Role of three-dimensional multidetector computerized tomography in diagnosis of Eagle’s syndrome

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Abstract  Objective: To confirm the diagnosis of Eagle's syndrome by three-dimensional MDCT among patients with clinical suspicion of the disease.
Materials and methods: Non-contrast MDCT neck scans of 18 patients of clinical prediagnosis of Eagle's syndrome and 6 control subjects over 9 months period were reviewed for styloid process lengths and medial angulations using conventional and three-dimensional images.
Results: Our study included 18 patients and 6 controls. The means of styloid process lengths and medial angulations were 2.6 cm and 69.4°, 2.2 cm and 73° respectively. Statistical significance was found (P < 0.05) between the medial angulations of SP of patients and controls rather than between the lengths. MDCT revealed that 10 out of 18 patients had elongated styloid processes, 6 were bilateral, and 4 were unilateral 3 of them were right sided. Mean length of elongated styloid processes was 4.4 cm (range from 3.3 to 5.4 cm), 4.5 cm in males and 4.2 cm in females. Three out of 18 patients had narrowed bilateral medial styloid process angulation, two of whom were bilateral and one case was unilateral with additional styloid process elongation.
Conclusion: MDCT with three-dimensional reconstructions is valuable in diagnosing Eagle's syndrome by virtue of determining styloid process length and medial angulation, thus confirming clinical suspicion and aiding proper management.

1. Introduction

The stylohyoid complex (SHC), a bone–ligament complex, is derived from the second pharyngeal arch (Reichert’s cartilage). It consists embryologically of four parts: the tympanohyal portion, which fuses to the petrous temporal bone to form the base of the SP, the stylohyal portion, which forms the main body of the SP and the ceratohyal portion, which becomes the stylohyoid ligament and the hypohyal portion, forming
the lesser horn of the hyoid bone and representing the junction between the SHL and the hyoid bone (1).

The SP is a cylindrical bony outgrowth located in front of the stylohyoid foramen and it extends from the temporal bone outward. The SP is positioned between the internal carotid artery (ICA) and external carotid artery (ECA) and positioned posterolateral to the tonsillar fossa. Medial to the SP is the internal jugular vein along with cranial nerves VII, IX, X, XI and XII. The SP tip is close to the ECA laterally, while medially, the SP tip is close to the ICA with sympathetic chain (2,3).

Eagle’s syndrome refers to an elongated, increased in thickness or angulated ossified stylohyoid complex which can project into the tonsillar fossa and irritate the surrounding anatomical structures in the neck (4). Because of its strategic position, any abnormality of the SHC may lead to non-specific clinical symptoms including pharyngeal pain localized to the position, any abnormality of the SHC may lead to non-specific symptoms can be confused with a wide variety of facial pain syndromes (5).

Eagle’s syndrome was first described by Eagle in (6). He identified two subtypes of the syndrome, the classic Eagle’s syndrome; unilateral pharyngeal pain, aggravated by swallowing and frequently reverberating in the ear, and the carotid or vascular syndrome and is attributed to impingement of the internal carotid artery, extracranially by the styloid process. This can cause a compression when turning the head or in dissection of the carotid artery resulting in a transient ischemic accident or stroke (7).

Symptoms of Eagle’s syndrome rely on the length, width and angulation of the styloid process (8). Styloid process elongation (SPE) can be assumed if either the SP or the adjacent stylohyoid ligament ossification shows an overall length in excess of 30 mm (9). Langlais et al. (10) have classified the styloid process elongation into three morphological types; elongated – the styloid process and the stylohyoid ligament appear like a continuous structure, this is the commonest type (8); pseudoarticulated – the process seems to be joined to the stylomandibular or stylohyoid ligament by means of a single pseudo-joint and segmented – the styloid process and ligaments consist of several mineralized segments.

Medial angulation of SP should not be less than 65° (11). Clinical suspicion of Eagle’s syndrome is made through palpation of the ESP in the tonsillar fossa which is normally not felt and confirmation can be done by radiographical imaging, more commonly; a panoramic radiography (PR) is used to determine SPE, however, PRs are not capable of displaying the orientation and dimensions of the styloid process. On the other hand, multidetector computed tomography (MDCT) provides a reliable visualization of these features (12).

