

# Elongated Stylohyoid Process: A Pathological or Physiological Phenomenon?

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## Abstract

**Background:** Calcification and morphological variation are fairly common in patients presenting to oral and maxillofacial radiology clinics with stylohyoid complex.

**Objectives:** The present study used digital radiography to investigate in detail whether or not elongated stylohyoid complex is linked to clinical symptoms, gender, and increased age. Finding such relationship can affect the diagnosis of the condition and the selection of treatments.

**Methods:** The present cross-sectional study was conducted on 186 patients aged 30 to 70 presenting to a private oral and maxillofacial radiology clinic in Rafsanjan, Iran, for digital dental panoramic radiography. All the patients completed a demographic questionnaire and clinical symptoms associated with stylohyoid complex. The chi-square test and Fisher's exact test were used to compare categorical variables, while independent two-sample t-test and one-way ANOVA were used to compare quantitative variables, in both men and women and across age groups. The significance level was set at 0.05.

**Results:** A total of 186 participants entered the study, consisting of 90 men (48.4%) and 96 women (51.6%). The mean stylohyoid process size was calculated as  $27.08 \pm 7.80$ . The most common radiographic morphology (on both the right and the left sides) was continuous, followed by pseudo calcified and segmental. The most common calcification pattern observed on both sides was completely calcified pattern, followed by partially calcified pattern, calcified outline, and nodular pattern.

**Conclusions:** According to the results obtained, the calcification and elongation of the stylohyoid process as shown by radiography are more of a physiological than pathological phenomenon that exacerbates with age.

**Keywords:** Styloid-Stylohyoid Syndrome, Elongated Styloid Process Syndrome, Panoramic Radiography

## 1. Background

The stylohyoid complex consists of the styloid process, the stylohyoid ligament, and the lesser cornu of the hyoid bone derived from the first and second pharyngeal arch and Reichert's cartilage (1, 2). The normal length of the styloid process is 20 to 25 mm in adults. Anomalies of the process emerge as the elongation or calcification of the stylohyoid ligament (3, 4).

The ossification or calcification of the stylohyoid ligament normally extends bilaterally down from the base of the skull (5); however, the cause of this calcification remains to be discovered. The elongated styloid process or the ossified stylohyoid ligament is referred to the styloid-stylohyoid syndrome, also known as the Eagle syndrome, the stylohyoid syndrome, or the styloid process neuralgia (1, 3, 6). When ossification occurs with a trauma and it is associated with symptoms such as pain, irritation of

the throat, chronic pharyngitis, pain radiating to the ear and the mastoid, dysphagia and foreign body sensation in the throat, the condition is diagnosed as the Eagle syndrome, which is a relatively common disorder that is often ignored. The condition is diagnosed as the stylohyoid syndrome when the ossification and elongation of the process presents with symptoms but with no history of trauma (2, 4, 5).

The condition is diagnosed as elongated styloid process when the total length of the bony process or its calcified portion exceeds 30 mm in radiographs. Lengths below this value indicate a normal process and those above it indicate an elongated or abnormal process (3, 4, 7, 8). The ossification of the stylohyoid ligament tends to be detected accidentally in panoramic radiographs (5).

When encountering calcified stylohyoid complex or elongated styloid process, most dentists do not know whether the size of the process is normal based on the pa-

tient's age and gender and whether or not the symptoms, pain, and discomfort expressed by the patient indicate a stylohyoid complex (9).

The majority of patients with ossified stylohyoid ligaments shows no symptoms and does not require any treatments; however, treatments such as surgery and injection of long acting local anesthetic may be required in some cases (1-3, 6).

Given that digital radiography produces images with a higher resolution, which can contribute substantially to the accuracy of the measurements and the radiographic views, the present study was conducted to investigate the relationship between stylohyoid complex calcification as detected by digital panoramic radiographs and clinical symptoms, as well as the relationship between radiographic morphology and patterns of calcification of the complex in patients presenting to a private oral and maxillofacial radiology clinic in Rafsanjan, Iran, in 2014.

