

RESEARCH ARTICLES

The prevalence of the stylohyoid ligament ossification in Surabaya, Indonesia: an incidental finding study in panoramic radiographs

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ABSTRACT

Stylohyoid ligament ossification is a growth disorder that is often detected as an incidental finding on panoramic radiography. Its etiology and pathogenesis are still not fully understood. Eagle's Syndrome is related to stylohyoid ligament ossification, but this syndrome is often misdiagnosed or even undiagnosed so that the patients experience losses due to undergoing various unnecessary treatments. The appearance of stylohyoid ligament ossification on panoramic radiography can help to confirm the diagnosis of Eagle's Syndrome. Until now there has been no research regarding stylohyoid ligament ossification at RSGMP UNAIR. This study aimed to determine the incidence of stylohyoid ligament ossification that is observed through panoramic radiography at RSGMP UNAIR. This research is a descriptive observational study. The data used is secondary data from soft file panoramic radiographs of RSGMP UNAIR patients in the period May 2019-May 2023 which is in accordance with the sample inclusion criteria, as well as reading results by a dental radiology specialist. The data was then grouped based on gender, age, and morphology (unilateral/bilateral) and analyzed using the Cohen's Kappa Coefficient reliability statistical test. The results showed that 416 patients (9.09%) experienced stylohyoid ligament ossification. The highest distribution occurred in female with 260 patients (62.5%), the 25-64 years age group with 274 patients (65.86%) and the bilateral type with 341 patients (82%). From this study, the distribution data of stylohyoid ligament ossification based on gender, age, and morphology (unilateral/bilateral) were obtained.

Keywords: eagle's syndrome; ossification; panoramic radiography; stylohyoid ligament

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INTRODUCTION

The ossification of the stylohyoid ligament (SHL), commonly referred to as the elongation of the styloid process, represents a form of heterotopic ossification in the craniofacial region. Heterotopic ossification itself denotes the pathological formation of bone within soft tissues, particularly within muscles or connective structures, and is often associated with trauma, surgery, or systemic conditions.¹ Although SHL ossification is generally considered an incidental radiographic finding, it holds clinical significance due to its potential association with Eagle's Syndrome, a condition characterized by cervicopharyngeal symptoms such as dysphagia, odynophagia, orofacial pain, and referred otalgia.^{2,3}

Panoramic radiography, or orthopantomography (OPG), remains a widely

employed imaging modality in dentistry, owing to its broad anatomical coverage, cost-effectiveness, and ease of access. This imaging technique provides two-dimensional visualization of the maxillofacial region and is often utilized for the incidental identification of stylohyoid ligament ossification.⁴ Various epidemiological studies have demonstrated substantial differences in the prevalence of SHL ossification, ranging from 3.3% to 84.4%, highlighting the heterogeneity of findings across populations, methods, and measurement criteria.^{5,6}

Eagle's Syndrome, first described by Watt Eagle in 1937, arises from the elongation of the styloid process or ossification of the SHL, which leads to irritation or compression of adjacent neurovascular structures.⁷ This syndrome is typically divided into two variants: the classic

type, associated with pharyngeal symptoms and foreign body sensation, and the vascular type, which involves compression of the internal carotid artery and may lead to transient ischemic attacks or stroke.^{8,9} Despite the potential severity of symptoms, Eagle's Syndrome remains underdiagnosed or misdiagnosed in clinical practice, resulting in unnecessary treatments that fail to address the underlying pathology.¹⁰

The etiology of SHL ossification remains multifactorial and partially understood. Several theories have been proposed, including reactive ossification following trauma or surgery, genetic predisposition, abnormal embryologic development, age-related degenerative changes, and mechanical overuse due to mandibular malposition.^{11,12} Hormonal influences, particularly in postmenopausal women, are also suspected to contribute to ligamentous degeneration and subsequent ossification.¹³

Although SHL ossification is often bilateral, symptoms tend to manifest unilaterally, further complicating clinical recognition.⁸ It is also important to note that not all individuals with radiographic evidence of elongation or ossification exhibit clinical symptoms, which challenges the specificity of imaging findings for diagnosing Eagle's Syndrome.¹⁴ Therefore, comprehensive clinical correlation, including history, physical examination, and confirmatory imaging when necessary, is critical in establishing a definitive diagnosis.

