RESEARCH ARTICLE

Radiologic Assessment of Styloid Process Length in a Kurdish Population from Sulaymaniyah Using Multidetector Computed Tomography: A Cross-Sectional Study

Salah M Fateh Faraj*[1]

[1]Department of Radiology, College of Medicine, University of Sulaimani, Sulaymaniyah, Iraq.

Ann Coll Med Mosul 2026; 48 (1):31-37.
Received: 3rd March 2026, Revised 3rd May 2026, Accepted: 22th May 2026.
***Corresponding author: Salah M Fateh Faraj , ✉ salah.fateh1973@gmail.com**
Doi: 10.33899/acmm.v48.i1.61877

ABSTRACT

Background: The styloid process (SP) is a cranial structure whose elongation may be clinically significant, particularly in Eagle syndrome.
Objectives: This study aimed to determine normative SP dimensions and the prevalence of elongation in a Kurdish population using multidetector computed tomography (MDCT), and to analyze associations with age, gender, and height.
Methods: A cross-sectional study was conducted on 500 individuals (250 males, 250 females; age 16–70 years) undergoing paranasal sinus MDCT at radiology centers in Sulaymaniyah, Kurdistan, Iraq. SP length was measured bilaterally on 3D-reconstructed images. Elongation was defined as >30 mm.
Results: The mean right and left SP lengths were 26.42 ± 6.05 mm and 26.52 ± 5.94 mm, respectively. Males had significantly longer SPs than did females (right: 27.71 ± 6.04 mm vs. 25.14 ± 5.80 mm, left: 27.79 ± 5.83 mm vs. 25.25 ± 5.78 mm, $p < 0.001$). Elongated SPs (>30 mm) were seen with higher prevalence in men (right: 23.2%; left: 23.6%) than women (right: 16.4%; left: 14.8%, $p = 0.0503$). The 95th percentile for SP length is 38 mm (right) and 37 mm (left). There was a moderate correlation between SP length and height ($r = 0.56$ right, $r = 0.54$ left), while age had a weak correlation with SP length. Regression analysis found that age, height, and male gender were independent predictors of both SP length and risk of elongation.
Conclusion: Normative SP lengths in the Kurdish population vary by gender and height, with elongation more frequent in males and taller individuals. These results suggest that using population-specific reference values may improve diagnostic accuracy and reduce the risk of misinterpretation in clinical practice.
Keywords: Computed Tomography, Kurdish population, Styloid process.

INTRODUCTION

The styloid process (SP) is a thin bony projection arising from the inferior aspect of the temporal bone, located anterior to the stylomastoid foramen. It serves as an attachment site for several muscles and ligaments, including the stylohyoid, styloglossus, and stylopharyngeus muscles, as well as the stylohyoid and stylomandibular ligaments, collectively referred to as Riolan's bouquet [1]. Normal length of the SP is between 20 mm and 30 mm; however, the abnormal growth of this structure as well as calcification of the stylohyoid ligament can result in a set of symptoms called Eagle syndrome (ES) [2]. People with ES can have neck and facial pain, difficulty swallowing, the feeling of having a foreign object in their throat, and compression to their blood vessels and nerves, which reflects the need for definitive anatomical assessment [3].

Radiological evaluation is essential for the determination and management of SP pathology. Panoramic radiographs have been the primary method used for screening purposes [4], however, because of the inherent limitations of panoramic radiographs (e.g., magnification errors, overlapping adjacent structures, and distortion because the image produced is 2-dimensional) Multidetector Computed Tomography (MDCT) has become the established standard for morphometric assessment with three-dimensional representation and sub-millimeter accuracy in measuring the dimensions of the subject being evaluated. While MDCT is a reliable tool for morphometric evaluations, population-specific variation exists in the established normative values for SP lengths based on the ethnic and geographic origin of the individual [5, 6]. Thus, in order to decrease the chance of misdiagnosis or unnecessary surgical procedures, the creation of specific reference data for the target population is necessary.

In recent years, studies have greatly increased the specificity of the directional mapping of the anatomical variations of the SP; however, there are still voids in the data across large areas of the globe. For example, Kaaki et al. [3] reported that the rate of prevalence for elongated styloid processes in the population of Saudi Arabia is 4.26%, with males recording a significantly greater prevalence than females. Similarly, Triantafyllou et al. [7] have conducted a systematic review which demonstrates that the worldwide average lengths of elongation vary widely depending on geographical region, therefore making it inappropriate to set a standard or normative threshold for elongation in all areas of the world.

