

BATI KARADENİZ BÖLGESİNDE UZAMIŞ STİLOİD PROÇESİN KONİK IŞINLI BİLGİSAYARLI TOMOGRAFİ İLE DEĞERLENDİRMESİ

Assessment of Elongated Styloid Process with Cone-Beam Computed Tomography in Western Part of the Black Sea Region

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ÖZET

Amaç: Bu çalışma Türk populasyonunda uzamış stiloid proçes morfolojisini, prevalansının cinsiyet ve yaş ile ilişkisini değerlendirmeyi amaçlamıştır.

Gereç ve Yöntem: 170 hastanın Konik Işınli Bilgisayarli Tomografi (KİBT) görüntüleri değerlendirildi. Çalışmaya dahil edilen hastaların yaş ve cinsiyetleri kaydedildi. Uzamış stiloid proçesin morfolojisi analiz edildi ve prevalans belirlendi. Uzamış stiloid proçeslerin ortalama uzunluğu ölçüldü.

Bulgular: 170 hastanın (340 stiloid proçes) 68'inde (40%) uzamış stiloid proçes gözlemlendi. Ortalama uzunluk 35.25 mm olarak bulundu. 170 hastanın 4'ünde (2.4%) uzama sağ tarafta, 28'inde (16.5%) sol tarafta, 36 (21.2%) hastada bilateral olarak görüldü. Çalışmamızda, en sık görülen morfoloji Tip 1 olarak bulundu. En sık görülen kalsifikasyon paterni ise Tip D olarak gözlemlendi.

Sonuç: Bu çalışmada, KİBT, stiloid proçesin değerlendirilmesi ve ölçümü için panoramik radyograflara alternatif bir metod olarak sunuldu.

Anahtar Kelimeler: Anatomik varyasyonlar; Konik ışınli bilgisayarli tomografi; Uzamış stiloid proçes

ABSTRACT

Objective: This study aimed to evaluate the prevalence and morphology of elongated styloid process and its relation to gender, age and location in Turkish population.

Materials and Methods: Cone beam computed tomography (CBCT) images of 170 patients were evaluated. Age and gender of the patients who were included in this study were recorded. Morphology of elongated styloid process was analyzed and prevalence was determined. Mean lengths of elongated styloid processes were measured.

Results: Elongated styloid process was observed in 68 (40%) of 170 patients (340 styloid processes). Mean lengths of elongated SP were 35.25 mm. Elongation was observed in right side in 4 (2.4%) of 170 patients while was observed in left side in 28 (16.5%) patients and it was seen bilaterally in 36 (21.2%) patients. In our study, the most frequent morphology was observed as Type 1. The most common calcification pattern was Type D.

Conclusion: In this study, CBCT was presented as an alternative method to panoramic radiographs for the measurement and the assessment of the styloid process.

Keywords: Anatomic variations; Cone-beam computed tomography; Elongated styloid process

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INTRODUCTION

The styloid process (SP) is thin and sharp which locates anteroinferiorly from the temporal bone inferior side (1). The SP embryologically develops from the Reichert's cartilage of the second pharyngeal arch with the stylohyoid ligament and the lesser horn of hyoid bone which creates a formation termed as stylohyoid apparatus or stylohyoid complex (2). The SP length is normally about 20-30 mm (3). When the length of SP is longer than this average, the term of elongation is mentioned (2). This SP elongation or ligaments' calcification causes the stylohyoid syndrome or Eagle syndrome. This syndrome was first mentioned by Eagle who was an otorhinolaryngologist. The SP tapers in the direction of its edge that reaches in the pharyngeal wall. There are many important neurovascular structures close to SP such as the internal carotid artery, internal jugular vein, and cranial nerves X, XI, and XII that exist in the medial way of SP (3). This syndrome may be diagnosed as unilateral or bilateral. It is supposed that the compression of the SP on some neurovascular structures causes the symptoms such as dysphagia, recurrent throat pain, sense of foreign mass, headache, otalgia, pain during mouth opening, rotation of the neck and tongue extension, dizziness, chewing problem, voice change and hypersalivation (4).

