



RESEARCH ARTICLE

PREVALENCE OF ELONGATED STYLOID PROCESS IN YEMENI POPULATION OF SANA'A CITY, YEMEN

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Abstract

Background and Aim: The styloid process (SP) is a cylindrical bony projection that originates from the inferior part of the petrous temporal bone, directly in front of the stylomastoid foramen. Numerous ligaments, muscles, and nerves are intimately associated with the (SP). When the measurement is more than 30 mm, it is deemed elongated. ES which is typified by a variety of neck and head pains, as well as tinnitus, earache, trigeminal neuralgia, and headache, is related to the elongation of the SP (ESP). The reason of the survey was to look into the ESP prevalence, shape, and calcification pattern in the Yemeni community in Sana'a City, as well as how these factors relate to subgroups and gender.

Methods: This study explored OPG of 1176 Yemeni subjects over the age of 14 years. Some radiograph together with a suspected SP was disregarded from the study. The obvious SP length was calculated by a single qualified maxillofacial and dental radiologist. The distributions of the SP according to sex, age, different types, styloid process length classifications, and differences in the mean length of the ESP in Yemenis were calculated.

Results: The study screened Yemenis for Eagle syndrome, with 35% males and 65% women, with 49.3% having the condition. Styloid process elongation was categorized into elongated type I (20.4%), segmented type III (15.4%), pseudoarticulated type II (2.9%), and type IV elongation due to distant ossification (4.3%). The mean length of the ESP was 29.97±8.17 mm, with no significant differences detected in different age groups.

Conclusion: With or without symptoms, panoramic radiographs are a cost-effective, readily available, and practical diagnostic technique for the early identification of an extended styloid process. Larger sample sizes, however, would be useful in determining how common this extended styloid process is among Yemenis in different areas.

Keywords: Eagle's syndrome, panoramic radiographs, prevalence, styloid process, Yemeni population.

INTRODUCTION

The phrase "styloid process" refers to a cylinder-shaped structure that frequently emerges from the temporal bone anterior to the stylomastoid foramen, and it comes from the Greek word "stylos", which means post¹. The SP typically has a mean radiographic length of 2 to 3 cm². Because it is positioned among external and internal carotid arteries, the SP apex is clinically significant. The tip of the styloid process is continuous with the stylohyoid muscle, which extends to the smaller cornu of the hyoid bone³. ES may be brought on by the elongation of this SP or the ossification of the

stylohyoid ligament. Pietro Marchetti, an Italian physician, was the first to report this in 1652. Eagle first introduced the word "stylalgia" in 1937 to refer to the pain that the elongation of the styloid process causes when certain vascular and neural structures are compressed⁴. Radiographic sign of an hardened section of the stylohyoid chain has been estimated to be show in 2% to 4% of the worldwide population. The vast majority of these people have no symptoms⁵. There is a weak relationship between the degree of the ossification and the extent of the indications when symptoms do persist. The ESP is most frequently

established via OPG. However, CT is utilized to supplement the data that OPG provides^{5,6}.

Based on the morphological form of elongation, Langlais *et al.*⁷, established a category for ESP: Type I is elongated, Type II is pseudoarticulated, and Type III is segmented and comprises (A) calcified contour, (B) partly calcified, (C) nodular, and (D) entirely calcified, depending on the calcification pattern⁷. Therefore, the goal of this study was to use OPG to ascertain the prevalence of ESP in the Yemeni population of Sana'a city and to analyze the calcification pattern and morphology of ESP in relation to sub-age groups and gender. Due to the lack of earlier studies on the ESP condition or the inadequate number of studies conducted, this research was conducted, which aimed to ascertain the prevalence of the ESP and the shape and pattern of calcification in the Yemeni community in the city of Sana'a, as well as how these factors are related to sub-age groups and gender.

METHODS

Population: The survey was based on 1176 OPG recovered simultaneously from archival registers. Every OPG was selected from our clinics at the Sana'a University Faculty of Dentistry in Sana'a City, Yemen, between 2023 and 2024. Originally, 1176 individuals with dental issues had their OPGs done for routine checkups rather than to investigate potential oral conditions.

Apparatus: As recommended by the manufacturer, all OPG were carried out using the OP200D running at 85 kV and 2.5 mA with a 10-second exposure cycle (Instrumentarium, Finland).

Exclusion criteria: The study excluded radiographs with questionable hyoid bone complex flaws, positioning and magnification issues, and placement over normal anatomical structures.