To date, limited data exist on the prevalence and demographic distribution of SHL ossification in Indonesia, particularly in the city of Surabaya. As one of the largest urban populations in the country, Surabaya represents a valuable setting for conducting an epidemiological assessment of this anatomical variation. This study aimed to evaluate the incidence of SHL ossification identified through panoramic radiographs of patients at Universitas Airlangga Dental Hospital Surabaya. As one of the largest urban populations in the country, Surabaya represents a valuable setting for conducting an epidemiological assessment of this anatomical variation. Universitas Airlangga Dental Hospitals was specifically chosen as the study site because

it serves as a major referral center for panoramic radiography in Surabaya, accommodating a diverse patient population, which makes it highly suitable for epidemiological research. Furthermore, the study sought to analyze the distribution of SHL ossification by sex, age group, and morphological pattern. The findings are intended to enhance clinical awareness of this condition and support the early recognition of potential Eagle's Syndrome in dental and medical practice.

MATERIALS AND METHODS

This descriptive observational study gathered secondary data from the panoramic radiographs in RSGMP UNAIR patients. The panoramic radiograph data were collected over a four-year period, from May 2019 to May 2023. Ethical clearance approval of the present study was obtained from the Health Research Ethical Clearance Commission at the Faculty of Dental Medicine, Universitas Airlangga (Number: 09/UN3.9.3/Etik/PT/2023).

The inclusion criteria of the samples including good quality panoramic radiographs of the patients aged more than 5 years with ossification of the stylohyoid ligament in the form of a homogeneous linear radiopaque image extending from the mastoid process area and crossing the posteroinferior aspect of the ramus towards the hyoid bone, and the length of the styloid process is greater than or equal to 25 mm. To minimize selection bias, all panoramic radiographs taken during the study period that met the inclusion criteria were included, regardless of patient symptoms, diagnosis, or treatment history. This ensured that the sample represented the full range of patients undergoing panoramic imaging at the facility.

The presence of the ossification was observed by three authors using imageJ application to measure the styloid process and ensure the reliability of the included data. The included data were categorized by gender, age, and morphology. Gender is a biological characteristic from birth, namely male and female. Age is calculated from the

time a person was born until the time the picture was taken. This study uses age classification according to the World Health Organization (WHO), namely 5–14 years (Middle Childhood), 15–24 years (Adolescents and Youth), 25–64 years (Adults), and 65 years and above (Elderly). The morphology in this study is divided based on ossification which can occur bilaterally on two sides or unilaterally on one side (Table 1).

Before the radiographs were assessed, all three observers participated in a calibration session using 30 randomly selected panoramic

radiographs not included in the main sample. This session was conducted to standardize the identification and measurement criteria for SHL ossification. Observers repeated the evaluation of the same 30 radiographs after a two-week interval to assess intra-observer reliability. Cohen's Kappa coefficient was calculated for both inter-observer agreement (0.924, indicating near-perfect agreement) and intra-observer agreement (0.91, indicating near-perfect agreement), using IBM SPSS Version 26 software (IBM Corp., Armonk, NY, USA).

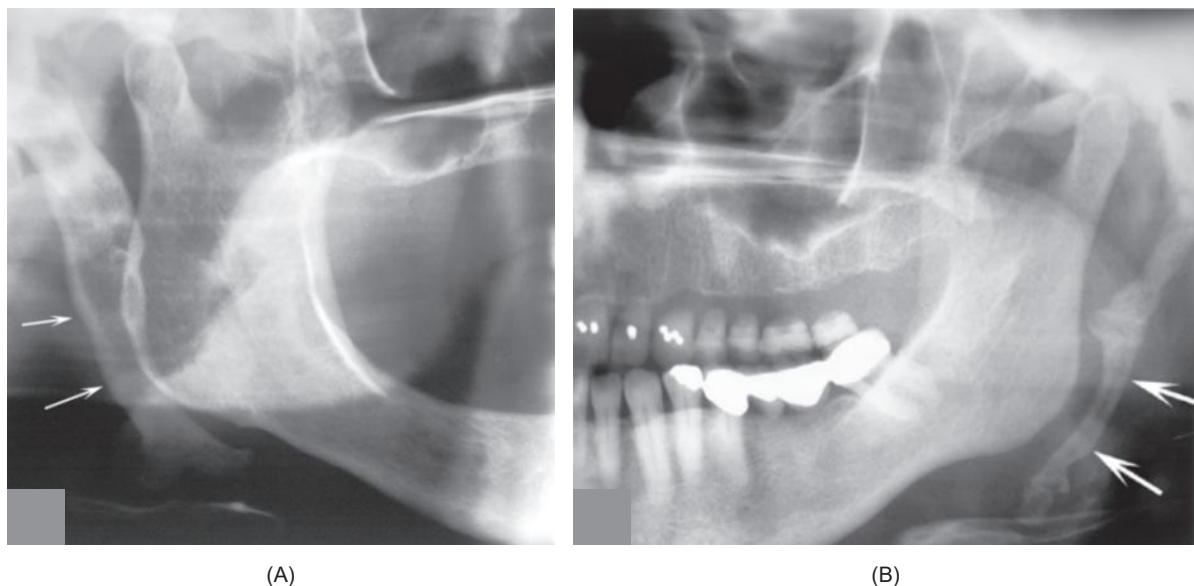


Figure 1. Radiographic view of stylohyoid ligament ossification (arrow)