Radiographic and clinical examination are important to diagnose elongated SP and Eagle's syndrome. The differential diagnosis should be carefully reviewed. The list of differential diagnoses are dysfunctions of temporomandibular joint, tumors of tongue base, and trigeminal and glossopharyngeal neuralgia (5), besides migraine states, myofascial pain, unerupted third molars and cervical arthritis (6).

Because of the closeness to some important structures, it is important to know variance of SP for clinicians and radiologists. So the aim of this study is to assess elongated SP in Cone Beam Computed Tomography (CBCT) scans according to gender and location (unilateral or bilateral). The length of the elongated SP was measured. Calcification and elongation patterns were classified.

MATERIAL AND METHODS

The ethical approval was approved by the Abant İzzet Baysal University Ethical Committee (Institutional review board number: 2018/145). CBCT scans of all patients who referred to Abant İzzet Baysal University Dentomaxillofacial Radiology Department in 2016-2017 with various reasons were retrospectively analyzed. 340 styloid processes were evaluated, belonging to the archive from a Dentomaxillofacial Radiology Department of Abant İzzet Baysal University.

The subject comprised 94 females and 76 males. Age range was from 18 to 88. These scans were obtained from i-CAT (120 KvP, 7 mA; Imaging Sciences International, Hatfield, PA).

The scans were provided considering the recommendation of manufacturer. Only high-quality scans were included in the study. Any CBCT scan with questionable SP was excluded from the study. Morphology of elongated SP was evaluated and prevalence was determined. Mean lengths of elongated SPs were measured. Measurements were performed from the point where the styloid process left the tympanic plate to the apex of the process. The SPs which were longer than 30 mm were evaluated as elongated. The lengths of the SP were measured with the help of the measurement tools on the accompanying software.

Elongation of SP was analyzed as unilateral or bilateral, and classified according to the system of Langlais et al. (7) The classification of Langlais et al. (7) about elongated SP is based on three types of complex—Type I, elongated; Type II, pseudoarticulated; and Type III, segmented (Figure 1).

According to the study of Langlais et al. (7) the calcification patterns (Figure 2) were categorized as follows:

Type A: External Calcification (outline): Uninterrupted SP with no presence of calcification.

Type B: Partial Calcification: Radiopaque calcified segments of SP are present.

Type C: Nodular Calcification: Nodular appearance, radiopaque calcification of SP is observed.

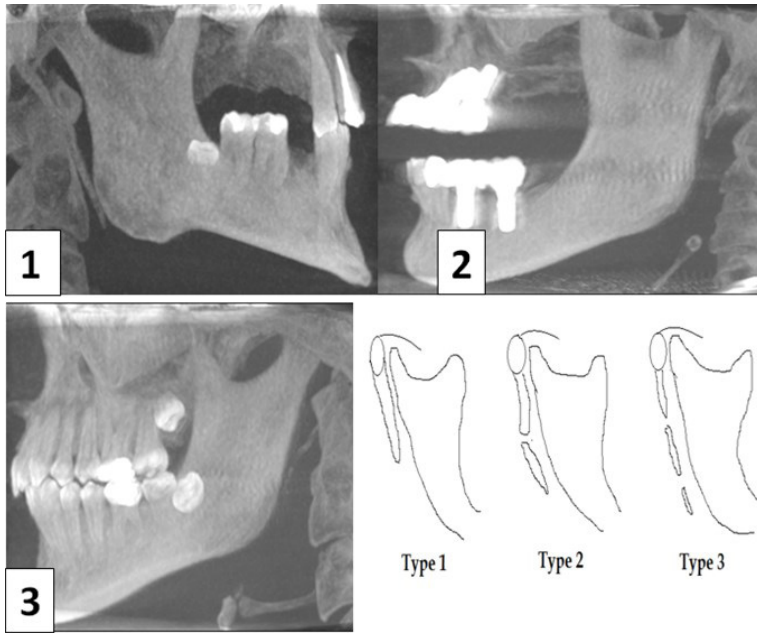


Figure 1. Sagittal CBCT scan shows Type 1, Type 2 and Type3 elongation. (Drawing based on Bagga et al.(18) according to the classification of Langlais et al.(7))