## 2. Methods

The present cross-sectional study was conducted on 186 patients aged 30 to 70 presenting to a private oral and maxillofacial radiology clinic in Rafsanjan in 2014 for digital panoramic radiography for their dental procedures. Patients with temporomandibular joint disorder, salivary gland disorders, ear infection, or glossopharyngeal neuralgia were excluded from the study after clinical examinations (3, 9).

The patients' radiographs were taken with a digital panoramic system (Planmeca Promax, Helsinki, Finland) with age and size factors particular to each patient. Patients whose base of the temporal bone was not clearly detected in the radiographs due to a poor head position (for measuring the stylohyoid process length) were excluded from the study.

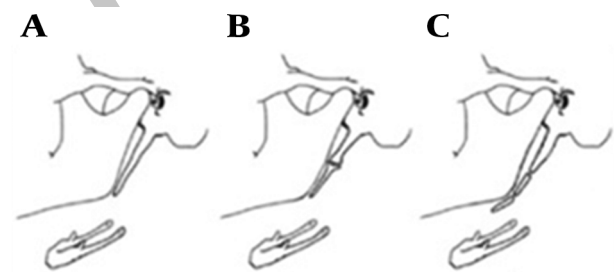
All the patients completed a demographic questionnaire asking about their age, gender, and symptoms associated with the stylohyoid complex such as pain in the throat, sensation of a foreign body in the throat, dysphasia, pain on turning the head, speech or pronunciation disorder, pain on opening the mouth, history of recurrent ear pain, history of recurrent headache, history of recurrent dizziness, and history of losing consciousness. The question and answer method was used in the case of patients who were illiterate or unable to fill out the questionnaire. A code was assigned to each questionnaire. A radiologist then carefully examined the stylohyoid complex on the radiograph on both the left and right sides in terms of size, radiographic morphology, and calcification pattern and recorded them in a checklist with the questionnaire codes.

The length of the stylohyoid complex was measured in mm from the base of the temporal bone to the top of the complex regardless of its continuity or interruption in Planmeca Romexis 3.0.9 and recorded in a checklist.

According to previous studies, a stylohyoid complex with a length of 30 mm or more is classified as an elongated styloid process (ESP) while a complex with a length below 30 mm is classified as a normal complex (10, 11).

The radiographic morphology of the stylohyoid complex was classified into three groups as per the Langlais classification (12). In the continuous morphology, the radiographic appearance is characterized by an uninterrupted integrity of the stylohyoid complex along its entire length. The segmental morphology consists of short or long non-continuous segments of the stylohyoid complex. In the pseudoarticulated morphology, the short or long segments of the stylohyoid complex appear to be joint to each other with a pseudoarticulation (similar to the radiographic appearance of knuckles (Figure 1).

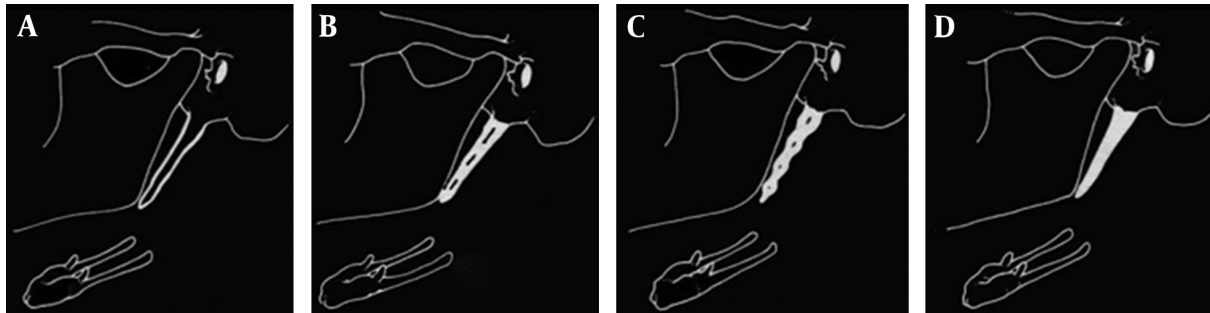
Figure 1. The Morphology of the Stylohyoid Complex



