J Surg Med. 2025;9(11):240-244.
https://doi.org/10.28982/josam.8456

JOSAM

Research article
https://jsurgmed.com/

Journal of Surgery and Medicine

e-ISSN: 2602-2079

Computed tomography evaluation of elongated styloid process and calcified stylohyoid ligament: Revisiting Eagle's syndrome

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Ethics Committee Approval
The study was approved by Ankara Yıldırım Beyazıt University, Yenimahalle Training and Research Hospital Non-Interventional Scientific Research Ethics Committee, decision number E-2025-31, dated October 30, 2025.
All procedures in this study involving human participants were performed in accordance with the 1964 Helsinki Declaration and its later amendments.

Conflict of Interest
No conflict of interest was declared by the authors.

Financial Disclosure
The authors declared that this study has received no financial support.

Published
2025 November 27

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Abstract

Background/Aim: Eagle's syndrome (ES) presents with a wide range of symptoms resulting from the impingement of nerves and/or compression of vessels in the neck by an elongated styloid process and calcified stylohyoid ligament. Although the literature includes numerous case reports on ES, large patient series studies are limited. This study aims to provide a comprehensive analysis of ES, evaluate its consistency with existing literature, and report findings from 88 patients, representing one of the largest series to date conducted at a high-volume center specializing in head imaging.
Methods: A retrospective analysis was conducted on 8,509 patients who underwent computed tomography (CT) for various indications between 2019 and 2023. A total of 88 patients were diagnosed with ES. For each patient, preliminary diagnosis and gender were recorded.
Results: Out of 8,509 patients evaluated, 88 (1.0%) were diagnosed with ES. Of the 88 confirmed ES cases, 47 (53.4%) were female and 41 (46.6%) were male. It was determined that 3 of the 88 patients (3.4%) diagnosed with ES had a preliminary diagnosis of ES, while 96.6% did not have a preliminary diagnosis.
Conclusion: Establishing a strong preliminary diagnosis of ES, rather than identifying it incidentally on imaging, depends on a detailed knowledge of regional anatomy and the ability to correlate clinical symptoms with underlying anatomical structures. Of the 88 patients diagnosed with ES, 3 (3.4%) had a preliminary diagnosis—all of whom were women—while the remaining 96.6% did not. Our findings highlight a marked discrepancy between clinical suspicion and radiological diagnosis of ES. This gap underscores the importance of incorporating objective imaging into routine evaluation to improve diagnostic accuracy and prevent misdiagnosis.

Keywords: stylocarotid syndrome, styloid process, internal carotid artery, Eagle's syndrome, carotid artery syndrome

How to cite: Akkaşoğlu Taş S, Çetin H, Çalışkan S. Computed tomography evaluation of elongated styloid process and calcified stylohyoid ligament: Revisiting Eagle's syndrome. J Surg Med. 2025;9(11):240-244.

Introduction

Eagle first described what is now known as Eagle syndrome (ES) in 1937, based on a patient he had observed over several years. The patient presented with persistent throat and ear pain following a tonsillectomy and was initially considered neurotic due to the lack of visible pathology. In 1935, Eagle palpated a firm and tender structure in the left tonsillar fossa, which reproduced the patient's symptoms. This finding led to the identification of an elongated styloid process as the underlying cause of the clinical presentation [1, 2].

The symptoms associated with Eagle's syndrome are primarily attributed to two pathophysiological mechanisms: impingement or irritation on nearby nerves in the neck, and compression of adjacent carotid arterial branches or their tributaries [1, 3].

Eagle noted that typical cases of the syndrome often involve neuralgic symptoms due to irritation of the sensory and motor fibers of the glossopharyngeal (IX) nerve, and less commonly the trigeminal (V), facial (VII), and vagus (X) nerves. Patients may experience altered taste, pharyngeal or esophageal muscle spasms, and pain during swallowing. Symptoms frequently arise after tonsillectomy, likely due to scar tissue irritating nearby nerve endings. The typical presentation of the syndrome occurs when the elongated styloid process is directed anteriorly or medially, which is its most common orientation. Surgical shortening of the elongated styloid process often relieves these symptoms.