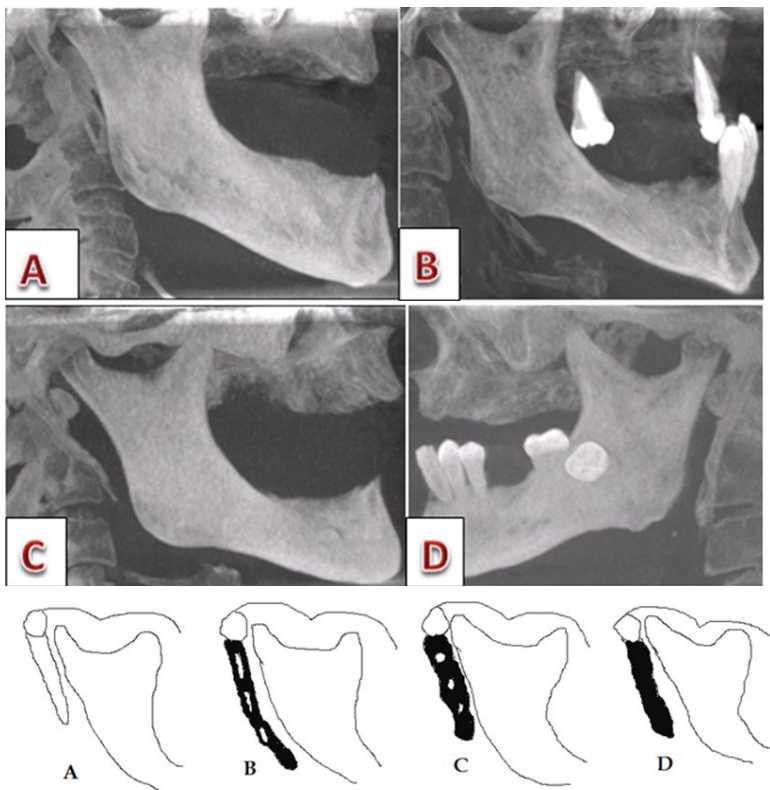


Figure 2. Sagittal CBCT scans show type A,B,C and D. (Drawing based on Bagga et al.(18) according to the classification of Langlais et al.(7))

Type D: Completely Calcified: In this type, SP is seen as homogeneously radiopaque and calcified.

The relationships between age and dimensions of left and right SP were also investigated.

The descriptive values of the data were calculated as number, frequency, mean \pm SD and provided as tables. Independent samples t-test was used for the dimension and age differences between gender. Paired samples t-test was used for comparison of left and right dimension of styloid process.

RESULTS

94 (55.3%) of 170 patients were female and 76 (44.7%) patients were male. The mean age was 39.8. SP of 102 patients were not elongated. In 4 of them (2.4%), the right process was elongated, 28 (16.5%) had left elongated process and 36 (21.2%) had bilateral elongated process (Table 1 and Figure 3).

Out of a total 340 SPs, elongation was determined in 136 (40%). Bilateral elongation was more frequently found than the unilateral elongation.

Table 2 provides descriptive informations about age, right and left dimension and mean dimension. The significant difference was not found between right and left dimension (P=0.933). Table 3 shows descriptive informations about age and dimension of male and females. No statistically significant differences were found between age and dimensions.