A, Continuous (uninterrupted integrity of the stylohyoid complex); B, pseudoarticulated (the portions of the stylohyoid complex are apparently jointed to each other); C, segmented (noncontinuous portions of the stylohyoid complex)

The calcification pattern of the stylohyoid complex was also examined based on the Langlais classification (12). The complex can take either one of the four classification patterns that exist: (A) Calcified outline; (B) Partially calcified; (C) Completely calcified; and (D) Nodular. The calcified outline indicates that most of the process consists of a central radiolucent area with a thin radiopaque border (similar to the radiographic appearance of a long bone). The partially calcified pattern indicates that the process consists partly of a thicker radiopaque outline and full opacification and small and sometimes interrupted radiolucent centers. The completely calcified pattern indicates that the process is fully radiopaque with no radiolucent interiors. The nodular pattern indicates that the process consists of a scalloped outline and is partially or fully calcified with different degrees of central radiolucency (Figure 2).

To evaluate the intra-observer variability, the stylohy-

**Figure 2.** Calcification Patterns

A, Calcified outline (a thin radiopaque border with a central radiolucency); B, partially calcified (a thicker radiopaque outline and almost complete opacification); C, nodular (a knobby or scalloped outline, with varying degrees of central radiolucency); D, completely calcified (totally radiopaque).

oid process length was measured and the morphology and pattern of calcification and the stylohyoid process were examined two weeks after the initial examination of the panoramic radiographs, and 20 radiographs were randomly selected and reviewed with no knowledge of the initial values.

The data collected were entered SPSS version 21.0 in a set order. The chi-square test and Fisher's exact test were used to compare the radiographic appearances and morphologies, calcification patterns and clinical symptoms in both men and women and in different age groups. The independent two-sample t-test and one-way ANOVA were used to compare the mean length of the process on the left and right sides in both men and women and across age groups. The intra-observer variability was evaluated using the paired t-test (for the mean length of the stylohyoid process) and cohen's kappa coefficient ( $\kappa$ ) (for calcification patterns and radiographic morphology). The level of statistical significance was set at 0.05 for all the tests.

### 3. Results

The present study investigated a total of 186 subjects, including 96 women (51.6%) and 90 men (48.4%). The majority of participants were below 40 years of age (47.3%), while the age group of 50 and older comprised the smallest percentage of the population (21.7%). The 40 - 49 age group comprised 31.0% of the patients.

The study conducted on the stylohyoid process length showed that 104 stylohyoid processes (64.2%) were less than 30 mm long while 58 were longer than 30 mm (35.8%) and therefore considered elongated.

The most frequent clinical symptoms observed included history of recurrent headaches (22.0%), history of recurrent ear pain (10.0%), pain on turning the head (9.7%), history of recurrent dizziness (8.6%), and pain on opening

the mouth (7.5%); none of the clinical symptoms examined in this study were significantly related to age ( $P > 0.05$ ).

The findings of this study showed that the process elongation is not related to any of the clinical symptoms examined regardless of the side involved (Table 1).

Comparison of the relationship between the patients' age and their process length led to the conclusion that the mean length of the stylohyoid complex increases, but not statistically significant ( $P > 0.05$ ), with age.

