbakan University, Faculty of Dentistry, Dentomaxillofacial Radiology Clinic for the first examination between January 2020 and January 2022 were obtained from the database and examined. Individuals were evaluated by dividing them into three groups according to their age SP lengths were measured on both sides, and those greater than 30 mm were contemplated elongated. The data were evaluated in the SPSS V.21 program. In 1000 evaluated patients, ESP of >30 mm was detected in 304 individuals. It was determined that SP length did not differ according to age groups, gender, and systemic disease ($p < 0.05$). Panoramic radiographs are useful, economical, and easily reachable diagnostic equipment in the diagnosis of symptomatic or asymptomatic ESP. Furthermore, it would be more useful to evaluate the prevalence of ESP with larger sample groups and advanced imaging methods.

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INTRODUCTION

The term styloid process (SP) comes from the Greek vocable “*stylos*” meaning a column. As can be understood from this definition, SP, which has a thin and cylindrical structure, is anatomically located between the internal and external carotid artery, in the anterior part of the temporal bone, anterior to the stylomastoid foramen¹. The average length of SP reported as “normal” in adults is 25 mm². For SP sizes above the normal value, the

definition of the elongated styloid process (ESP) is used³. In 1937 the ESP designation was first defined by Dr. Watt W. Eagle. Eagle syndrome, which is characterized by symptoms such as head, and neck aches, difficulty in swallowing, and foreign body sensation in the throat associated with ESP, is also named after Dr. Watt W. Eagle⁴⁻⁶.

ESP is usually asymptomatic, but approximately 4% of the patients may have symptoms such as vertigo, earache, tinnitus, trismus, dysphagia, and facial pain.

Depending on size, shape, and location, ESP may cause paralysis by compressing the carotid artery⁷. The differential diagnosis of ESP includes many diseases with similar symptoms such as cervical myofascial pain syndrome, glossopharyngeal neuralgia, migraine, trigeminal neuralgia, otitis media, temporomandibular joint pain, tonsilloliths, and atherosclerosis. Therefore, clinicians should know the normal anatomy and abnormalities of SP^{8,9}. There are different theories about the etiology of ESP based on anatomical, embryological, and physiological origins, but the mechanism of ESP formation is still not fully understood².

Different imaging methods such as panoramic radiography, lateral head radiography, computed tomography (CT), and cone beam computed tomography (CBCT) are utilized in the diagnosis of ESP.³ Among these methods, panoramic radiography is the preferred method in the diagnosis of ESP due to its widespread use, low cost, low radiation dose, and showing the entire maxillofacial complex in a single image, and ESP is usually detected incidentally on routine panoramic radiographs^{2,10}.

This study was aimed to evaluate the prevalence of ESP on digital panoramic images in a selected patient group and to evaluate the distribution of the SP length of the patients according to age, gender, and systemic diseases.

MATERIALS AND METHODS

The approval for the study was obtained from the Necmettin Erbakan University Ethics Committee with the number 2023/262. Panoramic images of 1000 patients who applied to Necmettin

Erbakan University, Faculty of Dentistry, Department of Dentomaxillofacial Radiology between January 2020 and January 2022 were obtained from the database, and the study group was formed. Panoramic images were obtained by the same technician in the Morita Veraviewepocs 2D panoramic device (J Morita MFG Corp., Kyoto, Japan) according to the protocol (70 kVp, 5mA, 8 s) recommended by the manufacturer.

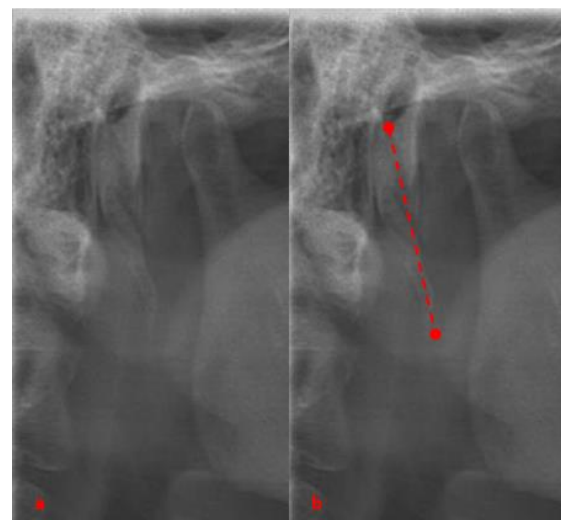


Figure 1. (a) View of SP on panoramic image. (b) Reference points used in SP length measurement; the upper point represents the first point of separation of the SP from the temporal bone, and the lower point represents the inferior extreme point of the SP.