RESULTS

A total of 4,575 panoramic radiographs data were screened for the presence of ossification of the stylohyoid ligament. After selection based on inclusion criteria, it was found that 416 patients (9.09%) had ossification of the stylohyoid ligament. Based on the Cohen's Kappa Coefficient statistical test, the reliability of the assessment between three observers regarding the presence of stylohyoid ligament ossification has a value of 0.924, that stated to be near perfect agreement.

The data was then categorized into three groups based on gender, age, and morphology. Data distribution based on gender showed that

stylohyoid ligament ossification was found in female with the data as many as 260 (62.5%) and in male as many as 156 (37.5%).

Data distribution based on age is grouped into four categories based on age classification according to the World Health Organization (WHO). The most cases of stylohyoid ligament ossification were found in the 25–64 years age group with 274 data (65.86%), followed by the 15–24 years age group with 99 data (23.8%), 65 years and over with 42 data (10.1%), and 5–14 years with 1 data (0.24%). Data distribution based on morphology showed that stylohyoid ligament ossification was found bilaterally in 341 (82%) and unilaterally in 75 (18%).

Table 1. Types of stylohyoid ligament ossification based on morphology


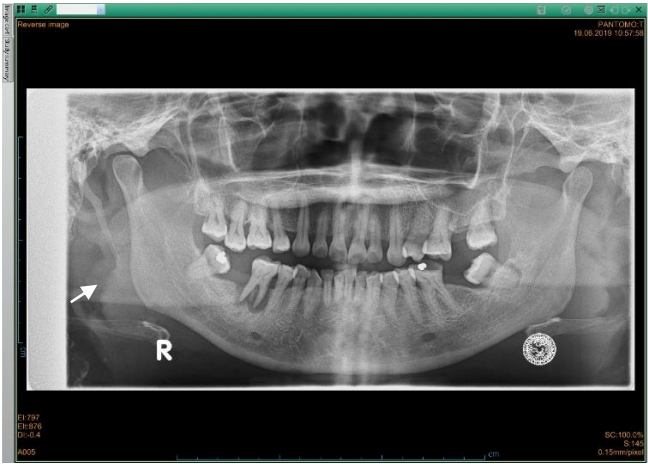
Morphology	Panoramic radiography of RSGMP UNAIR patients
Bilateral	
Unilateral	

Table 2. Stylohyoid ligament ossification data results based on gender

Gender	Number	(%)
Male	156	37.5
Female	260	62.5
Total	416	100

Table 4. Stylohyoid ligament ossification data results based on morphology

Morphology	Number	(%)
Unilateral	75	18
Bilateral	341	82
Total	416	100

Table 3. Stylohyoid ligament ossification data results based on age

Age	Number	(%)
5-14 years	1	0.24
15-24 years	99	23.8
25-64 years	274	65.86
65 years and above	42	10.1
Total	416	100

DISCUSSION

This study revealed a 9.09% prevalence of stylohyoid ligament ossification among 4,575 panoramic radiographs obtained at Universitas Airlangga Dental Hospital. This incidence is within the lower range compared to international studies, where prevalence has varied significantly from as low as 3.3% to as high as 84.4% depending on diagnostic criteria, imaging methods, and

population demographics.^{5,6} The use of a cutoff length of ≥ 25 mm to define ossification, as adopted in this study, reflects one of the more commonly used standards in similar investigations.¹⁵ However, variations in measurement thresholds (≥ 25 mm vs. ≥ 30 mm), radiographic technique, and ethnic anatomical diversity may account for the observed discrepancies in prevalence rates.

The radiographic appearance of ossified SHL typically manifests as a continuous or segmented radiopaque line extending inferiorly from the mastoid region to the vicinity of the hyoid bone. In this study, radiographic interpretation was performed independently by three observers, achieving a Cohen's kappa coefficient of 0.924, indicating near-perfect inter-rater reliability and strengthening the validity of the findings.

A notable predominance of SHL ossification was observed in female patients (62.5%), which is consistent with prior studies reporting a higher prevalence of this anatomical variation among women.^{16,17} Several hypotheses have been proposed to explain this sex-based disparity. One widely accepted explanation is the influence of hormonal changes, particularly during menopause, which may promote degenerative changes in connective tissues, including the stylohyoid ligament, thus increasing the likelihood of calcification and ossification.¹³

Moreover, it has been observed that symptomatic Eagle's Syndrome is more frequently reported in women, although the reasons for this remain unclear and may involve a complex interplay between anatomical variation, pain perception thresholds, and neurovascular sensitivity.¹⁸ This finding emphasizes the importance of a high index of suspicion when evaluating cervical or oropharyngeal complaints in middle-aged and older women.