The most common radiographic morphology observed in the study was continuous morphology (83.3% on the right and 82.3% on the left), followed by pseudoarticulated morphology (16.1% on the right and 14.5% on the left), and segmental morphology (0.5% on the right and 3.2% on the left). The most common calcification pattern observed on both sides was completely calcified pattern (54.8% on the right and 52.2% on the left), partially calcified pattern (24.2% on both the right and the left), calcified outline (18.8% on the right and 21% on the left), and nodular pattern (2.2% on the right and 2.7% on the left). No significant differences were observed between different age groups in terms of radiographic morphology and calcification pattern ( $P > 0.05$ ). The present study calculated the mean process length as  $27.08 \pm 7.80$  mm; on the left side, the mean process length was  $28.22 \pm 8.38$  mm in men and  $26.58 \pm 7.58$  mm in women; on the right side, it was  $28.81 \pm 7.65$  mm in men and  $26.77 \pm 8.62$  mm in women. Although the length of the process was greater in men than in women, the difference was not statistically significant ( $P > 0.05$ ; Table 2). Results also showed that the mean process length, on either side, did not differ across age groups ( $P > 0.05$ ).

No significant differences were observed between the mean length of the stylohyoid process in 20 randomly-selected subjects as blindly read at first and as re-read two weeks later ( $P > 0.05$ ). Comparison of the process length

**Table 1.** The Relationship Between Elongated Stylohyoid Complex and Clinical Symptoms

Variable		Normal Process (n = 97)	Unilateral or Bilateral Elongated Process (n = 89)	P Value
Pain in the throat	Yes	5 (5.2)	5 (5.6)	0.999
	No	92 (94.8)	84 (94.4)	
Sensation of a foreign body in the throat	Yes	1 (1.0)	5 (5.6)	0.106
	No	96 (99.0)	84 (94.4)	
Dysphasia	Yes	3 (3.1)	6 (6.7)	0.315
	No	94 (96.9)	83 (93.3)	
Pain on turning the head	To the right	1 (1.0)	2 (2.2)	0.968
	To the left	3 (3.1)	3 (3.4)	
	On both sides	5 (5.2)	4 (4.5)	
	None	88 (90.7)	80 (89.9)	
Speech or pronunciation disorder	Yes	6 (6.2)	4 (4.5)	0.749
	No	91 (93.8)	85 (95.5)	
Pain on opening the mouth	Yes	9 (9.3)	5 (5.6)	0.345
	No	88 (90.7)	84 (94.4)	
A history of recurrent ear pain	The right ear	3 (3.1)	3 (3.4)	0.672
	The left ear	3 (3.1)	3 (3.4)	
	Both ears	4 (4.1)	1 (1.1)	
	None	87 (79.7)	82 (92.1)	
A history of recurrent headache	Yes	25 (25.8)	16 (18.0)	0.200
	No	72 (74.2)	73 (82.0)	
A history of recurrent dizziness	Yes	10 (10.3)	6 (6.7)	0.386
	No	87 (89.7)	83 (93.3)	
A history of losing consciousness	Yes	1 (1.0)	2 (2.2)	0.607
	No	96 (99.0)	87 (97.8)	

on the left and right sides as measured at the first and second times revealed Cohen's kappa coefficient to be 1 ( $\kappa = 1$ ), indicating fully consistent morphologies between the two measurement times. Comparison of calcification patterns on the left side between the two measurement times revealed Cohen's Kappa Coefficient to be 0.876 ( $\kappa = 0.876$ ), indicating an acceptable consistency; on the right side, this coefficient was calculated as 0.985 ( $\kappa = 0.985$ ), indicating a full consistency between the measurements.

#### 4. Discussion

The stylohyoid process consists of three parts: styloid process, stylohyoid ligament, and lesser cornu of the hyoid bone; together, they make up the stylohyoid complex (1, 2). An increase in the styloid process length and calcification of the stylohyoid complex can lead to the styloid

or the Eagle syndrome. Calcification and morphological variation is relatively common in patients presenting to oral and maxillofacial radiology clinics with the stylohyoid complex (3, 4).

The mean process length was measured as  $27.08 \pm 7.80$  mm in this study, while previous studies have reported it to be 10 to 36 mm. The variation in the values reported may be due to differences in the study populations' ethnicity and age (4, 9, 13). A variety of factors such as panoramic magnification and the angle between stylohyoid process and cranial base may have also affected the measurements (4).

