

Prevalence of Elongated Styloid Process in a Central Brazilian Population

EVANICE MENEZES MARÇAL VIEIRA¹, ORLANDO AGUIRRE GUEDES², SYLVANIA DE MORAIS³, CARLO RALPH DE MUSIS⁴, PAULO ARTUR ANDRADE DE ALBUQUERQUE⁵, ÁLVARO HENRIQUE BORGES⁶

ABSTRACT

Background: Eagle's syndrome comprises a rare disorder caused by compression of an elongated or deformed styloid process or ossified/calcified stylohyoid ligament on neural and vascular structures. It is characterized by facial and neck pain and can be confused with a wide variety of facial neuralgias, oral and dental diseases and temporomandibular disorders. An imaging evaluation associated with a careful clinical examination, are mandatory in structuring a correct differential diagnosis and in the establishment of a proper therapeutic protocol.

Aim: To investigate the prevalence of the elongated styloid process in a Central Brazilian population and its relation to gender, age and side.

Materials and Methods: Digital panoramic radiographs of 736 patients (412 female and 324 male, with a mean age of 35.03 years) were consecutively selected from a private radiology clinic's secondary database. The apparent length of the styloid process was measured from the point where the styloid left the tympanic plate to the tip of the process by two specialists in

dental radiology, with the help of the measuring tools on the accompanying software. Styloid process measuring more than 30 mm was considered elongated. The statistical analysis included frequency distribution and cross tabulation. The data were analysed by using Chi-squared tests. The level of significance was set at 5% for all analyses.

Results: A total of 323 (43.89%) radiographic images were suggestive of elongated styloid process. No statistically significant difference was found between the genders, although a higher prevalence was noticed in female participants. Approximately, 31% of the elongated styloid process was observed in 18-53-year-old participants ($p < 0.05$). Two hundred and sixty seven styloid processes (36.28%) were elongated on both right and left sides.

Conclusion: The prevalence of elongated styloid process was high and no statistically significant correlation was found between the presence of elongated styloid process and the studied variables with the exception of the age.

Keywords: Anatomic variations, Digital panoramic radiography, Eagle's syndrome

INTRODUCTION

The styloid process (SP), which is derived from the Reichert's cartilage of the second branchial arch, is a cylindrical bony projection, of approximately 20 to 30 mm in length, located in the temporal bone, immediately in front of the stylomastoid foramen [1,2]. Elongated styloid process is a term used to describe SP that is longer than the normal [3]. Elongated styloid process and its clinical symptoms (neck and facial pain) characterize the Eagle's Syndrome (ES) [4].

The morphological characteristics of the SP have been studied in different populations [3,5-10] using different methodologies [11-14], including dried skull [14-16], panoramic radiographs [3,6,8-10], computed tomography (CT) [5,17-19] and cone beam computed tomography (CBCT) [1,20]. Although radiographic images are a two-dimensional representation of a three-dimensional structure, they are the primary resource available for study and represent a non-invasive method for diagnosis and treatment planning for the main procedures relating to the maxilla and mandible [21,22]. Panoramic radiograph has been shown to be a suitable tool for epidemiological studies and its imaging technique makes it extremely well suited for imaging findings in the maxillofacial complex.

There is limited information on the occurrence of elongated styloid process in the Brazilian population [7,11,15]. The geographical location specifies and race differences justify the analysis of the prevalence of the elongated styloid process in a Central Brazilian population, and its relation to gender, age and side using digital panoramic radiograph.

MATERIALS AND METHODS

The present study was performed as a retrospective analysis of panoramic radiographs of 736 patients (412 female and 324 male), aged between 3 and 88 years (mean = 35.03 years, standard Deviation=17.76), obtained between April and December 2010 and consecutively selected from a private radiology clinic's secondary database (CROIF - Buccal and Maxillofacial Diagnostic Center, Cuiabá, MT, Brazil). Panoramic radiographs with questionable SP, having positioning and magnification errors and with superimposed normal anatomical structures were excluded from the study. The study protocol was approved by the Research Ethics Committee of the University of Cuiabá (UNIC) (Protocol #2012-060). The patients signed an informed consent term.