Inclusion criteria: The selected OPG were of patients over 14 years of age with a maximum age of 70 years. To obtain the percentages of different age groups, the subjects were separated into subgroups 15-19, 20-29, 30-39, 40-49, 50-59, and ≥ 60 years.

Measurement of styloid process: The length of the SP was measured in a manner similar to that described by Ilgüy *et al.*⁸, any SP extending below an imaginary line connecting the anterior nasal spine and the mastoid process was considered elongated; the form of elongation and calcification of the SP on the right and left sides was calculated according to Langlais *et al.*⁷. Dr. Yusra measured the apparent length of the SP with the assistance of an experienced oral and maxillofacial

radiologist and using measuring tools on the accompanying software (Clinic view 9.2, Instrumentarium) with a magnification factor of 1.4.

Data analysis: Data were explained using applicable descriptive statistics. It was performed applying SPSS version 26. Data were illustrated in numbers and percentages. Non-parametric quantitative data were reported in terms of mean and standard deviation (after using Shapiro-Wilk test of normality). At the 5% level, the significance criterion was established. The results were deemed significant when the *p*-value was less than 0.05. The association of ES with gender and age groups among Yemenis screened for ES was analyzed by shaping the OR.

Ethical approval: Sana'a University's Faculty of Dentistry's Medical Ethics Committee granted ethical permission (reference number 22/2023, dated June 1, 2023), and all data including the patient's identity were kept private.

RESULTS

Demographics of individuals who were screened for ES are displayed in Table 1. Males only count 412 (35%), while women count 764 (65%). The common of people were in the 30-39 age group, accounting for 323 (27.5%), followed by the 20-29 age group, accounting for 306 (27.5%), and the 40-49 age group, accounting for 246 and 20.9; other age groups were fewer frequent.

Table 1: Gender and age distributions of Yemenis screened for Eagle syndrome.

Variables	N (%)
Sex	
Male	412 (35.0)
Female	764 (65.0)
Age groups	
15-19 years	82 (7.0)
20-29 years	306 (26.0)
30-39 years	323 (27.5)
40-49 years	246 (20.9)
50-59 years	139 (11.8)
60< years	80 (6.8)
Total	1176 (100)

Table 2 lists the frequency of Eagle Syndrome and its various forms by side among a subset of Yemenis in Sana'a City. Of the people that were tested, 580 (49.3%) had Eagle Syndrome. Taking into account that 429 (36.5%) of the sites exhibit bilateral ES, 74 (6.3%) are unilateral on the left side, and 77 (6.5%) are unilateral on the right.

Table 2: Prevalence of Eagle Syndrome and its different sides among selected Yemenis.

Eagle Syndrome	N (%)	X ²	p
Normal	596 (50.7)	Reference	
Eagle Syndrome (ES) Bilateral	429 (36.5)	48.2	<0.0001
Normal in right with ES in left (Unilateral)	74 (6.3)	568	<0.0001
Normal in left with ES in right (Unilateral)	77 (6.5)	562	<0.0001
Total Eagle Syndrome	580 (49.3)	0.46	0.49
Total	1176 (100)		

Table 3: Prevalence of different classifications of styloid process elongation (C.T.R) based on the type of calcification on the right side of the skull and neck.

Type of calcification in right side	N (%)
Normal	671 (57.1)
Type I (elongated)	240 (20.4)
Type II (Pseudoarticulated)	34 (2.9)
Type III (Segmented)	181 (15.4)
Type IV (Distant)	50 (4.3)
Total	1176 (100)

Type I Elongated- Uninterrupted elongation. Type II – Pseudoarticulated-Styloid process is joined to the mineralized stylohyoid ligament by single pseudo articulation. Type III –Segmented- Short or long non-continuous. Type IV _Elongation of styloid process due to distant ossification.

The prevalence of various ESP (C.T.R.) categories according to the kind of calcification on the right side of the skull and neck is displayed in Table 3. Type I Elongated: 240 (20.4%) features uninterrupted elongation; type II pseudoarticulated: 34 (2.9%) features a single pseudoarticulation connecting the SP to the stylohyoid ligament or mineralized stylohyoid; type III segmented: 181 (15.4%) features short or long noncontinuous elongation; and type IV ESP due to distant ossification counts 50 (4.3%). The prevalence of various ESP (C.T.R.) categories according to the kind of calcification on the left side of the neck and skull is displayed in Table 4.

Table 4: Prevalence of different classifications of styloid process elongation (C.T.R) based on the type of calcification on the left side of the skull and neck.