While significant progress has been made, there continues to be a lack of morphometric data regarding Kurdish populations. Previous research, in particular styling length as correlated with anthropometric characteristics such as height and age, has produced variable findings which impede our understanding of the factors contributing to the development of this structure. The current research addressed these gaps in knowledge and provide empirical evidence to clarify average values for Kurdish individuals with elongations based on the available data. The objectives of the current study were to determine normal measurements and frequency of elongated SPs among a Kurdish population by means of MDCT; to examine possible associations between SP length and age, sex, and height variables.

METHODS AND MATERIALS

Study design and setting

This cross-sectional study utilized MDCT scans acquired during paranasal sinus assessments. Retrospective data were collected from January 2023 to May 2024, while prospective data were acquired from July 2024 to January 2025. The research was conducted at multiple radiology centers in the Sulaymaniyah district of Kurdistan, Iraq.

Study Population

The study population included individuals aged 16–70 years who underwent paranasal sinus MDCT at radiology centers in Sulaymaniyah, Kurdistan, Iraq. The target sample size was chosen by reviewing similar radiologic studies of SP length, and was set to fall within this range to allow reliable analysis by sex and age [8]. Ultimately, 500 participants entered the study. Participants were recruited using consecutive sampling: retrospectively by screening existing MDCT scans and records from January 2023 to May 2024, and prospectively by inviting all eligible patients referred for paranasal sinus MDCT between July 2024 and January 2025. Exclusion criteria included age <16 or >70 years, technical issues precluding accurate measurement, clinical or radiologic suspicion of Eagle syndrome, craniofacial anomalies affecting styloid morphology, and calcified stylohyoid ligament.

Study Procedures

Imaging technique: MDCT imaging studies were performed according to a standardized protocol designed to evaluate the paranasal sinuses. Patients were positioned supine in the scanner and scanned using a caudo-cranial direction from the hard palate to above the frontal sinuses. All images were acquired at a tube voltage of 125 kV, tube current between 80 and 160 mAs, field of view between 140 and 160 mm and slice thickness between 0.625 and 1.0 mm. After obtaining thin-section axial images, multiplanar reformation (MPR) images were reconstructed in coronal and sagittal planes. Both bone and soft tissue algorithms were used to enhance anatomical detail and allow accurate three-dimensional reconstruction using MPR images.

The length of the SP was measured bilaterally as a result of 3D reconstruction images taken from its origin on the temporal bone to the end of the SP (Fig. 1). The measurements were made in millimeters (mm) for both the right and left sides of the SP, providing consistency of measurement in all cases. The elongation of the SP was initially evaluated using a 30 mm cutoff, which functioned as a reference point for statistical analysis rather than a definitive threshold for classifying elongation in specific instances. The 30 mm threshold was employed in accordance with standard protocols in analogous studies; however, additional analysis utilizing the 95th percentile was conducted to yield a more thorough and population-specific comprehension of SP length.

Fig. 1. 3D reconstruction image showing measurement of the SP

Statistical Analysis

The statistical analysis was carried out using IBM SPSS Statistics (Version 25). Descriptive Statistics such as mean, standard deviation, and range were utilized to describe the age, height, and SP length, on the right and left sides of the body, for each individual. To enable comparisons between the groups of participants based on age, the participants were divided into three groups; and the SP lengths were statistically analyzed between the groups using a One-way Analysis of Variance (ANOVA) or Kruskal - Wallis Test, depending on the distribution of SP length data of the groups. The comparison of SP length between the sexes was based on the Independent Samples T-test. Height and SP length were correlated using the Pearson's Correlation Coefficient if the height and SP length met the requirements for even distribution or Spearman's Rank Correlation Coefficient if the height and SP length data did not meet requirements for even distribution. The cutoff value for statistical significance was set at $p < 0.05$.