In 1946, Eagle described a variant of ES called carotid artery syndrome (or stylocarotid syndrome), in which pain follows the pathway of the internal or external carotid artery. This condition was based on a case where an elongated and curved styloid process compressed the external carotid artery, leading to chronic head and neck pain. Some patients may also experience tinnitus, possibly due to vibrations transmitted through bone, even though the cochlea is supplied by the basilar artery. In such cases, the internal carotid artery may be abnormally superficial and tender due to displacement by the styloid process. This can lead to diagnostic confusion, as the prominent artery might be mistaken for an enlarged cervical lymph node. Repeated self-palpation can worsen the pain, which is thought to result from irritation of the sympathetic nerve fibers in the arterial wall [1, 4].

The literature is abundant in case reports and small case series on ES, but comprehensive studies remain limited [5-14]. Additionally, there is inconsistency regarding whether the syndrome is primarily characterized by unilateral or bilateral elongation of the styloid process. This variability largely stems from differing definitions and diagnostic criteria applied across studies. A review of the literature reveals considerable confusion among researchers concerning the laterality and incidence of ES, as most reports focus on either its vascular or neurological clinical presentations rather than the anatomical basis of the syndrome as a whole.

The present study addresses this gap by providing a large-scale, anatomy-based assessment of Eagle syndrome confirmed by multidetector computed tomography (MDCT). It is the first to evaluate the consistency between preliminary clinical diagnosis and radiological confirmation, offering a more objective understanding of the syndrome's true prevalence and laterality.

Materials and methods

This retrospective cross-sectional study evaluated the prevalence and diagnostic concordance of ES using MDCT at Ankara Bilkent City Hospital between January 1, 2019, and December 31, 2023.

Ethical approval was obtained from the Yenimahalle Research and Training Hospital Ethics Committee (approval number: E-2025-31).

Patients undergoing head and neck MDCT were considered. Patients were excluded if they met any of these criteria: age under 18 years, fractures involving the head or neck, prior head or neck surgery, poor-quality or incomplete MDCT images, or incomplete clinical records. After exclusions, 8,509 patients were included in the analysis.

The preliminary diagnosis of ES was recorded based on the referring physician's notes documented in the electronic patient charts prior to the MDCT.

The primary outcome was ES, defined as a styloid process >3 cm with calcified stylohyoid ligaments. Secondary outcomes included concordance between preliminary clinical diagnosis and radiological confirmation. Demographic data (age, sex) were collected from hospital records. All MDCT scans were systematically reviewed using standardized anatomical criteria.

Potential bias from retrospective data and incomplete clinical records was addressed by standardizing imaging review and data extraction methods.

The final cohort included 8,509 patients, of whom 88 (1.0%) were diagnosed with bilateral ES.

Statistical analysis

Descriptive statistics for age were provided as mean (SD), while for discrete data, the number and percentage values were given. The Independent Samples t-test was used to compare the ages of women and men. The McNemar test was used to compare the ES rates of preliminary diagnosis and CT diagnosis. Fisher's exact test was used to compare the rates of preliminary diagnoses between women and men. Statistical analyses were performed using the Statistical Package for the Social Sciences (version 20.0; SPSS Inc., Chicago, IL, USA). A p-value of less than 0.05 was considered statistically significant.

Results

Out of 8,509 patients evaluated, 88 (1.0%) were diagnosed with bilateral ES. Of the 88 confirmed ES cases, 47 (53.4%) were female and 41 (46.6%) were male. The average age of patients was 51.54 (13.98) years, with a minimum age of 25 and a maximum age of 76. There was no statistically significant difference in age between female and male patients with ES (P=0.137) (Table 1). Of the 88 patients diagnosed with ES, 3 (3.4%) had a preliminary diagnosis—all of whom were women—while the remaining 96.6% did not have a preliminary diagnosis. Preliminary diagnosis rates were compared between female and male patients with ES, and no statistically significant difference was found (P=0.245) (Table 2). Concordance between preliminary diagnosis and CT confirmed ES was assessed (P=0.016) (Table 3).