In this study, we aimed to confirm the diagnosis of Eagle’s syndrome by three-dimensional multidetector computed tomography (3D MDCT) among a series of patients referred with clinical suspicion of the disease.

2. Materials and methods

2.1. Patients

This retrospective study was done between July 2011 and November 2012 among Egyptian population, it included 18 patients (12 males and 6 females; mean age 46.7, range: 32–65 years) which were referred for non contrast MDCT neck by the Ear, Nose and Throat consultant on bases of clinical suspicion of Eagle’s syndrome. Twelve of our patients complained of odynophagia, 2 patients had odynophagia accompanied by otalgia, while 4 patients had the complaint of foreign body sensation in the throat.

Six control individuals (4 males and 2 females, mean age 51 years; range 35-62 years) were included in the study within the same period; they were referred for CT neck as a part of assessment of obstructive sleep apnea and had no relevant clinical history suggestive of Eagle’s syndrome.

2.2. MDCT scanning

MDCT neck scans were done in Misr Radiology Center, Cairo, Egypt. In all cases, CT neck scans were performed without intravenous contrast injection with 16- section multidetector row CT scanner (Bright Speed; GE medical systems, Milwaukee, USA) using standard parameters of 0.75 mm collimation and 0.5 mm slice thickness, **kV 120; mAs 360; helical pitch 0.562:1 and rotation time 0.8 s.

2.3. Image reconstruction and analysis

In both patients and control individuals of the study, the styloid processes were reviewed in axial conventional images then we transferred the original raw data to the workstation (ADW4.0 GE Medical Systems, USA) where three dimensional (3D) images were reconstructed by using volume rendering (VR) and surface shaded display (SSD) techniques. The length and medial angulation of SP were measured through the 3D images. The styloid process length is measured between the point at which the SP attaches to the temporal bone and the end of the SP (ossification in the stylohyoid ligament attached to the SP was added to the length). The medial angulation of the styloid process is measured between the line crosses from the bases of both SP and the longitudinal axis of its trunk.

2.4. Statistical analysis

Student’s t-test was used for comparison between two independent groups; the patients and control group to determine the significant difference between the mean lengths and medial angulations of styloid processes. The probability of error (P-value) of <0.05 was considered to be statistically significant. IBM SPSS statistics (V. 21.0, IBM Corp., USA, 2012) was used for data analysis.

3. Results

Our study was carried out with a total of 18 patients: 12 (67%) males and 6 (33%) females mean age was 46.7 (age ranges from 32 to 65 years), another 6 control individuals were included, 4 males and 2 females, mean age was 51 years.

Interpreting the lengths of styloid processes of patients in 3D images of the CT neck scans, it was found that the mean value for lengths of styloid processes among patient series (36 styloid processes) was 2.6 cm. Regarding the 6 control individuals, 2.2 cm (range 1.4–3.6 cm) was the mean length of SPs (12 styloid processes), 2.4 cm was the mean of the right side
and 2.6 cm of the left side. There was no statistical significance between lengths of SP of patients and that of control subjects ($P = 0.25, p > 0.05$).

Ten patients out of 18 (55.6%) (6 males and 4 females) had ESP (a total of 16 ESPs), 6 (60%) of whom had bilateral ESP (Fig. 1), 3 (30%) were unilateral right sided and 1 (10%) patient was unilateral left sided. Elongated styloid processes ranged from 3.3 to 5.4 cm, mean was 4.4 cm, and mean length of elongated right styloid processes was 4.37 cm while 4.36 cm for the elongated left ones. The mean value of lengths of ESP in males (4.5 cm) was higher than that in females (4.2 cm).

The mean medial angulation of SP in the 18 patients of the study (36 medial angulations) was 69.4°, 69° for the right side (range 56–79.2°) and 70° for the left side (range 57.3–80.7°). The mean medial angulation among control subjects (12 medial angulations) was 74.2°, 73° for the right side (range 68.4–80°) and 76° for the left side (range 71–84.5°). There was statistical significance between the medial angulations of SP of patients and that of control subjects ($P = 0.02, P < 0.05$).