Ethical Considerations

The informed consent procedures in this study were modified based on whether patients had been enrolled in either the retrospective (data collected from existing patient records with no direct patient contact) or prospective (where informed consent was obtained in order to summon patients back to the hospital for confirmation of demographics) phases of the research study. Also, informed consent was obtained from those patients who had long SP to assess their possible symptoms related to the ES. Patient confidentiality and patient privacy were fully protected. Approval to access patient files was obtained from all participating hospitals and from their institutional review board (IRB) prior to the commencement of the study. Ethical approval was obtained from the College of Medicine, University of Sulaimani (Reference No. 77, dated 25-2-2026).

RESULTS

In this study, a total of 500 subjects participated, with half of the participants being female and the other half male.

Regarding Age and Height by Gender; The mean age was 38.72 ± 14.61 years in females and 37.04 ± 14.28 years in males, with no statistically significant difference between the groups ($p = 0.195$). In contrast, males had statistically significant greater mean height compared to females (175.28 ± 6.67 cm vs 162.84 ± 5.11 cm, $p < 0.001$). (Table 1**).**

Table 1
Age and Height by Gender

Gender	n	Mean Age (years)	Mean Height (cm)
Female	250	38.72 ± 14.61	162.84 ± 5.11
Male	250	37.04 ± 14.28	175.28 ± 6.67
p-value	—	0.195	<0.001

The study sample had overall (including both females and males) mean age of 37.88 ± 14.45 years (range: 16–70 years) and a mean height of 169.06 ± 8.60 cm (range: 150–194 cm). The mean length of the right SP was 26.42 ± 6.05 mm (range: 10–46 mm), while the left SP measured 26.52 ± 5.94 mm (range: 10–50 mm) (

Table **2**). The mean right SP length in females was 25.14 ± 5.80 mm (range: 10–42.0 mm, median: 25.0 mm), while in males it was 27.71 ± 6.04 mm (range: 12.0–46.0 mm, median: 27.0 mm). Similarly, the mean left SP length in females was 25.25 ± 5.78 mm (range: 10.0–42.0 mm, median: 25.0 mm), compared to 27.79 ± 5.83 mm in males (range: 13.0–50.0 mm, median: 28.0 mm) (Fig. 2).

The prevalence of SP elongation (>30 mm) was higher in males than females on both sides. Among females, 16.4% (41/250) had elongation on the right and 14.8% (37/250) on the left, while in males, 23.2% (58/250) had elongation on the right and 23.6% (59/250) on the left ($p = 0.0503$) (Table 3).

The 95th percentile values for SP length indicate that, in the total study population, the right SP measured up to 38 mm and the left up to 37 mm. When analyzed by gender, the 95th percentile for females was 36 mm on the right and 35 mm on the left, while for males it was higher, at 40 mm on the right and 38 mm on the left (

Table 4).

Table 2
Distribution of age, height, and SP length (right and left).

Variable	Mean	Std. Deviation	Minimum	Maximum	Range
Age (years)	37.88	14.45	16	70	54
Height (cm)	169.06	8.60	150	194	44
Right SP (mm)	26.42	6.05	10	46	36
Left SP (mm)	26.52	5.94	10	50	40

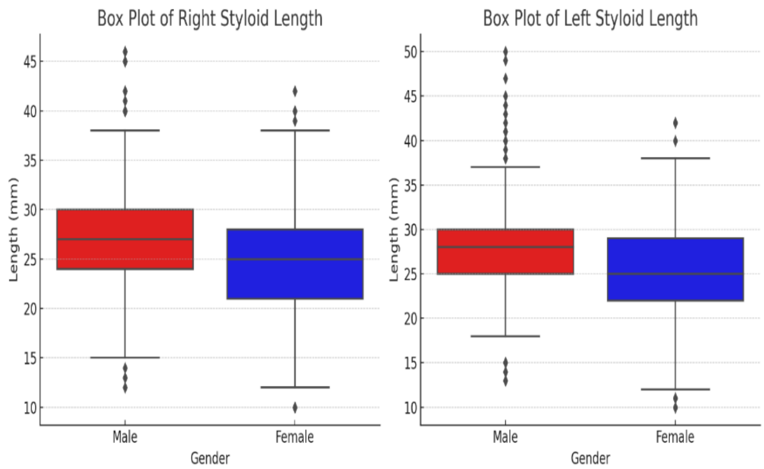

Fig. 2. Box Plot of Right and Left Styloid Length by Gender.