Types	N (%)
Normal	671(57.1)
Type I (elongated)	238(20.2)
Type II (pseudo articulated)	32(2.7)
Type III (Segmented)	188(16.0)
Type IV (Distant)	47(4.0)
Total	1176(100)

Type I Elongated: 238 (20.2%) features uninterrupted elongation; type II pseudoarticulated: 32 (2.7%) features a single pseudoarticulation connecting the SP to the stylohyoid ligament or mineralized stylohyoid; type III segmented: 188 (16%) features short or long noncontinuous elongation; and type IV elongation of the styloid process due to distant ossification counts 47 (4.0%). Table 5 shows the classification of styloid process elongation (C.T.R.) based on typical calcification on the right side. Calcified outline counting 459 (39%), partially calcified counts 146 (12.4%), nodular counts 282 (24%), and completely calcified counts 289 (24.6%).

Table 5: Classification of elongation of styloid process (C.T.R) based on Pattern calcification in right side).

C.T.R	N (%)
A: Calcified outline	459 (39)
B: Partially calcified	146(12.4)
C: Nodular	282(24)
D: Completely calcified	289(24.6)
Total	1176(100)

CT radiation by angiography.

Table 6 shows the classification of styloid process elongation (C.T.R.) based on typical calcification on the left side. Calcified outline counting 478 (40.6%), partially calcified counts 140 (11.9%), nodular counts 292 (24.8%), and completely calcified counts 266 (22.6%).

Table 6: Classification of elongation of styloid process based on pattern of calcification in left side (C.T.R).

C.T.R	N (%)
A: Calcified outline	478(40.6)
B: Partially calcified	140(11.9)
C: Nodular	292(24.8)
D: Completely calcified	266(22.6)
Total	1176(100)

Table 7 shows the differences of the average length ESP on the left side contrasted to the right side among different age groups for selected Yemenis in Sana'a city. The average length of the ESP on the right side for the total was 29.97 ± 8.17 mm VS 29.93 mm ± 8.5 mm for the left side. There was no important difference on the average length of the ESP on the right side contrasted with the left side for diverse age groups, and there is also no significant important variation between different age groups. Table 8 shows the differences in the average length of the ESP on the right part contrasted to the left part between the sexes selected from Yemenis in Sana'a city. The average length of the ESP on the right part of the male patients was 31.7 ± 9.1 mm versus 29.03 ± 7.4 mm for females and this difference was significant as the ESP was longer in men than in women. There was besides a significant difference in the average length of the ESP on the right part compared to the left side for the male group as the difference between them was -2.68 mm with 95% CI = -3.6480 to -1.7120 , with $p < 0.0001$. Though, there was no significant difference between the left and right sides in the female group ($p = 0.35$). Table 9 shows the differences of the average length ESP on the right part compared to different age groups. There was no significant variant in the average of the length of the elongated styloid process on different age groups in the right side. Table 10 shows the differences in the mean length of the ESP in different age groups on the left part. There was a significant decrease in the mean length of the ESP in the 20-29 age group where the mean was 29.2546 ± 7.3 mm compared to the 15-19 age group where the difference was -2.3 mm with 95%

$CI=-0.43$ to -0.25 , $p=0.025$. There was a significant decrease in the mean length of the ESP in the 30-39 age group where the mean was 28.9 ± 7.6 mm compared to the 15-19 age group where the difference in decrease was -2.6 mm with 95% $CI=-4.6$ to -0.5 , $p=0.01$. Additionally, there were no significant variances in the other age groups compared to the younger age group. Table 11 shows the association of Eagle syndrome with

sex and age groups among Yemenis screened for Eagle syndrome in Sana'a city, Yemen. There was an association between males and Eagle syndrome with the odds ratio for males being 2.1 with 95% CI 1.6-26 and X^2 35.5 and $p<0.0001$. Eagle syndrome, on the other hand, did not significantly correlate with age groups.

Table 7: The differences of the mean length elongated styloid process on the right side compared to the left side among different age groups for selected Yemenis in Sana'a city.

