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Evaluation of the length and angulation of the styloid process in the patient with pre-diagnosis of Eagle syndrome*

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Clinical symptoms caused by the elongated styloid process (SP) or calcified stylohyoid ligament were first described by W. Eagle and they are now known as Eagle syndrome (ES). Normal length of SP was stated by Eagle as 2.5 cm. The objective of this study was to determine and discuss the length of SP and medial angulation degree with computed tomography (CT), which is an affective modality in the identification of ES, and a comparison with related studies.

Three-dimensional (3D) images obtained from the axial CT scans of 22 cases (11 males and 11 females) aged between 24 and 80 years, who referred to Cumhuriyet University Hospital, Department of Radiology for multi slice CT with the pre-diagnosis of ES, were used. Lengths of the SP and medial angulations were measured on the obtained images. Inter- and intra-group comparisons were carried out using Wilcoxan and Mann-Whitney U tests.

The mean length of the SP was found as 4.1 ± 1.1 cm. When inter- and intra-group lengths of the right and left SP were compared, the difference was not significant ($p > 0.05$). The mean medial angulation of the SP was found as 67.5 ± 5.1°. There was a significant difference found between the right side medial angulation and left side medial angulation in all persons ($p < 0.05$).

Lengths of the right and left SP of the patients with pre-diagnosis of ES were close to each other. However, the right-side angulation was observed to be smaller than the left medial angulation in all the patients. Similarly, right side medial angulation of the females was smaller than the left side medial angulation, but this difference was absent in the males. Eagle syndrome should be kept in mind in patients with a sore throat radiating to the ears with swallowing and an observed non-compliance between the complaints such as feeling a foreign body in the throat and facial pain, and physical examination of those who do not have a response to long-term medical therapy should be performed. (Folia Morphol 2011; 70, 4: 295–299)

Key words: Eagle syndrome, styloid process, 3-dimensional computed tomography

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INTRODUCTION

Styloid process (SP) is a cylindrical structure in front of the stylomastoid foramen, inferior and anterior, extending from the inferior face of the petrous part of the temporal bone toward the tonsillar fossa between the internal and external carotid arteries. The SP proceeds as the stylohyoid ligament and attaches to the lesser horn of the hyoid bone. The internal jugular vein, vagus, glossopharyngeal, accessories, and hypoglossal nerve, internal carotid artery, sympathetic chain, and sphenomandibular ligament are located at its medial point [22]. Stylohyoid complex includes SP, stylohyoid ligament, and the lesser horn of the hyoid bone. Stylohyoid complex develops from the second branchial (Reichter cartilage) arch. Stylohyoid complex consists of four segments: (1) the tympana-hyal, which is embryologically embedded into the temporal bone; (2) the stylo-hyal, which forms the main structure of SP; (3) the cerato-hyal, which forms the stylohyoid ligament; and (4) hypo-hyal elements, which become the lesser horn of the hyoid [11].

Eagle syndrome (ES), or stylohyoid syndrome, is a disease caused by elongated SP or calcified stylohyoid ligament. Elongated SP and related clinical findings were described by Eagle in 1937. A blunt pain in the pharynx frequently hitting the ear, the feeling of a foreign body in the throat, and swallowing difficulty are the first findings stated by Eagle [7]. On the other hand, ossification of stylohyoid ligament was first defined by Pietro Marchetti in 1652 [10]. Elongated SP is one of the reasons for head and neck pain [11]. Accurate diagnosis is important since its signs are similar to those of the other diseases in this area. Establishment of the diagnosis with clinical findings alone is difficult and should be supported by radiological examination [23].

In this study, the length and medial angulation degree of SP were determined with three-dimensional (3D) images obtained from CT scans of patients with the pre-diagnosis of Eagle syndrome, and the efficiency of the method was discussed.

MATERIAL AND METHODS

Eleven males (Group 1, mean age 44.6 ± 16 years, range: 24–80 years) and 11 females (Group 2, mean age 45.1 ± 12.2 years, range: 26–64 years), a total of 22 patients (mean age 44.8 ± 13.9 years, range: 24–80 years), with pre-diagnosis of Eagle syndrome, referred to the Cumhuriyet University, Department of Radiology for multi-slice computed tomography (CT), were included in the study.