The most observed type was type 1. In right side, 30 (17.6%) patients had Type 1 elongated process, 4 (2.4%) had Type 2 and 2 (1.2%) had Type 3. 10 (5.9%) patients had Type A in right side, 2 (1.2%) had Type B, 12 (7.1%) had Type C and 16 (9.4%) had Type D elongated process. However, in left side, 38 (22.4%) patients had Type 1 elongated process, 2 (1.2%) had Type 2 and 2

Table 1. Distribution of elongation localization

	N	%
No Elongation	102	60,0
Right	4	2,4
Left	28	16,5
Bilateral	36	21,2
Total	170	100,0

Table 2. Descriptive values about age and dimension

	N	Minimum	Maximum	Mean	Std. Deviation
Age	170	18	88	39,80	19,35
Right dimension	38	30,0	50,0	35,347	6,03
Left dimension	50	30,0	52,0	35,18	5,72

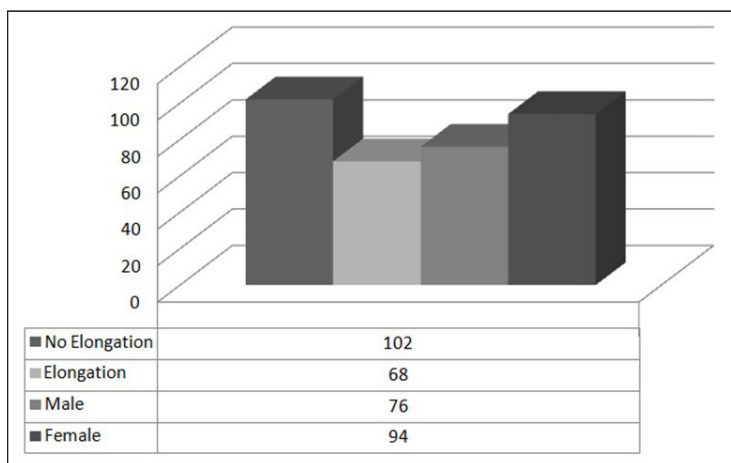


Figure 3. The diagram shows the number and percentage of the distribution of styloid process elongation according to gender.

(1.2%) had Type 3. 12 (7.1%) patients had Type A in right side, 12 (7.1%) had Type C and 28 (16.5%) had Type D elongated process. Type B elongated process wasn't observed in left side (Table 4).

Table 3. Descriptive values about age and measurements

	Gender	N	Mean	Std. Deviation	p
Age	M	76	42,16	20,417	0.315
	F	94	37,89	18,456	
Right dimension	M	16	36,5888	6,61398	0.460
	F	22	34,4455	5,72143	
Left dimension	M	22	34,945	6,5326	0.860
	F	28	35,364	5,2453	

Table 4. Calcification and Elongation pattern in the study sample

	Right	Left
Type A	10 (5.9%)	12 (7.1%)
Type 1	30 (17.6%)	38 (22.4%)
Type B	2 (1.2%)	-
Type 2	4 (2.4%)	2 (1.2%)
Type C	12 (7.1%)	12 (7.1%)
Type 3	2 (1.2%)	2 (1.2%)
Type D	16 (9.4%)	28 (16.5%)
Total	76	94

The measurements of SPs were performed and were found ranging from 30 to 52 mm. Mean length was found as 35.25 mm.

DISCUSSION AND CONCLUSION

SP elongation is an uncommon situation and it isn't frequently observed in clinical examination. Eagle's syndrome is occurred because of SP elongation and is observed with various symptoms (8). However, Frommer reported that the direction and curvature of SP is more significant than length for causation of symptoms (9).

There are several studies about SP elongation in the literature (Table 5). To the best of our knowledge, the panoramic radiographic studies were more than the

studies with CBCT. So, this was our motivation to do this study.