Age groups in Years		Right side/mm	Left side/mm	Difference	95% CI	p
15-19 n=82	Mean	30.8293	31.5024	0.7	-2.5-3.9	0.66
	SD	9.33520	11.50610			
20-29 n=306	Mean	29.3402	29.2546	-0.1	-1.2-1.05	0.86
	SD	7.28856	7.32686			
30-39 n=323	Mean	29.7771	28.9297	-0.8	-1.9- 0.35	0.84
	SD	7.43742	7.60112			
40-49 n=246	Mean	30.2610	30.5817	0.3	-1.3-1.9	0.71
	SD	8.92026	9.44296			
50-59 n=139	Mean	30.4273	30.9554	0.3	-1.3-1.9	0.7
	SD	7.67858	7.73066			
60< n=80	Mean	30.5975	31.2575	0.6	-2.7-3.9	0.72
	SD	11.01508	10.68282			
Total n=1176	Mean	29.9707	29.9370	-0.07	0.74-0.6	0.83
	SD	8.17703	8.54862			

*The difference between the observed means in two independent samples (left/right)

Table 8: The differences of the mean length elongated styloid process on the right side compared to the left side among different sex for selected Yemenis in Sana'a city.

Sex		Right side/mm	Left side/mm	Difference	95% CI	p
Male n=412	Mean	31.7160	32.3699	-2.680	-3.6480 to -1.7120	<0.0001
	SD	9.19749	9.94812			
Female n=764	Mean	29.0295	28.6250	-0.420	-1.3074 to 0.4674	0.35
	SD	7.40735	7.36960			
Total n=1176	Mean	29.9707	29.9370	-0.07	0.74-0.6	0.83
	SD	8.17703	8.54862			

DISCUSSION

Reichert's cartilage and the first and second humeral arches are the sources of the styloid process and ligaments. Reichert's cartilage has been demonstrated to connect the styloid and hyoid bones during fetal development. The styloid ligament may become partially or totally osseous in adults while retaining parts of its embryonic cartilage. These formations could

be the source of the occasional pain and suffering if they solidify. Several explanations have been proposed; however, the precise origin of the elongation is still unclear. It may be because of the growth of bony tissue at the insert of the SL, it may be due to calcification of the styloid ligament by an undiscovered process, or it may be as a result of the resolution of a cartilaginous counterpart of the styloid ligament^{9,10}.

Table 9: The differences of the mean length elongated styloid process on the different age groups in the right side.

Age groups in Years		Right side/mm	Difference	95% CI	p
15-19 n=82	Mean	30.8293		Reference	
	SD	9.33520			
20-29 n=306	Mean	29.3402	-1.5	-3.3-0.37	0.11
	SD	7.28856			
30-39 n=323	Mean	29.7771	-1.1	-3-0.8	0.25
	SD	7.43742			
40-49 n=246	Mean	30.2610	-0.5	-2.7-1.7	0.63
	SD	8.92026			
50-59 n=139	Mean	30.4273	-.04	-2.6-1.8	0.72
	SD	7.67858			
60< n=80	Mean	30.5975	-0.2	-3.3-2.9	0.89
	SD	11.01508			

*The difference between the observed means in two independent samples (left/right).

Table 10: The differences of the mean length elongated styloid process on the different age groups in the left side.

Age groups in Years		Left side/mm	Difference	95% CI	p
15-19 n=82	Mean	31.5024		Reference	
	SD	11.50610			
20-29 n=306	Mean	29.2546	-2.3	-0.43-0.25	0.025*
	SD	7.32686			
30-39 n=323	Mean	28.9297	-2.6	-4.6-0.5	0.01*
	SD	7.60112			
40-49 n=246	Mean	30.5817	-0.9	-3.3-1.6	0.4
	SD	9.44296			
50-59 n=139	Mean	30.9554	-0.6	-3.1-1.9	0.6
	SD	7.73066			
60< n=80	Mean	31.2575	-0.2	-3.6-3.2	0.9
	SD	10.68282			

*The difference between the observed means in two independent samples (left/right).

Table 11: The association of Eagle syndrome with gender and age groups among Yemenis screened for Eagle syndrome in Sana'a City, Yemen.

Variables	N (%)	OR	95% CI	X ²	p
Sex					
Male n=412	252 (61.2)	2.1	1.6-26	35.5	<0.0001*
Female n=764	328 (42.9)	0.47	0.4-0.6	35.5	<0.0001
Age groups					
15-19 years n=82	42 (51.2)	1.1	0.6-1.7	0.12	0.72
20-29 years n=306	144 (47.1)	0.8	0.6-1.1	0.8	0.35
30-39 years n=323	154 (47.7)	0.9	0.7-1.1	0.48	0.48
40-49 years n=246	118 (48)	0.93	0.7-1.2	0.22	0.63
50-59 years n=139	79 (56.8)	1.4	0.9-2.0	3.6	0.059
60< years n=80	43 (52.4)	1.2	0.7-1.9	0.67	0.41
Total n=1176	580 (49.3)				

In the current study, the mean length of the elongated styloid on the right side of the total patients was 29.97 ± 8.17 mm versus 29.93 ± 8.5 mm on the left side (Table 7). As many academics have noted, it is known that the styloid process's length has always varied normally. The pathogenic relevance of segments longer than 30 mm was taken into consideration for examination, because it has been shown that the SP's normal radiographic length is between 2 and 3 mm.