Right and left side SP lengths were measured on each panoramic image. Measurements were made on the images using the length measurement tool available in the current software (Turcasoft). This program is a software that allows length, area, and angle measurements on panoramic images in the digital environment, as well as making sharpness and density adjustments and storing images. In the measurement of SP length, based on the method of İlgüy et al.⁷, the point where the SP first splits from the temporal bone and its extreme point were determined as reference points Figure 1.

The distance between these points was measured with the ruler tool in the Turcasoft program and the length value was calculated as “mm”. Measurements greater than 30 mm in length were considered ESP. The actual sizes in measurements were calculated using a magnification factor of 1.3. O'Carrol and Jackson¹¹ classification was used to evaluate the types of styloid ligament calcification Figure 2. All measurements were performed by a radiologist on a 27-inch flat panel color screen (Dell U2711HTM) with a resolution of 2,560x1,600 pixels, under appropriate lighting conditions. Measurements on 100 panoramic images of randomly selected patients were repeated 3 weeks later to assess intra-observer agreement.

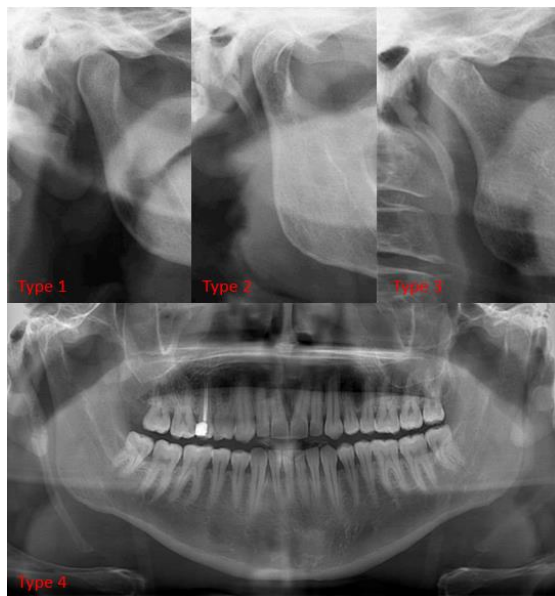


Figure 2. Examples of SP types according to the O'carrol and Jackson classification

The obtained data were transferred to the SPSS 21.0 (IBM Corp., Armonk, NY, USA) program. Descriptive statistics (mean, standard deviation) were determined for all factors in the study. Paired-sample T-test was used to compare right and left measurements. Independent sample T-test and One-Way ANOVA test were performed to evaluate the differences

in the measurements according to gender and age groups. The correlation of the measurements with each other and with the age groups was examined with the Pearson correlation test. Styloid types and age groups, gender, and systemic disease relationship were evaluated by Chi-square test, and a $p < 0.05$ significance level was accepted. Intra-observer agreement for length measurements was assessed by the Cronbach's-alpha test.

RESULTS

Right and left SP lengths were measured on 1000 panoramic images. Intra-observer agreement was found to be quite high (0.924) in the evaluation of the measurements. A total of 1000 (40 ± 15.24) patients [$531 (39.97 \pm 15.1)$ females and $469 (41.88 \pm 15.47)$ males] between the ages of 18-95 were evaluated Table 1.

SP was found to be greater than 30 mm in a total of 304 (30.4%) patients. It was observed that 291 (95.7%) ESPs were bilateral in these patients. It was determined that 169 of the patients with ESP were female (55.6%) and 135 were male (44.4%). The mean length of the right SP was 28.78 ± 7.49 mm, and the left average was 29.12 ± 7.71 mm. As a result of the statistical analysis, it was observed that there was no statistically significant difference between the right and left measurements Table 2.

There was no statistically significant difference between the right and left SP lengths for the genders. In women, the mean right SP was 28.59 ± 7.49 mm, left SP was measured as 28.94 ± 8.18 mm. In men, the mean right SP was 29.01 ± 7.89 mm and the left SP was measured as 29.35 ± 7.28 mm Table 3. Although there

was no significant difference between left and right SP lengths, it was observed that the left SP was longer than the right SP. The shortest right SP was 10 mm, while the left SP is the shortest 10.9 mm. It was determined that the longest right SP was 56.72 mm, and the left SP was 68.91 the longest.

There was no significant difference between right and left SP lengths for age groups Table 4. SP measurements were highest in the 61+ age group and lowest in the 41-60 age group for both right and left

measurements. It was found that right and left SP measurements correlated with each other, but not with age groups Table 5. In the dispersion of SP types according to their age, it was established that the most common Type 1 was in the 18-40 age range, while the least common Type 4 was in patients aged 61 and over. In total, the most common type was Type 1, and the least common was Type 4 Table 6. No statistically significant relationship was found between SP types and both gender and systemic diseases Table 7,8.