The present study examined the mean length of the stylohyoid complex in age groups of below 40, 40 to 49, and 50 and above, and found that the length of the stylohyoid complex increases with mean age, although the increase is not statistically significant. The results of studies conducted by Okabe (13), Ballbuena (9), Krenmair (14), Ocarell

**Table 2.** Comparison of the Mean Process Length and Frequency Distribution of Morphology and Calcification Pattern by Gender

Stylohyoid Complex		Men (n = 90), No. (%), Mean $\pm$ SD	Women (n = 96) No. (%), Mean $\pm$ SD	P Value	
Left	Process Length (mm)	28.22 $\pm$ 8.38	26.58 $\pm$ 7.58	0.162	
	Radiographic Morphology	Continuous	73 (81.1)	80 (83.3)	0.557
		Pseudo	15 (16.7)	12 (12.5)	
		Segmental	2 (2.2)	4 (4.2)	
	Calcification Pattern	Outline	20 (22.2)	19 (19.8)	0.010
		Partial	29 (32.2)	16 (16.7)	
		Nodular	4 (4.4)	1 (1.01)	
Completely		37 (41.1)	60 (62.5)		
Right	Process Length (mm)	28.81 $\pm$ 7.65	26.77 $\pm$ 8.62	0.974	
	Radiographic Morphology	Continuous	76 (84.4)	79 (82.3)	0.554
		Pseudo	13 (14.4)	17 (17.7)	
		Segmental	1 (1.1)	0	
	Calcification Pattern	Outline	24 (26.7)	11 (11.5)	0.022
		Partial	21 (23.3)	24 (25.0)	
		Nodular	3 (3.3)	1 (1.0)	
Completely		42 (46.7)	60 (62.5)		

Abbreviation: SD, standard deviation.

(15), Anbiaee (4), and Radfar (16) revealed a direct relationship between mean length of the stylohyoid complex and increased age. Although most of the studies were descriptive and cross-sectional in design and did not examine the patients' longitudinal timeline against the elongated styloid process, they found that this relationship held between the two variables; considering this probability, calcification of the stylohyoid ligament and the elongation of the process as shown by radiography are more of a physiological than a pathological phenomenon that exacerbates with age.

The results of the present study indicate that the mean length of the stylohyoid complex is higher in men than in women on both sides; however, the difference is not statistically significant. The results of studies by Ezzaddini (8), Anbiaee (4), Ballbuena (9), and Bozkir (3) indicated the lack of a relationship between gender and elongation of the stylohyoid complex; however, Okarrel (15) and Jung (17) linked elongation to gender, stating that process elongation is more prevalent in women than in men. The disparity of findings may be attributed to differences in the study methods, sample size, and population; nevertheless, this difference is negligible, as gender has a little effect on the increased elongation of the stylohyoid complex.

The completely calcified pattern was the dominant pat-

tern of calcification in the stylohyoid complex and continuous appearance was the dominant morphology observed in all the age groups. Ilguy (18) and Anbiaee (4) obtained similar results.

The present study found no relationships between clinical symptoms and increased age. Radfar (16) and Bullbuena (9), however, found that the intensity of clinical symptoms such as pain in the head and neck, coughing, and foreign body sensation in the throat are associated with the intensity of the complex elongation; nevertheless, they did not find any relationship between the intensity of clinical symptoms and the mean age. The results of these two studies are consistent with the results obtained in the present study suggesting the lack of a relationship between increased age and increased intensity of symptoms. It should be noted, however, that the present study did not examine the intensity of symptoms.

#### 4.1. Conclusion

Calcification of the stylohyoid ligament and the elongation of the process as shown by radiography are more of a physiological than a pathological phenomenon that exacerbates with age.



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## Footnote

**Conflicts of Interest:** We have no conflicts of interest

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