Lins et al. (10) studied 2500 panoramic radiographs and found 216 (8.64%) elongated SP. In our opinion, higher result of this study is related to the lower number of panoramic radiographs. Öztunç et al. (11) was assessed 208 patients, 112 (54%) had elongated SP. This high result may arise from the use of CBCT. Contrary, type 2 was most frequently found in their study. Similar to study of Lins et al. (10) and Öztunç et al.(11) , in our study, the majority of patients had bilateral elongation (21.2%).

However, there is some studies that reported less results with using CBCT. According to the study of İlgüy et al. (12), the CBCT images of 69 patients were evaluated and the mean length of stylohyoid complex was found as 28.2 mm for males and 22.5 mm for females. In our study, the mean length of styloid process was 34.8 mm for females and 35.7 mm for males. Donmez et al.(13) also reported the prevalence of elongated SP as 15.1% (151 patients with elongated SP of total 1000 patients) using CBCT. According to their study, type 1 was the most common type of SP on both sides while Type 2 was the least common type on both sides. Differently, type 3 was the least common type in our study.

Marçal Vieira et al.(14) reported that 323 of 736 patients (43.89%) had elongated SP and 36.28% of them had bilateral elongation. In our study, this rate was 40% and 21.2% of the patients had bilateral elongation.

The results of our study revealed a high prevalence (40%) of elongated SP in a Turkish population. This prevalence is higher than the study of Mathew et al. (35%), Rizzatti-Barbosa et al., (20%) and Leite et al., (19.56%) but lower than the study of Bagga et al. (52.1%), de Andrade et al. (76%). (15-19) Alzarea et al.(20) also reported a high prevalence (43.93%) of the elongated SP and found that type I elongation was more common which is similar to our study.

Table 5. Detailed information about elongated SP in previous studies.

Author	Year	Imaging Modality	Total patients number	Prevalence of SP	The most frequent location	The most frequent types	The length of SP
AlZarea BK. (20)	2017	Panoramic radiography	198	87 of the 198		Type 1	28.75±8.36 (right side) 29.05±8.49
Bagga et al. (18)	2012	Panoramic radiography	2706	52.1%	5.2% left side 5.4% right side 41.5 % bilateral	Type 1/Pat-tern B	8.47±0.57mm (left side) 8.42±0.55mm (right side) 7.56±1.11mm (bilateral)
Donmez et al. (13)	2017	CBCT	1000	15.1%	92.1% bilateral	Type 1	30.05 to 85.49 mm (right side), 30.14 to 83.72 mm (left side)
İlgüy et al. (12)	2013	CBCT	69	-	-	-	22.57±6.02 (in females) 28.21±14.36 (in males)
İlgüy et al. (36)	2005	Panoramic radiography	860	3.7%	Most being bilateral	Type 1/Type B (left side), Type D (right side)	34 ± 8 mm (left side), 35 ± 15 mm (right side)
Kursoglu et al. (22)	2005	Panoramic radiography	55	83.6%	38 elongated SP in right side, 39 in left side	Type 1/Type A	-
Lins et al. (10)	2015	Panoramic radiography	2500	8.64%	84.7% bilateral	Almost calcified/elongated	35.5mm (left side);37.6mm (right side)
Marçal Vieira et al. (14)	2015	Panoramic radiography	736	43.89%	36.28% bilateral	-	-
Mathew et al. (15)	2017	Panoramic radiography	100	35%	-	Type 1/Type A	-
More and Asrani (25)	2010	Panoramic radiography	500	19.4%	66 of 97 bilateral	Type 1	25.41 ± 6.32 mm (left side) 25.53 ± 6.62 mm (right side)
Öztunç et al. (11)	2014	CBCT	208	54%	28 (13%) left, 16 (8%) right side, 68 (33%) bilateral	Type 2/Pat-tern B	3.62 ± 0.48 cm (in males) 3.81 ± 0.84 cm (in females)
Reddy et al. (21)	2013	Panoramic radiography	260	154 of 520	-	Type 1/Type D	3.67±0.62 cm (the mean)
Roopashri et al. (24)	2012	Panoramic radiography	300	107 Of 300	78.5% bilateral	Type 1	-
This study	-	CBCT	170	40%	21.2% bilateral	Type 1/Type D	34.8 mm (in females), 35.7 mm (in males) 35.3 mm (right side) 35.2 mm (left side)