Table 1. Descriptive statistics of patients by gender and age

	Female	Male	Total
n	531	469	1000
Mean(Age)	39.97	41.88	40.86
Std. Deviation	15.102	15.475	15.245
Minimum	18	18	18
Maximum	95	89	95

Table 2. Mean values and statistical analysis of right and left SP length measurements

	n	Mean (mm)	Std. Deviation	Correlation	p value
Right Styloid Length	1000	28.78	7.49	0.826	0.504*
Left Styloid Length	1000	29.12	7.71		

Paired Samples T-Test, *p>0.05 There is no statistical difference between the measurements

Table 3. Mean values and statistical analysis of right and left SP length measurements for genders

	Gender	n	Mean (mm)	Std. Deviation	Std Error Mean	Min.	Max.	p value
Right Styloid Length	Female	531	28.59	7.49	0.58	10	54.78	0.657*
	Male	469	29.01	7.89	0.73	11.4	56.72	
Left Styloid Length	Female	531	28.94	8.18	0.63	10.9	63.52	0.755*
	Male	469	29.35	7.28	0.72	11.9	68.91	

Independent Samples Test, *p>0.05 There is no statistical difference between the measurements

Table 4. Mean values and statistical analysis of right and left SP length measurements for age groups

	Age groups	n	Mean (mm)	Std. Deviation	Std Error Mean	p value
Right Styloid Length	18-40	375	28.95	7.41	0.71	0.875*
	41-60	381	28.49	7.33	0.65	
	61 +	244	29	7.8	1.28	
	Total	1000	28.78	7.49	0.77	
Left Styloid Length	18-40	375	29.15	8.42	0.81	0.381*
	41-60	381	28.53	7.47	0.66	
	61 +	244	30.55	7.34	1.19	
	Total	1000	29.12	7.71	0.91	

One-Way Anova, *p>0.05 There is no statistical difference between the measurements

Table 5. Correlation of right and left SP measurements with each other and with age groups

	Age groups	Right Styloid Lengt	Left Styloid Lengt
Age groups	1	0.009	0.032
Right Styloid Length	0.009	1	0.826**
Left Styloid Length	0.032	0.826**	1

Pearson Correlation Test, **Correlation is significant at the 0.01 level

Table 6. SP types and statistical analysis by age groups

		Age Groups			Total	p value
		18-40	41-60	61 +		
Types	Type 1	197	182	81	460	0.039*
	Type 2	81	86	47	214	
	Type 3	83	97	106	286	
	Type 4	14	16	10	40	
	Total	375	381	244	1000	

χ^2 Test, *p>0.05 There is no statistical difference between age groups and SP types

Table 7. SP types and statistical analysis by gender

		Gender			Total	p value
		Female	Male	Percentage		
Types	Type 1	250	210	46	460	0.229*
	Type 2	113	101	21.4	214	
	Type 3	146	140	28.6	286	
	Type 4	22	18	4	40	
	Total	531	469	100	1000	

χ^2 Test, *p>0.05 There is no statistical difference between gender and SP types

Table 8. SP types and statistical analysis by systemic diseases

		Systemic Diseases		Total	p value
		None	Present		
Types	Type 1	370	90	460	0.851*
	Type 2	137	77	214	
	Type 3	204	82	286	
	Type 4	23	17	40	
	Total	734	266	1000	

χ^2 Test, *p>0.05 There is no statistical difference between systemic diseases and SP types

DISCUSSION

In this study, SP length measurements were evaluated with panoramic radiography due to its widespread use, diagnostic performance, low cost, and low radiation dose¹². Cone-beam Computed Tomography (CBCT) is an additional and effective method to accurately diagnose the length, angle, and structure of the styloid chain complex. However, it is not as common as panoramic imaging because it is used in a limited number of patients and cases. Apart from these, other imaging methods used for the evaluation of the styloid process are postero-anterior skull view, Towne's view X-ray, lateral cephalogram, lateral-oblique mandible view, and computed tomography^{3,4}.

The prevalence of ESP varies widely in different populations. Studies have reported that the prevalence of ESP varies between 0.4% and 83.6%^{13,14}. In this study, the prevalence of ESP was found to be 30.4% in the selected patient group. It is reported that this difference between studies is due to differences in measurement and evaluation procedures and differences between races¹⁵. The prevalence of ESP in studies performed with panoramic radiography varies between 4% and 28%^{7,16}. Since the results of our study are in this range, they agree with similar studies.