The SP series has numerous variations, such as the degree of process length, angle and direction of deviation, calcification, and segment thickness¹¹. Therefore, in order to characterize each styloid's radiographic appearance, it is required to specify the type of elongation and calcification that it possesses. Therefore, Langlais *et al.*⁷, categorized the SP according to the type of extension and calcification so as to simplify the explanation. The shape and calcification of the SP were described in the current study using a similar classification. In the current study type I Elongated: 240 (20.4%) features uninterrupted elongation; type II pseudoarticulated: 34 (2.9%) features a single pseudoarticulation connecting the SP to the stylohyoid ligament or mineralized stylomandibular; type III segmented: 181 (15.4%) features short or long noncontinuous elongation; and type IV ESP caused by distant ossification counts 50 (4.3%) (Table 3). To determine whether the SP is extended, a OPG is utilized instead of computed tomography¹². In the current research, the average length of the ESP on the right part for the total was 29.97 ± 8.17 mm VS 29.93 ± 8.5 mm for the left part.

There was no visible variation the average the length of the ESP on the right part contrasted with the left side for various age groups, and there is also no visible variation among various age groups (Table 7). This result is like to that described by Shaik *et al.*¹³, in Saudi Arabia where the average SP length was 30.67 ± 6.2 mm. Also, our results were different from the paper operated by Gokce *et al.*, in a populace in Türkiye¹⁴.

There was a visible decrease in the average length of the ESP in the 30-39 age group where the mean was 28.9 ± 7.6 mm compared to the 15-19 age group where the difference in decrease was -2.6 mm with 95% CI=-4.6 to -0.5, $p=0.01$ (decrease the length of the SP with an rise in the age). This is in contrast to what was reported by Shaik *et al.*, in Saudi Arabia where they observed a rise in the length of the SP with age¹³. Our results were also different from studies conducted by different authors in Turkish and Brazilian populations^{15,16}.

In this study, the average length of the ESP on the right side of male patients was 31.7 ± 9.1 mm versus 29.03 ± 7.4 mm in females and this difference was significant as the ESP was longer in males comparing females (Table 8). Our result is constant with the study of Shaik *et al.*, in Saudi Arabia where they observed that the SP was longer in males vs in females and more on the left part than the right part¹³. However, our results were not consistent with the studies by different authors in Skaf *et al.*¹⁵, Shah *et al.*¹⁶, and Balcioglu *et al.*¹⁷, where there was no difference with gender in the mean length of the ESP.

Type I form was the mainly popular manner of morphology seen in all patients (20.4%). Ilgüy *et al.*⁸, observed similar findings in characterize of the most popular form of ESP. Though, they observed that fractional calcification was the most predominant pattern. In the same way, Bagga *et al.*¹⁹, in addition to Reddy *et al.*¹⁸, described parallel findings in terms of the most popular form of SP.

Limitation of the study

The limitations of the current study on the prevalence of elongated styloid process include the sample size, which makes it difficult to generalize the findings, and the reliance on retrospective data that may lack detailed clinical information. Another major limitation is the reliance on panoramic radiography, a two-dimensional imaging technique that may not be sufficient to provide a complete picture compared to three-dimensional techniques.

CONCLUSION

The dentist must be aware of natural variations of the SP, the medical significance of which is not well recognized. ESP is frequently an unintentional asymptomatic radiography result. Therefore, an ESP can be found with appropriate clinical and radiographic assessment. For the rapid identification of ESP with or without symptoms, the OPG are a cost-effective, easily accessible, and useful diagnostic tool. Also, further research in clinical history, habits, signs and symptoms associated with ESP in Yemeni population.

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AUTHOR'S CONTRIBUTIONS

Sharf-Aldeen YAA: Conducted the systematic analysis, developed the concepts, organized the data, and performed the clinical and laboratory examinations. **Al-Shamahy HA:** critical review. **Al-Kabsi TA:** critical review. Final manuscript was checked and approved by all authors.

DATA AVAILABILITY

Upon request, the accompanying author can furnish the empirical data used to bolster the findings of the study.

CONFLICT OF INTEREST

None to declare.

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