Computed tomography scans showed bilateral styloid processes were more than 3 cm long and calcified stylohyoid ligaments (Figure 1–4).

Table 1: Comparison of age between women and men with ES

	Mean (SD)	*P*-value
Female	49.46 (13.18)	0.137
Male	53.92 (14.64)	

SD: Standard Deviation

Table 2: Comparison of preliminary diagnosis rates between women and men with ES

Preliminary diagnosis	Female n(%)	Male n(%)	*P*-value
No	44 (93.6)	41 (100)	0.245
Yes	3 (6.4)	0 (0.0)	

n: number

Table 3: Comparison of ES rates between preliminary diagnosis and CT diagnosis

Preliminary diagnosis (ES)	Post-CT diagnosis (ES) No n(%)	Post-CT diagnosis (ES) Yes n(%)	*P*-value
No	81 (100)	0 (0.0)	0.016
Yes	7 (77.8)	2 (22.2)	

McNemar test

Figure 1: Coronal computed tomography (CT) scan shows bilateral elongated styloid processes (red arrows) and calcified stylohyoid ligament (yellow arrows).

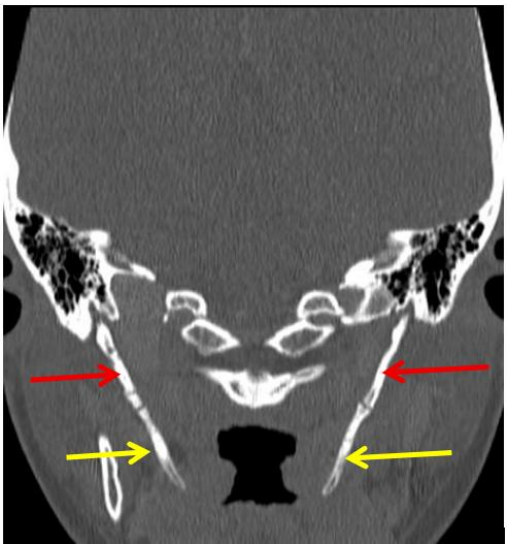


Figure 2A: Axial section, the stylohyoid ligaments are calcified (red arrows) and indented laterally on both palatine tonsils (blue arrows).

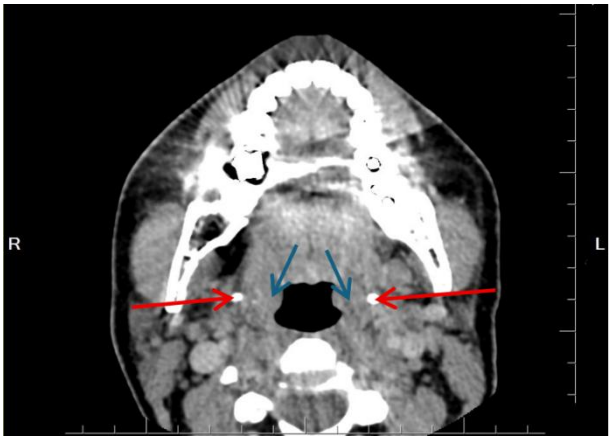


Figure 2B: Axial section, elongated styloid process (red arrows).

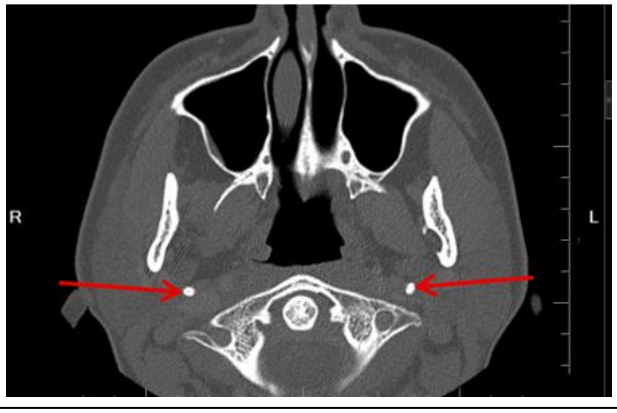


Figure 3: Parasagittal section, elongated styloid process (red arrow) and stylohyoid ligament calcification (yellow arrow).