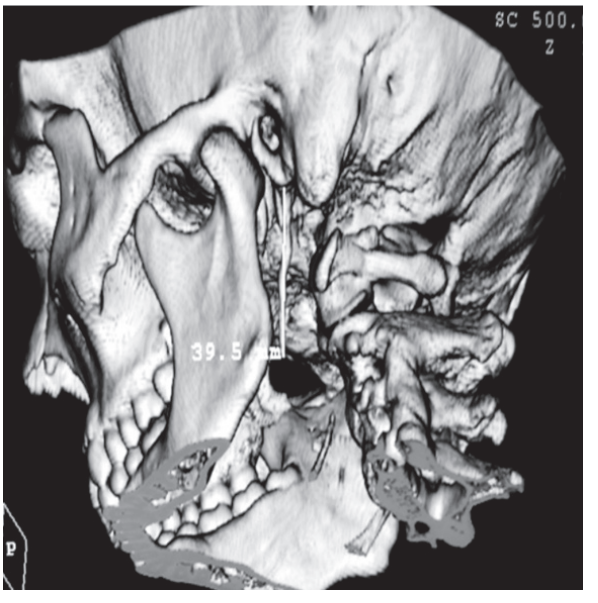

Figure 1. Left styloid process of a 24-year-old case with Eagle syndrome on 3-D computed tomography images with a length of 39.5 mm is observed as longer than normal.

In all the cases, CT examinations were performed with a 16-slice CT scanner (Briiliance 16, Philips, Amsterdam, Netherland) using standard parameters of 16 × 0.75 mm collimation and 1 mm slice thickness. The presence of the bone structure extending from the bilateral styloid process to the hyoid bone was monitored on the acquired axial BT scans. Then three-dimensional (3D) reconstructive images were created by the "volume rendering" method on the workstation. No contrast agent was used during the examinations. Length and angulation of SP were measured through the 3D images. The length between the point at which the SP attaches to the temporal bone and the end of the SP was measured. Ossification in the stylohyoid ligament attached to the SP was added to the length (Fig. 1). The medial angle between the line crosses from the bases of the SP, and its trunk was measured (Fig. 2). The length and medial angle measurements were recorded according to genders and sides.

Wilcoxan rank test was used in the determination of right and left SP length and medial angulation degree regardless of the gender, and Mann-Whitney U test was used for comparison of the length and medial angulation degrees of the males and females according to the sides.

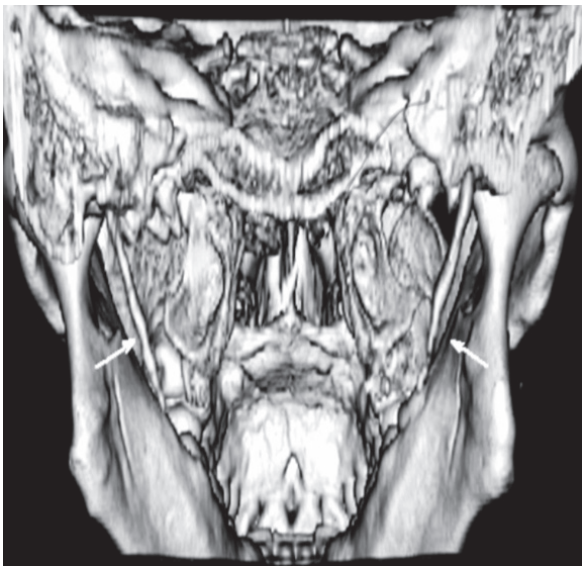

Figure 2. Right and left medial angulation.