The use of panoramic radiography in the diagnosis of ESP has been suggested by many researchers^{7,16,17}. This is because it is a simple technique and the entire maxillofacial complex is visualized on a single film^{18,19}. However, it is necessary to be careful in the acquisition and analysis of images and to minimize the distortion that

occurs in panoramic radiography by using the appropriate method. It is also important to calculate the factor of magnification in the image¹⁴. If these criteria are not met, different statistical results may occur in millimetric measurements. In this study, these criteria were carefully evaluated, and panoramic images with low image quality and distortion were not included in the study. In addition, the measurements were carried out by calculating the magnification factor.

Different techniques have been used in the literature for the measurement of SP length. In the measurement of SP length, Jung et al.²⁰ used the distance between the tympanic plain of the temporal bone and the tip of the SP. Guimaraes et al.²¹ on the other hand, the lower border of the ear cartilage was taken as a reference, and the values measured 1 cm and above from this border were accepted as ESP⁷. In this study, the method of İlgüy et al.⁷ was used and values measured at 30 mm and above were determined as ESP.

ESP can be seen unilaterally or bilaterally on panoramic radiographs. In the studies of Guimaraes et al. and Lins et al. bilateral ESP was detected in approximately 84% of the patients^{14,21}. In the study of Andrade et al., the incidence of bilateral ESP was found to be 54%²². In this study, bilateral ESP was found in 96% of the patients with ESP. The reason for this difference may be due to the racial differences between the study groups. Altındağ et al. evaluated SP according to the Jankowski classification and found it to be bilateral at a rate of 80.4%. Although it was studied in the same population, this difference between the results may be due to the use of different study groups and different classifications.

The average reported length of SP in adults is 20-30 mm^{2,12}. Eagle reported that the normal length of SP was approximately 25 mm.²³ Natsis et al.²⁴ in their study on dry skulls, found the mean value of SP length to be 25.2 mm for right-sided measurements and 24.7 mm for left-sided measurements. In this study, the mean length of the right SP was 28.78 mm, and the left SP length was found to be 29.12 mm on average, which was slightly higher.

In the literature, when the prevalence of ESP is evaluated according to gender, it is seen that there are different results. Lins et al.¹⁴, Vieira et al.¹⁵, and Chabikuli and Noffke²⁵ reported that the prevalence of ESP was higher in women than in men, while More et al.¹⁶, Bagga et al.²⁶, Shaik et al.²⁷, and more reported that the prevalence of ESP was higher in men. In this study, the prevalence of ESP was found to be higher in women (56.6%). There was no significant difference in the mean length of SP in men and women. In many studies, it has been reported that gender does not have a significant effect on SP length^{3,24,28,29}. In the study by Nalçacı and Mısırlıoğlu¹⁸ in which they evaluated SP in individuals over 55 years of age, no significant relationship was observed between gender and SP length. However, it was determined that the SP length in men inclined to be longer than in women. Similar results were found in this study.

Jung et al.²⁰ suggested that genders and age groups were equally distributed in their study, and therefore the results of their study were more accurate than other studies. In their study, they observed that the length of SP was bigger in men, and the length of SP increased with age. In the study of Mısırlıoğlu et al.¹⁸, age groups and genders show an equal distribution.

However, their results are different from the results of Jung et al. In the literature, there are different opinions about the age-related increase in SP length. Shaik et al.²⁷, Sokler and Sandev³⁰, and Anbiaee and Javadzadeh³¹ argued that SP length correlated with age. Natsis et al.²⁴, Öztunç et al.³², and Gökçe et al.³³ revealed that there was no correlation between age and SP length. In this study, no significant difference was found between age groups in SP measurements, and no correlation was found between age and SP length.

CONCLUSION

As a result of the study conducted on a limited number of patients, the prevalence of ESP in panoramic radiography was found to be 30.4%. Although the prevalence of ESP was higher in women, SP length measurements did not show significant differences between genders and age groups on average. In addition, there was no significant correlation between SP length and age. To view the SP, panoramic radiography is an easy-to-access and useful method. However, examining it with advanced imaging techniques will reveal more accurate results.

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CONFLICT OF INTEREST

There is no conflict of interest

ETHICS CONSIDERATION

The approval for the study was obtained from the Necmettin Erbakan University Ethics Committee with the number 2023/262.

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AUTHOR CONTRIBUTION

All authors have contributed to all process in this research, including preparation, data gathering and analysis, drafting and approval for publication of this manuscript.

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