Table 3
Prevalence of SP Elongation (>30 mm) by Gender

Gender	Right >30 mm (%)	Left >30 mm (%)	p-value*
Female	16.4% (41/250)	14.8% (37/250)	0.0503
Male	23.2% (58/250)	23.6% (59/250)	

*Chi-square

Table 4
95th Percentiles of SP Length by Gender.

Group	Right Styloid (mm)	Left Styloid (mm)
Total	38	37
Female	36	35
Male	40	38

The correlation analysis revealed a strong positive relationship between the right and left SP lengths (r = 0.82). Both right and left SP lengths showed moderate positive correlations with height (r = 0.56 and r = 0.54, respectively), indicating that taller individuals tend to have longer SPs. In contrast, the correlations between SP length and age were weak (r = 0.05 for right, r = 0.09 for left), suggesting little to no association between age and SP length. Height and age were weakly and negatively correlated (r = –0.13) (**Error! Not a valid bookmark self-reference.**).

The mean right SP length was 25.78 ± 6.17 mm in the 16–30 years age group, 27.11 ± 6.15 mm in the 31–50 years group, and 26.27 ± 5.53 mm in the 51–70 years group. For the left SP, the mean lengths were 25.84 ± 6.23 mm, 26.95 ± 5.94 mm, and 26.92 ± 5.29 mm, respectively, across the same age groups. The Kruskal-Wallis test showed no statistically significant differences in SP length among the different age groups for either the right (H = 3.08, p = 0.214) or left side (H = 2.48, p = 0.289). as shown in Table 6**.**

Table 5
Correlation of Styloid Length with Age and Height.

Variable	Age	Height	Right Styloid	Left Styloid

Age	1	–0.13	0.05	0.09
Height	–0.13	1	0.56	0.54
Right Styloid	0.05	0.56	1	0.82
Left Styloid	0.09	0.54	0.82	1

Table 6
Styloid Length Across Age Groups.

Age Group (years)	N	Right Styloid (mm), mean (SD)	Left Styloid (mm), mean (SD)
16–30	191	25.78 (6.17)	25.84 (6.23)
31–50	204	27.11 (6.15)	26.95 (5.94)
51–70	105	26.27 (5.53)	26.92 (5.29)
Kruskal-Wallis Test	H Statistic	3.08	2.48
	p-value	0.214	0.289

Table 7
Styloid Length Across Age Groups.

Predictor	Coefficient (β)	Std. Error	t-value	p-value
Intercept	5	2	2.50	0.012
Age (per year)	0.03	0.008	3.75	<0.001
Height (per cm)	0.12	0.015	8.00	<0.001
Gender (Male vs Female)	2	0.5	4.00	<0.001

Table 8
Logistic Regression for Risk Factors of Styloid Elongation.

Predictor	Coefficient	Std. Error	z-value	p-value	Odds Ratio
Intercept	-4.20	1.25	-3.36	0.001	0.015
Age	0.04	0.015	2.67	0.008	1.041
Height	0.06	0.020	3.00	0.003	1.062
Gender (Male)	0.80	0.350	2.29	0.022	2.225

The multiple linear regression analysis identified age, height, and gender as significant predictors of SP length. Specifically, for each additional year of age, SP length increased by 0.03 mm ($\beta = 0.03$, $p < 0.001$), and for each additional centimeter in height, it increased by 0.12 mm ($\beta = 0.12$, $p < 0.001$). Males had, on average, a 2 mm longer SP compared to females ($\beta = 2$, $p < 0.001$). The intercept was 5 mm ($p = 0.012$). These results indicate that greater age, taller stature, and male gender are all independently associated with increased SP length in this population (Table 7).

The logistic regression analysis identified age, height, and male gender as significant risk factors for SP elongation (>30 mm). Each additional year of age increased the odds of elongation by 4.1% (OR = 1.041, $p = 0.008$), and each additional centimeter in height increased the odds by 6.2% (OR = 1.062, $p = 0.003$). Males had more than twice the odds of styloid elongation compared to females (OR = 2.225, $p = 0.022$). The intercept was –4.20 ($p = 0.001$), corresponding to an odds ratio of 0.015. These findings indicate that older age, greater height, and male gender are independently associated with an increased risk of SP elongation in this population (Table 8).

