

Morphometric evaluation of the styloid process of the temporal bone as an aid in age and sex discrimination – A retrospective digital panoramic study

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Abstract

Introduction: Maxillofacial radiology plays a significant role in forensic anthropology for age and sex discrimination in case of mass disasters. Anatomically, Styloid process is bony structure; cylindrical in shape arises from the temporal bone which tapers gradually towards apex. A careful clinical and radiological examination can lead to early detection of its length, anatomic variations and elongation. Therefore, morphometric analysis of length of the styloid process can be one of the adjuvant tools for age and sex discrimination in forensic anthropology.

Aim: To evaluate the length and anatomic variations of the styloid process as an aid in age and sex discrimination using digital panoramic radiographs.

Materials and Methods: Digital panoramic radiographs of 3800 individuals were randomly taken from private diagnostic clinic's database.

All the panoramic radiographs were evaluated for the radiographic length and anatomic variations of the styloid process bilaterally using measuring tool inbuilt in the software. The obtained data was analyzed using SPSS software version 21.0.

Results: The mean lengths of the styloid processes were statistically significant as the age advances and also in males and females bilaterally (p value < 0.05) with the prevalence rate of elongated process reported as 22.47%.

Conclusion: The morphometric evaluation of the styloid process of the temporal bone can be used as an adjuvant in age and sex discrimination using digital panoramic radiograph.

Keywords: Digital panoramic radiography, Eagle's syndrome, Forensic anthropology, Morphometric analysis, Styloid process.

Introduction

The human skull plays a significant role in forensic anthropology as it contains various unique anatomical structures such as frontal sinus, nasal septum, sella turcica, orbital aperture, styloid process, vascular groove patterns, etc.¹⁻⁴ Among all, the styloid process is underrated.⁵ The styloid process of the temporal bone is slender bony anatomical structure, measures approximately 25-30 mm. In males and females, the length of the styloid process of the temporal bone differs, thereby can be used as an adjuvant for sex discrimination in case of mass disasters such as cyclones, tsunamis, earthquakes, bomb blasts, etc.^{6,7} Elongated styloid process well-known as Eagle's syndrome or Stylalgia is mainly characterized by head and neck pain, dysphagia,odynophagia and increased salivation.⁸⁻¹⁰

The maxillofacial radiology helps to determine the sex using ante-mortem radiographs. On comparing with the post-mortem radiographs, the personal and sex determination can be established in case of dead, deceased or decayed human remains and living individuals. Therefore, in the present study,

1. The length of the styloid process was evaluated for gender discrimination using digital panoramic radiographs
2. Determine the prevalence of the elongated styloid process in the present population.

Materials and Methods

The present retrospective study included 3800 digital panoramic radiographs (1900 males and 1900 females)

taken between January and September 2018 were randomly selected between 18 to 60 age group from private diagnostic clinic's database, Rajasthan. The panoramic radiographs taken with improper technique, patients positioning errors, magnification errors, artifacts or superimposed anatomical structures were excluded from the study while the radiographs taken with proper positioning technique without superimposed structures were taken in the study. As it is retrospective study, the ethical clearance was not applicable.

All the radiographs were taken using PLANMECA machine and ROMEXIS software under standard exposure parameters. The radiographic length of the styloid process was measured from the point from where the styloid process leaves the tympanic plate to the apex bilaterally using measurement tool of the software (Fig. 1). The length more than 30 mm were considered as elongated, irrespective of ossification of the styloid ligament or segmentation and were classified radiographically according to Langlais and Langland.¹¹ The obtained data was analyzed using SPSS software (version 21.0) using t-test and Chi square test.

Results

The present study reported the mean length of styloid process was greater in males as compared to females bilaterally (p value < 0.05). The mean length of left and right styloid process in males was reported as 27.12 ± 5.47 mm and 26.82 ± 6.28 mm while in females was 25.38 ± 5.26 mm and 25.16 ± 6.98 mm respectively (Table 1).

The length of the styloid process increases significantly with age with p value less than 0.05. As the age advances,

the length of the styloid process increases. The maximum number of individuals belongs to the second decade followed by fourth (Table 2). On evaluating 3800 panoramic

radiographs, 854 (22.47%) showed elongated styloid processes. Out of which 542 (14.2%) and 312 (8.21%) showed right and left elongated styloid process respectively.

Table 1: The mean length of the left and right styloid process in males and females

Gender	n (%)	Mean Length of Styloid Process (mm)	
		Left side	Right side
Males	1900 (50%)	27.12 ± 5.47	26.82 ± 6.28
Females	1900 (50%)	25.38 ± 5.26	25.16 ± 6.98
P value		0.001*	0.000*

*statistically significant

Table 2: The mean length of the styloid processes in different age groups.