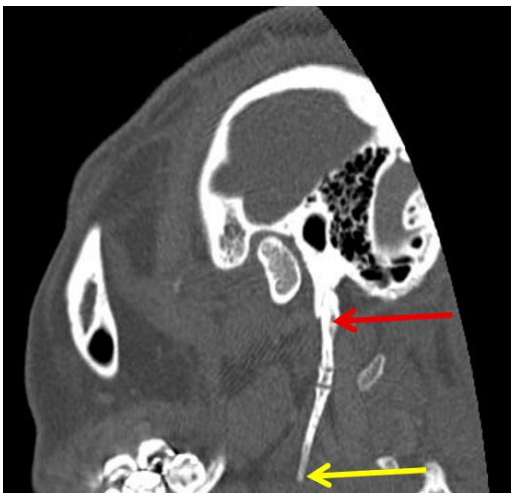
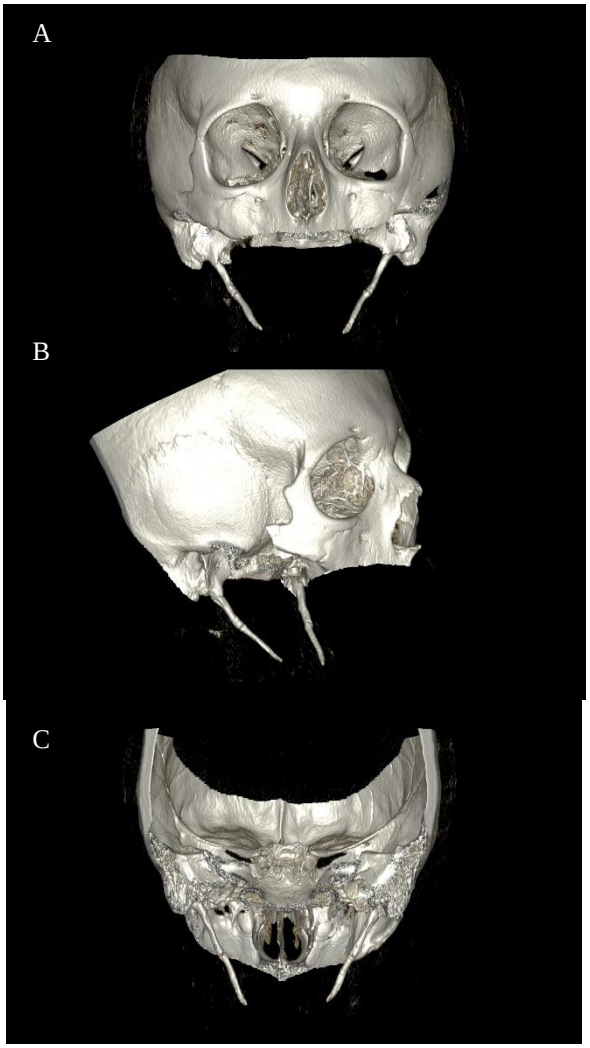


Figure 4A, B, C: Three dimensional (3D) computed tomography demonstrated bilateral elongated styloid processes and calcified stylohyoid ligaments. **A:** anterior view, **B:** oblique view, **C:** posterior view



Discussion

Eagle described the syndrome in patients who had previously undergone tonsillectomy, which is characterized by the elongation of the styloid processes and the presence of symptoms attributable to this anatomical variation. Eagle linked the symptoms to postoperative fibrosis between the tonsillar fossa and styloid process, which compresses the trigeminal, facial, glossopharyngeal, or vagus nerves [1, 2].

There is an ongoing discrepancy between the original Eagle's literature and the current literature regarding the definition of ES. While a substantial number of published articles describe ES as symptomatic, many current literature sources assert that the condition should be defined specifically as symptomatic and/or asymptomatic.