DISCUSSION

Accurate assessment of styloid process (SP) length is clinically important because elongation may be associated with Eagle syndrome, neurovascular compression, dysphagia, cervicofacial pain, and surgical planning in head and neck procedures [2,12]. Despite the widespread use of the traditional 30 mm cutoff to define elongation, increasing evidence suggests that SP dimensions vary substantially among different ethnic and geographic populations[7]. Consequently, applying a universal reference threshold may lead to overdiagnosis or underdiagnosis in certain populations. The present study provides population-specific MDCT reference values for the Kurdish population and evaluates the influence of demographic factors such as sex, age, and height on SP morphology.

A total of 500 patients was evaluated in the current study, with ages ranging from 16 to 70 years and a mean age of 37.88 ± 14.45 years. The mean length of the SP on the right side was 26.42 ± 6.05 mm (range: 10–46 mm), while on the left side it was slightly longer at 26.52 ± 5.93 mm (range: 10–50 mm). Although the difference between the right and left sides was small, it was statistically significant, suggesting bilateral asymmetry in SP length among the individuals in the present study. When comparing these findings with previous studies, the mean SP lengths observed in the Kurdish population were higher than those reported in Iranian and Indian cohorts. For instance, Shayganfar et al.[8] found mean right and left SP lengths of 25.4 ± 7.3 mm and 25.2 ± 7.2 mm, respectively, in an Iranian sample, while Mathur et al.[1] reported even lower values in an Indian population (23.74 ± 4.5 mm right, 22.74 ± 3.72 mm left). In contrast, studies from Turkey and Kashmir reported mean SP lengths more comparable to or exceeding those in the present study, with Cullu et al. [5] documenting 28.3 ± 5.8 mm (right) and 28.6 ± 6.2 mm (left), and Shah et al.[9] reporting 31.1 ± 4.2 mm (right) and 31.6 ± 4.7 mm (left). These differences highlight the influence of ethnic and regional factors on SP length.

Sex-based differences were also evident, with males exhibiting significantly longer SPs than females, a finding consistent with previous studies [1, 5, 8, 10]. All reported greater SP lengths in males, attributing these differences to genetic and hormonal influences on skeletal development, particularly the effects of androgens [11]. The present study further supports these observations, as males not only had higher mean SP lengths but also higher 95th percentile values compared to females.

A strong positive correlation was found between height and SP length ($r = 0.56$ right, $r = 0.54$ left, both $p < 0.001$), indicating that taller individuals tend to have longer SPs. This relationship aligns with the findings of other studies [8], who also reported a significant association between height and SP length. In contrast, no significant differences in SP length were observed across age groups in this study, which is consistent with the results reported in other studies [5, 8, 10]. However, some literature suggests that SP length may increase with age due to ossification of the stylohyoid ligament [12], a factor that may not have been fully captured in this study due to the exclusion of cases with calcified ligaments. Based on the analysis of this study, the results indicate that using a common reference point (e.g., SP length of the papillary muscles > 30 mm) can result in a problem with the over-diagnosis of elongation of the SP or related syndromes in a given population. The fact that there are significant variations among different populations, such as Kurdish, Iranian, Indian, Turkish, and Kashmiri, this supports the need to consider population-specific reference ranges when evaluating patients with suspected SP elongation [1, 5, 8, 9].

Though the current study provides important data regarding the normative values for SP length in the Kurdish population, it is limited to individuals who underwent MDCT for assessment of the paranasal sinuses. There was also the exclusion of multiple anatomical variations (e.g., distance of the SP to the sphenoid sinus) when measuring the SP or length of the SP. Ultimately, however, the knowledge provided in this document adds to the understanding of SP length and clinical documentation for the various populations represented in this report.

LIMITATIONS

This study has some limitations. It was conducted in a single city (Sulaymaniyah), which may limit how well the findings represent the wider Kurdish population. In addition, participants were selected from patients undergoing MDCT for sinus evaluation, which may introduce some selection bias. Cases with calcified stylohyoid ligaments were also excluded, which could affect the assessment of age-related changes.