Three out of 18 patients of the study had narrowed medial styloid process angulations, 2 of whom had bilateral narrowing of the angle, the values of medial angulations were 56°, 57.3° (Fig. 2) and 57°, 62° in the two patients respectively, while the remaining one had unilateral right sided narrow medial angulation (52.4°) in addition to ESP.

4. Discussion

The reported length of styloid process reaches up to 30 mm. Elongated styloid process accounts approximately to 4–7% of the population, 4% only are symptomatic (13).

Styloid process elongation could be an incidental finding in some asymptomatic individuals (14). Abnormal angulation rather than elongation of the styloid process may be responsible for the irritation of a number of structures coursing through the parapharyngeal space (12).

Several imaging modalities are capable of detecting ESP such as plain radiographs, panoramic radiographs and computed tomography. Radiographic imaging is liable for superimposition of anatomical structures so computed tomography is more useful as it eliminates these drawbacks and it provides 2D images in variable planes and 3D-CT images from which we can get all the information about the styloid length, angulation and anatomical relations (14).

Treatment of Eagle’s syndrome is either conservative or surgical, but the conservative treatment is short lived (15). The two traditional surgical approaches are targeted to styloidectomy (removal of the elongated portion of the styloid process) through the intraoral approach (transpharyngeal) or the extraoral approach (16).

In our study, the mean age of patients was 46.7 years, Yavuz et al. (18) and Kosar et al. (18) reported the mean ages of their patients were 48.2 and 44.7 respectively.

Our study also revealed that there was statistical significance between the means of SP medial angulations between patients and control groups, while, there was no statistical significance between the means of SP lengths between patients and control groups. This might draw the attention to the clinical significance of narrow medial angulation of SP as an important etiology for symptoms rather than the SP elongation. This agrees with Okur et al. (24) who studied the SP medial angulations among symptomatic and asymptomatic subjects and concluded that the medial angulations of SP might be responsible for styalgia complaints in patients rather than the lengths of SP.

The incidence of CT positive cases for ESP among clinically suspicious patients of our study was 55.6%. Male to female ratio was 3:2 with male gender predilection 60%. Our finding is not fitting with Ilguy et al. (8) and Woolery (19) who found female predominance of Eagle’s syndrome while it agrees with Bozkir et al. (20) who stated that 63% of ESP patients were males and with Ekici et al. (21) and Gozil et al. (22) who presumed ESP are more frequent in males. The mean value of lengths of ESP in males was higher than that in females in our study which coincides with Gozil et al. (22), Ekici et al. (21) and Kosar et al. (18).

In our study, ESP lengths ranged from 3.3 to 5.4 cm and the mean was 4.4 cm, 60% of ESPs were bilateral, 30% were unilateral right sided, and while 10% were unilateral left sided. Ilguy et al. (8), Bozkir et al. (20), Balcioğlu et al. (23) and Kosar et al. (18) reported that bilaterality is mostly common. Bozkir et al. (20) stated that the mean length of ESP was 5.3 cm. It has been noted in our study that there is no significant variation in the mean length of right styloid processes (4.37 cm) compared to left ones (4.36 cm), this agrees with Yavus et al. (17) who reported in their patient group ESP ranged from 3.5 to 8.0 cm, 5.0 cm mean length for the right and 5.2 cm for the left. Kosar et al. (18) found the mean length of SP was 4.1 cm while it was 4.0 cm at the right, and 4.1 cm at the left side.

Regarding the medial angulations of styloid processes in our 18 patients of the study, we found that 3 patients had narrowed styloid process medial angulation, 2 of whom were bilateral and the remaining unilateral right sided case had

![Fig. 1](image1.png)  
**Fig. 1** Male patient, 47 years old, complained of odynophagia, 3D SSD CT oblique view shows elongated right (a) and left (b) styloid processes.
additional unilateral ESP at the same side. The mean medial angulation of styloid processes of those 3 patients was 69.2°, while Yavuz et al. (17) reported in their control group 2.8 cm mean length for the right and 2.6 cm on the left side.

In conclusion, MDCT with 3D reconstructions are valuable in diagnosing Eagle’s syndrome by virtue of determining styloid process length and medial angulation, thus confirming clinical suspicion and aiding proper management.

Conflict of interest

The authors have no conflict of interest to declare.

References