The age group with the highest number of SHL ossification cases in this study was the 25–64 years category (65.86%), followed by the 15–24 years group (23.8%) and those aged 65 years and above (10.1%). The presence of ossification in adults supports the aging-related degenerative theory proposed by Camarda et al, which

suggests that soft tissue elasticity diminishes over time, leading to chronic mechanical stress and subsequent ossification, especially at tendon-ligament junctions.¹²

Alternative pathophysiological models include Steinmann's reactive theories, which postulate that repetitive trauma or inflammatory stimulation—either directly to the styloid process or indirectly through adjacent structures—can trigger a metaplastic ossification response.¹¹ In both cases, the ossification process may proceed slowly and may remain asymptomatic for years. Additionally, mandibular malposition and occlusal imbalance have been implicated in the mechanical stimulation of the SHL, potentially exacerbating the ossification process.¹⁹ Interestingly, a very low prevalence (0.24%) was identified in children aged 5–14 years, suggesting that congenital or developmental origins, while possible, are relatively rare. This supports the notion that SHL ossification is predominantly acquired rather than inherited in nature.

The majority of ossification cases in this study were bilateral (82%), while only 18% were unilateral. This pattern is aligned with the anatomical configuration of the stylohyoid ligament, which is bilaterally symmetrical by nature.⁴ Nonetheless, it is worth noting that unilateral symptoms are more commonly reported in clinical cases of Eagle's Syndrome, underscoring the dissociation between radiographic morphology and clinical manifestation.⁸

Some authors have postulated that bilateral ossification may have a stronger genetic component, whereas unilateral ossification could be more strongly linked to localized trauma or chronic inflammation.²⁰ Conversely, Scaf et al reported a predominance of unilateral cases, which they attributed to muscle tension and occlusal abnormalities.²¹ These discrepancies again highlight the variability of findings across populations and reinforce the need for standardized classification systems, such as the O'Carroll classification, which categorizes ossification based on its vertical extent relative to the mandibular foramen.²²

Although SHL ossification may be radiographically evident, it is not synonymous with Eagle's Syndrome, which requires a constellation of clinical symptoms, palpatory findings, and radiological support. In this study, the clinical status of the patients was not assessed, thereby limiting the ability to correlate imaging findings with symptomatology. Nevertheless, the identification of ossification patterns remains crucial, as it may guide further clinical evaluation in symptomatic individuals. Eagle's Syndrome is typically diagnosed through a combination of patient history, physical examination (particularly digital palpation of the styloid process in the tonsillar fossa), and imaging modalities such as panoramic radiography, computed tomography (CT), or cone beam CT (CBCT).^{7,8} CBCT, in particular, offers three-dimensional visualization with greater accuracy in assessing the spatial relationship of the styloid process to adjacent structures.²³

Given the underdiagnosed nature of Eagle's Syndrome and the wide range of non-specific symptoms, clinicians must be vigilant and consider this condition in the differential diagnosis of head and neck pain, especially in cases refractory to conventional therapies. Accurate diagnosis can lead to appropriate management, which may include conservative measures such as analgesics and steroid injections or surgical intervention (styloidectomy) in refractory cases.²⁴

The present study is limited by its retrospective design and the absence of clinical data correlating radiographic findings with symptomatology. Furthermore, the reliance on OPG introduces potential measurement errors due to projection distortion and limited depth resolution. Future studies should employ three-dimensional imaging and incorporate clinical assessments to provide a more comprehensive understanding of the clinical significance of SHL ossification.

Longitudinal studies are also warranted to determine whether ossification progresses over time and whether early identification may predict the onset of Eagle's Syndrome symptoms. Additionally, genetic and histopathological investigations may shed light on the underlying

mechanisms of ligamentous ossification and help identify high-risk individuals.

CONCLUSION

The results of the study found that 416 (9.09%) of 4,575 population in Surabaya had ossification of the stylohyoid ligament. The highest distribution was found in female was 260 patients (62.5%), the age group 25-64 years was 274 patients (65.86%), and the bilateral type was 341 patients (82%). Therefore, it can be concluded that dentists must pay attention to the symptoms experienced by patients by taking a comprehensive medical history to help direct the examination in order to establish a diagnosis and plan treatment appropriately and accurately.

CONFLICT OF INTEREST

The authors declare no conflicts of interest related to this study.

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