CONCLUSIONS

This study offers a comprehensive MDCT-based evaluation of SP length in the Kurdish population, and demonstrates significant variation according to sex and body height. The findings support the concept that universal cutoff values may not be equally applicable across different ethnic and regional populations, highlighting the importance of considering demographic variation during radiologic assessment of suspected styloid elongation. Recognizing these differences may improve diagnostic interpretation and reduce the risk of unnecessary overdiagnosis of Eagle syndrome. In addition, these results provide a useful reference framework for future morphometric and clinical studies involving Kurdish and neighboring populations.

Acknowledgments

The author thanks all individuals who contributed to the completion of this study. As far as the manuscript preparation is concerned, numerous AI applications were used for editorial style and checking grammatical correctness. However, the scientific content, interpretation of data, and conclusions drawn from the research are entirely the responsibility of the author.

Conflict of interest

The author declares no conflict of interest.

Data availability

The study data may be acquired from the relevant author upon a reasonable request.

Funding

Not applicable

Author Contribution

The Author contributed to the study conception and design, radiologic image assessment, data interpretation, supervision of the study, manuscript drafting, critical revision of the manuscript, and approval of the final

version for publication. The author would like to acknowledge the radiology staff and all individuals who provided technical, administrative, or editorial assistance during the completion of this study.

REFERENCES

1. Mathur Y, Rai R, Sawant M. Evaluation of styloid process length using multidetector CT in an Indian population: a cross-sectional study. Int J Anat Radiol Surg. 2023;12(5):1–4. Doi: https://doi.org/10.7860/IJARS/2023/65547.2924.
2. Kapoor S, Gupta A, Satya S, Saidha PK, Saini U, Singh A. Role of the surgical approach in the treatment of Eagle syndrome. Int Arch Otorhinolaryngol. 2024;28(3): e400-e406. Doi: https://doi.org/10.1055/s-0043-1776717.
3. Kaaki M, Alassaf MS, Alolayan A, Almuzaini ES, Alsaeedi AK, Habeeb A, et al. Evaluation of styloid process elongation in Saudi Arabia. Cureus. 2024;16(1): e53136. Doi: https://doi.org/10.7759/cureus.53136.
4. More CB, Asrani MK. Evaluation of the styloid process on panoramic radiographs. Indian J Radiol Imaging. 2010;20(4):261–265. doi: https://doi.org/10.4103/0971-3026.73537
5. Cullu N, Deveer M, Sahan M, Tetiker H, Yilmaz M. Radiological evaluation of styloid process length. Folia Morphol (Warsz). 2013;72(4):318–321. Doi: https://doi.org/10.5603/FM.2013.0053.
6. Ishwar P, Verma S, Singh PK. Radiological Evaluation of Styloid process length and Morphological Variations using Multidetector Computed Tomography and Their Clinical Significance. J Popul Ther Clin Pharmacol. 2025;32(10):462–467. Doi: https://doi.org/10.53555/dasta442
7. Triantafyllou G, Paschopoulos I, Duparc F, Tsakotos G, Papadopoulos-Manolarakis P, Piagkou M. Anatomy of the stylohyoid chain. Diagnostics (Basel). 2025;15(7):925. Doi: https://doi.org/10.3390/diagnostics15070925.
8. Shayganfar A, Golbidi D, Yahay M, Nouri S, Sirus S. Radiological Evaluation of the Styloid Process Length Using 64-row Multidetector Computed Tomography Scan. Adv Biomed Res. 2018 May 29;7:85. Doi: https://doi.org/10.4103/2277-9175.233479.
9. Shah O, Shera F, Choh N, Gojwari T, Shafi F, Suhail J, et al. Styloid process: what length is abnormal? Galician Med J. 2021;28(1): E202114. Doi: https://doi.org/10.21802/gmj.2021.1.4.
10. Ekici F, Tekbas G, Hamidi C, Onder H, Goya C, Cetincakmak MG, et al. Stylohyoid chain variations by age and gender: an analysis using MDCT. Eur Arch Otorhinolaryngol. 2013;270(5):1715–1720. Doi: https://doi.org/10.1007/s00405-012-2202-5
11. Clarke BL, Khosla S. Androgens and bone. Steroids. 2009;74(3):296–305. Doi: https://doi.org/10.1016/j.steroids.2008.10.003.
12. Piagkou M, Anagnostopoulou S, Kouladouros K, Piagkos G. Eagle syndrome: a review of the literature. Clin Anat. 2009;22(5):545–558. Doi: https://doi.org/10.1002/ca.20804