Literature contains numerous reports of ES cases that are incidentally diagnosed through imaging with nonspecific clinical presentation [15, 17-19]. However, a closer analysis of these cases reveals that the patients are not truly asymptomatic; rather, they exhibit nonspecific symptoms that, upon detailed evaluation, can be anatomically attributed to ES [3, 5, 15-19]. This inconsistency may lead to confusion in both diagnosis and reporting, highlighting the need for a more unified and standardized definition.

This study presents 88 cases of ES, each involving bilateral elongation of the styloid processes accompanied by symptoms that are anatomically consistent with this structural anatomy. From this perspective, we believe that our study provides a precise definition of the syndrome and that the results derived from this framework are more scientific and objective compared to previous studies.

Several studies in the literature report that the prevalence of an elongated styloid process is approximately 4–7%, with 4–10% of these cases being symptomatic [3, 5, 20, 21]. In the study by Pagano et al. [5], only cases of vascular Eagle syndrome were reviewed. Among the 31 articles included, one reported two cases, another five cases, and the remaining articles presented a single case each; the authors also contributed a case from their own experience. Unlike that study, which focused exclusively on the vascular subtype, the present study provides comprehensive data on the overall prevalence of ES, including both vascular and neurological forms.

Searle et al. [15] described ES as typically unilateral and less commonly bilateral, estimating its incidence at 4–8 per 10,000 individuals. In the case report by Dabrowski et al. [16], unilateral ES was described as relatively rare, while bilateral ES was characterized as "exponentially more rare" and noted to have been mentioned only a few times in the literature. Bilateral ES was observed in 1.0% (88/8509) of our cases. Although earlier studies have reported bilateral involvement as extremely rare—often rarer than unilateral cases—our bilateral rate exceeded the unilateral rates reported in aforementioned studies, underscoring the strength and distinct contribution of our study. Given the significantly larger sample size and inclusion of all subtypes but only bilateral cases, the incidence reported in our study may offer a more accurate estimate of the true prevalence of bilateral ES in the general population.

Moreover, this study contributes to the literature by highlighting, for the first time, the concordance between preliminary clinical suspicion of ES and radiological confirmation using MDCT. Among 8,509 patients, only 9 were initially suspected to have ES based on clinical evaluation; however, 88 patients were ultimately diagnosed with the condition through imaging. Of the 9 patients with a preliminary diagnosis, only 3 (33.3%) were confirmed to have ES radiologically. Thus, the rate of true-positive preliminary diagnoses was just 0.035%, while the actual incidence of ES in the study population was 1.0%.

This significant discrepancy between clinical suspicion and confirmed diagnosis underscores the importance of improving clinical recognition of ES. Given the syndrome's wide range of symptoms—often involving cranial nerves (V, VII, IX, and X) and major vascular structures such as the internal and external carotid arteries—physicians should be aware of the varied clinical presentations. A thorough understanding of the anatomical basis and pathophysiology of ES is essential for improving diagnostic accuracy and ensuring that more cases are identified correctly at the preliminary stage. Moreover, these findings suggest that MDCT is more reliable than clinical suspicion alone for the accurate diagnosis of ES. Nevertheless, as our results are based on retrospective data, they should be interpreted with caution. To the best of our knowledge, this is the first study to draw attention to this diagnostic discrepancy between clinical suspicion and radiological confirmation. We aimed to highlight this issue and encourage further research on the subject. To substantiate our observations and determine the true diagnostic value of MDCT compared with clinical evaluation, well-designed prospective studies with larger sample sizes are warranted.

Conclusion

To establish a common language in the evaluation of ES, it is essential to first reach a consensus on its definition. Without this fundamental agreement, data regarding incidence, gender distribution, and diagnostic criteria remain inconsistent and lack scientific objectivity. The current literature demonstrates considerable variability on this point, further complicating efforts to standardize diagnosis and compare findings across studies. The present study, in our view, fills a gap on this discrepancy with the largest case series analyzed to date.

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