Age	n (%)	Mean Length of Styloid Process (mm)	
		Left side	Right side
18 - 20	482 (12.68%)	21.98 ± 4.65	22.17 ± 4.18
21 - 30	1167 (30.71%)	24.58 ± 5.73	24.14 ± 5.42
31 - 40	852 (22.42%)	25.61 ± 5.21	25.32 ± 5.85
41 - 50	1008 (26.52%)	25.94 ± 5.25	25.79 ± 5.37
51 - 60	291 (7.65%)	26.26 ± 5.10	26.47 ± 5.82
p value		0.017*	0.03*

*statistically significant



Fig. 1: Panoramic radiograph presenting the styloid process of the temporal bone bilaterally (Orange arrows)

Discussion

The styloid process of the temporal bone is one of the unique structures present in the human skull which can be used for age and sex discrimination in forensic anthropology. Theories proposed in the literature such as reactive hyperplasia, metaplasia, developmental anomaly, anatomic variations, etc. explained segmentation of the bony structure and its ossification with stylohyoid or stylomandibular ligaments.¹²⁻¹⁴

Various imaging modalities have been used for analyzing styloid process of the temporal bone such as anterioposterior skull radiograph, lateral skull radiograph, Town’s view radiograph, and CBCT, etc.¹⁵⁻¹⁷ Three dimensional CT scan is the best radiographic modality to evaluate its length and angulation but in the present study, digital panoramic radiographic view was used as it is frequently prescribed by the dental professionals along with

its low cost, lesser radiation exposure and extensive visualization of oral and maxillofacial structures including styloid process.^{18,19}

The mean styloid process length as reported by Eagle (1937) was 25 - 30 mm.^{20,21} The present study stated that the styloid process are longer in males than females and also increases as the age advances. A study conducted by Balcioglu et al.²² in 2009 on human dry skulls stated that the lengths are longer in males than females and also increases as the age advances. Another study conducted in 2011 on human dry skulls concluded the statistically significant differences between genders.²³

A radiographic study conducted by More et al²⁴ in 2010 on 500 panoramic radiographs reported the mean left and right length as 25.41 ± 6.32 mm and 25.53 ± 6.62 mm which is in context with the present study. The authors further concluded that males have larger styloid processes

than females and their length increases with advancing age. Hassan et al.²⁵ conducted similar study considering the importance of the styloid process stating that it is highly significant in assessing the gender in Iraqi population with p value less than 0.001. Another study published on Turkish population using panoramic radiographs stated the significant gender difference between the styloid processes lengths. The same study also concluded that there is significant differences even in age sub groups which are in accordance with the present study.²⁶

On the contrary, Bruno et al.²⁷ in 2017 conducted an epidemiological study using 1003 panoramic radiographs stating that there is zero correlation between age and the length of styloid process. Similar study conducted by Magat et al.²⁸ on 910 panoramic radiographs concluded no significant difference between styloid process characteristics, gender and age. The retrospective radiographic studies were conducted using 208 and 1000 CBCT's reported that there is no correlation between the styloid processes and genders. Authors even concluded CBCT as one of the alternative to other imaging modalities in the assessment of the styloid processes.^{29,30}

Till our knowledge, this is first study conducted on Rajasthan population evaluating the styloid processes prevalence. In the present study, 854 (22.47%) radiographs showed elongated styloid processes. Out of which, 542 (14.2%) and 312 (8.21%) showed right and left elongated styloid process respectively. The present study is in accordance with the study published by More and Asrani²⁴ showed elongated styloid process in 19.4% individuals. A study published on South Indian population³¹ reported with 24.8% prevalence and another similar study conducted in Mathura³², stated the peak occurrence of 52.1% in Northern population. Another panoramic study conducted on Turkish population stated only 7.7% prevalence of the styloid process.²⁶ Ilguy et al.³³ on evaluating the 860 panoramic radiographs concluded that 3.7% while Erol et al.³⁴ reported only 1.1% prevalence of the elongated styloid process. The greater predominance of elongated styloid process in the present study can be attributed to the dietary habits i.e. chewing hard food or arecanut, sternous exercises or workload, etc.

The present study reported the prevalence of the elongated styloid process and its significance in Rajasthan population. In the present study, smaller sample size was taken along with use of panoramic radiographs. Therefore, larger sample size along with advanced radiographic modality such as three dimensional CT scan is recommended for precise dimension of the styloid process.

Conclusion

The morphometric analysis of the styloid process of the temporal bone can be used as an adjuvant in age and sex discrimination using digital panoramic radiograph.

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Conflict of Interest: Nil.

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