In the study of Reddy et al. (21), type 1 and type D was commonly found. Kursoglu et al. (22) also found that type 1 was most frequently observed. These results are consistent with our study result. In the study of Shaik et al.(23), they observed that type 1 and type A were the most frequent types. In our study, we found that type 1 was the most common type but type D was the most frequently observed type. Few other studies also reported similar result about type 1 majority (24-26). Bilateral elongation was most commonly observed than unilateral elongation in the present study. This result was consistent with the other reports. (24,27-29) However, Scaf et al. (30) reported that the majority of the elongated SP was unilateral. They also reported that SP elongations were commonly observed in males than females. However, in the study of Bozkir et al.(27) and Roopashri et al.(24), it was reported that bilateral elongation was frequently observed in females than unilateral elongation. Similarly, we found the slight female predominance in our study.

In this study, the length of the elongated SP on the left side was significantly more when compared to the right side. This result was consistent with the study of AlZarea et al.(20), Bozkir et al.(27), Vadgaonkar et al.(31), Roopashri et al.(24) and Shaik et al.(23) However, More and Asrani (25) reported that the SP elongation was more frequently observed on the right side.

Öztunç et al. (11) and Nalçacı et al.(32) reported that age wasn't found to be statistically significant for elongated SP. Similarly, in our study, no statistically significant differences were found between age and dimensions of SP.

Tunçdemir et al.(33) reported an hypothesis about possibility of relationship between bruxism and SP elongation. As a result, it was found that there is statistical significance differences between bruxism patients and control group. According to our study result, to explain the reasons of variations between individuals, reported studies about additional parameters such as missing teeth, bruxism, unilateral mastication will be helpful.

Elongated SP is generally observed as asymptomatic finding, and its etiology is still unclear. Several hypotheses are mentioned as pathogenesis: Stylohyoid ligament ossification, reactive metaplasia or hyperplasia, anatomical alteration or developmental disorder, aging and trauma causing elasticity loss in the stylohyoid ligament (18). Clinical and radiologic evaluation is essential for diagnosis of elongated SP. A signal of elongation is SP which may be palpated in the tonsillar fossa (4). For diagnosis of elongated SP, some modalities are used such as panoramic radiography, computed tomography for the skull base and neck imaging (34).

However, CBCT is majorly used for definitive measurement of anatomical structures in craniofacial area. The advantages of CBCT is dose reduction, rapid scan time and lower costs than computed tomography. For these features of CBCT, it is favorable technique for dentomaxillofacial radiology and surgery departments. This technology provides to clinicians greater image quality, accuracy and sensitivity (35). For this reason, we preferred to use CBCT for diagnosis of elongated SP in Turkish population of Black Sea region.

This study emphasizes that CBCT is an alternative method to computed tomography or panoramic radiographs for the measurement and the evaluation of the SP. The observation of SP is difficult in two dimensional radiographs. However, the studies about SP elongation using panoramic radiography were mostly found but there were less studies about this subject that used CBCT. The size and morphology of the SP can be easily evaluated by CBCT. In CBCT assessment of the head and neck region, the radiologist must notice variation of SP because of its clinical importance. Careful evaluation is important by reason of elongation being asymptomatic that is incidentally realized in scans.

According to the review of English literature, to the best of our knowledge, this study is the first Cone Beam Computed Tomographic evaluation of elongated styloid process in Turkish population of Black Sea region. This study will provide a comparison of the results of the three dimensional imaging with the results of the

reports using the panoramic radiography technique. However, studies with larger patient number would help to evaluate the prevalence of elongated SP in Turkish population.

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