RESULTS

Double-sided elongated SP was found in 19 (86.3%) of 22 patients and single-sided elongated SP in 3 patients. All the single-sided elongated SP cases with two at the left and one at the right were females. Mean length of the styloid process regardless of the gender and sides was found as 4.1 ± ± 1.1 cm for all the individuals, 4.0 ± 1.1 cm for the right side (male: 4.2 ± 0.9, range: 3–6.4 cm; female: 3.7 ± 1.2, range: 1–6.5 cm), while it was measured as 4.1 ± 1.2 cm for the left side (male: 4.3 ± ± 1.4, range: 3.2–8.2 cm; female: 4.0 ± 1.0, range: 2.1–5.9 cm). No statistical difference was found between the lengths of the right and left side of all the persons ($p = 0.270$, $p > 0.05$). Upon comparison of the lengths of the right and left-side SPs of the males with the females, there was no statistically significant difference defined ($p > 0.05$). The difference between the inter-group lengths of the right and left-side SPs was non-significant ($p > 0.05$) (Table 1, Fig. 1).

Mean medial angulation of the styloid process was found as 67.5 ± 5.1° (male: 68.3 ± 5.1°; female: 66.7 ± 5.2°), 66.0 ± 5.3° for the right side (male: 67.4 ± 5.5°, range: 57°–77°; female: 64.6 ± ± 4.9°; range: 57°–73°), while it was measured as 69.0 ± 4.6° for the left side (male: 69.2 ± 4.7°, range: 63°–76°; female: 68.8 ± 4.8°, range: 62°–78°).

There was a statistically significant difference between the right and left side medial angulations in all the persons ($p = 0.03$; $p < 0.05$). No statistical difference was found upon comparison of the right and left medial angulation degrees of the males and the right and left medial angulation degrees of the females ($p > 0.05$). When intra-group right medial angulation and left medial angulation of the males were compared, the difference was found to be statistically non-significant ($p > 0.05$), while a significant difference was defined in intra-group comparisons of the females ($p < 0.05$) (Table 1, Fig. 2).

DISCUSSION

There have been numerous studies conducted to determine the length of SP. The length of SP is highly variable in these studies. Eagle reported the normal length of SP as 2.5 cm [8]. Moffat et al. [16] carried out 80 cadaver dissections and reported the length of SP as 1.52–4.77 cm. Montalbetti et al. [17] stated the normal size of SP as less than 2.5 cm. In their study, Sokler et al. [24] found the length to be 2.6 cm at the right and 2.12 cm at the left side and defined 3 cm and above as elongated. In their 3D CT study with 138 cases, Başekim et al. [4] found the mean length of SP to be 2.83 cm (range: 1.58–5.48 cm) and defined 4 cm and above as elongated. Mansour et al. [14] also defined 4 cm and above as elongated, and the incidence of ES occurrence was reported to be higher in this condition. In their radiologic study with a wide series, Correll et al. [6] found the incidence to be 18.2% and showed that 93% of these were double-sided. Kubikova and Varga [13] reported a case with an SP length of 14 cm at both sides in a 28-year-old patient. From

Table 1. Lengths and medial angulation degrees of styloid process (SP) of females and males (mean ± SD)

	Right SP [cm]	Left SP [cm]	Right angle [°]	Left angle [°]
Male (n = 11)	4.2 ± 0.9	4.3 ± 1.4	67.4 ± 5.5	69.2 ± 4.7
Female (n = 11)	3.7 ± 1.2	4.0 ± 1.0	64.6 ± 4.9*	68.8 ± 4.8
Total (n = 22)	4.0 ± 1.1	4.1 ± 1.2	66.0 ± 5.3*	69.0 ± 4.6

*$p < 0.05$ compared with the left angle of its own group

panoramic radiographs, Balcioglu et al. [3] found the mean length of SP in males and females on the right and left sides to be 25.78 ± 5.68 mm; 22.69 ± 3.68 mm, 25.80 ± 5.75 mm; and 22.75 ± ± 3.65 mm, respectively. In this study, the mean length of SP was found as 4.1 ± 1.1 cm while it was 4.0 ± 1.1 cm at the right side (male: 4.2 ± 0.9 cm; female: 3.7 ± 1.2 cm), and 4.1 ± 1.2 cm at the left side (male: 4.3 ± 1.4 cm; female: 4.0 ± 1.0 cm). Regardless of gender, no statistical difference was found between the right and left sides in terms of the length of SP ($p > 0.05$). When we took the normal length of SP to be 2.5 cm, double-sided elongated SP was found in 19 (86.3%) of 22 patients and single sided in 3. Identification of the elongated SP in all the patients may be due to the pre-diagnosis of ES in all of them. The length of SP did not show a statistical difference for both sides between the males and females ($p > 0.05$). Double-sided elongation is highly common, but its symptoms are less severe [11]. Most of the cases were more than 30 years old and rarely younger [2]. The mean age of our cases was also more than 30 years (44.8). The incidence of elongated SP in the community has been stated as 4%, and 4–10.3% of them have been reported as symptomatic [18].

The actual reason for the styloid process of stylohyoid calcification is not clear although several theories have been proposed. Partial or complete calcification of the stylohyoid ligament might have been entirely genetically determined. In addition, trauma and early-onset menopause have also been suggested [5]. Two different clinical forms have been defined in ES. One of them, classic syndrome, occurs after tonsillectomy. There is a localised stunt pain in the tonsillar fossa. This pain radiates to the ear at the same side and may be accompanied by dysphagia, odynophagia, the feeling of a foreign body in the throat, and facial and/or cervical pain. The pain is rarely intensive [10]. All these symptoms occur with irritation of the 5^{th}, 7^{th}, 9^{th}, and 10^{th} cranial nerves located very close to the SP. The signs emerging after the tonsillectomy produce the hypothesis that locally occurring granular tissue confines the cranial nerves. Trauma in the soft tissue during tonsillectomy may result in elongation of the SP and calcification of the stylohyoid ligament [23]. The second form, carotid artery "Stylocarotid" syndrome, may arise regardless of whether tonsillectomy is performed or not. This occurs because of the mechanical irrigation of the sympathetic plexus in the internal and/or external carotid artery walls by the elongated SP or calcificated ligaments. When the internal carotid artery is compressed, the increase in cervical pain is remarkable. It is triggered and exacerbated by rotation and compression of the neck and radiates to the supraorbital and parietal regions in which the ophthalmic artery is distributed. In contrast, if the external carotid artery is irritated, the pain radiates to the infraorbital area. There may be a sense of numbness and vision disorders [10].

The SP is located between the internal and external carotid arteries. Deviation of the SP may cause pain as a result of the narrowing and irritation of the vessel [15]. There is no association between the severity of pain and the length of the styloid chain [12]. Abnormal angulation is responsible for the intensive symptoms rather than the length of SP [1, 25]. In this study, we observed the mean angulation degree as 67.5° (57°–78°). Regardless of gender, a statistical difference was found between the medial angulation on the right and left sides ($p = = 0.03$; $p < 0.05$). The right medial angulation was smaller than the left side (right 66.0°; left 69.0°). No statistical difference was defined between the medial angulation degree of the females and males for both sides ($p > 0.05$). In their study, Onbaş et al. [21] found the mean angulation degree to be 72.7° (between 55° and 90.5°). In their CT study with 138 cases, Başekim et al. [4] defined the mean angulation degree as 69.4° (between 60.6° and 84.1°). The angulation degree that we found was close to these values, but smaller. This difference supports the view that the angle may cause symptoms as it narrows due to the compression on the adjacent structures [4].

CT is an effective method for evaluation of the length, angulation, and other morphological features of SP [4, 9, 17, 18]. Three-dimensional images obtained from the spiral CT scans are an objective diagnostic tool for evaluation of the length, direction, and contiguities of SP and to inform patients about their disease [19]. Three-dimensional CT is recognised as the gold standard method in radiological diagnosis [20]. In conclusion, 3D-CT technique is a reliable method that can be used to accurately measure the length and angulation of SP, evaluate the anatomical structures adjacent to SP, and to plan the surgical approach. ES should be kept in mind for the differential diagnosis of pains localised in the head-neck area, especially in persons over 30 years old.

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