All panoramic images were obtained using a Cranex[®] D equipment direct digital D system (Orion Corp., Soredex, Helsinki, Finland), using a high frequency DC generator (40 kHz) sensitized in a CCD sensor measuring 147.5 x 6.1 mm with 96 µm/pixel resolution, a tube voltage of 57 - 85 kV and a current of 10 mA, with 17.6 seconds of exposure time. The magnification factor reported by the manufacturer was 1.3. All participants were seated during the exam and were oriented to have their heads positioned with the Frankfurt horizontal plane parallel to the floor. The SP were measured with the help of the measuring tools of the accompanying software (DIGORA[®] for Windows 2.7 software, Orion Corp., Soredex, Helsinki, Finland), on a computer with an Intel[®] Processor Core TM 2 Duo 1.86 Ghz-6300 (Intel Corporation, USA), a glass plate NVIDIA GeForce 6200 Turbo Cache (NVIDIA Corporation, USA), running Microsoft Windows XP Professional SP-2 (Microsoft Corp., Redmond, WA, USA) and EIZO



[Table/Fig-1]: Digital panoramic radiographic with suggestive images of bilateral elongated styloid processes (arrows)

monitor - FlexScan S2000, resolution of 1600 x 1200 pixels (EIZO Nanao Corporation Hakusan, Japan) by two specialists in dental radiology who were both qualified and experienced in the analysis of panoramic examinations. The SP was measured from the point where the styloid left the tympanic plate to the tip of the process, regardless of whether or not the styloid process was segmented [23]. SP measuring more than 30 mm was considered elongated [23] [Table/Fig-1].

STATISTICAL ANALYSIS

All data were entered into Excel 2010 (Microsoft, Remond, WA, USA). The statistical analyses were carried out with SPSS for Windows statistical software (Version 15.0. SPSS Inc., Chicago, IL, USA) and included frequency distribution and cross tabulation. The data were analysed by using Chi-squared tests. The level of significance was set at 5% for all analyses. The interobserver agreement was assessed by kappa statistics in 10% of the sample.

RESULTS

The kappa coefficient was 0.89, which indicated an excellent degree of interobserver agreement. [Table/Fig-2] shows the distribution of SP as function of gender and age. A total of 323

	Normal styloid process	Elongated styloid process	p-value
Gender (n=736)			
Female	224 (30.43%)	188 (25.54%)	0.282
Male	189 (25.68%)	135 (18.35%)	
Age (n=736)			
≤ 17	121 (16.44%)	28 (3.80%)	0.001
18-35	111 (15.08%)	112 (15.21%)	
36-53	123 (16.71%)	119 (16.21%)	
≥ 54	58 (7.88%)	64 (8.69%)	

[Table/Fig-2]: Distribution of the styloid process according to gender and age

	Elongated styloid process		p-value
	Unilateral	Bilateral	
Gender (n=736)			
Female	36 (4.89%)	152 (20.65%)	0.310
Male	20 (2.72%)	115 (15.63%)	
Age (n=736)			
≤ 17	11 (1.49%)	17 (2.31%)	0.014
18-35	16 (2.17%)	96 (13.04%)	
36-53	20 (2.72%)	99 (13.45%)	
≥ 54	9 (1.22%)	55 (7.47%)	

[Table/Fig-3]: Prevalence of the elongated styloid process according to gender, age and side

(43.89%) radiographic images were suggestive of elongated styloid process. No statistically significant difference was found between the genders, although a higher prevalence was noticed in female participants. Approximately, 31% of the elongated styloid process

was observed in 18-53-year-old participants ($p < 0.05$). [Table/Fig-3] presents the prevalence of elongated styloid process as function of gender, age and affected side. Two hundred and sixty seven styloid processes (36.28%) were elongated on both right and left sides. Statistically significant difference was found only between age and affected side.

DISCUSSION

ES is a rare disease that develops because of compression of an elongated or deformed SP or ossified/calcified stylohyoid ligament on neural and vascular structures [1,4,11,18,20]. The signs and symptoms commonly associated with ES are: persistent throat pain, foreign body sensation, dysphagia, referred otologia, change voice and neck and facial pain [8,10,12]. Most of these signs and symptoms can be confused with some disorders including a wide variety of facial neuralgias, oral and dental diseases and temporomandibular disorders [8,11]. An imaging evaluation associated with a careful clinical examination, are mandatory in structuring a correct differential diagnosis and in the establishment of a proper therapeutic protocol [1,11,20,23]. Surgical treatment positively resolves the symptoms [1]. Nevertheless, the proximity of the elongated styloid process to the vulnerable structures and the risk of harming nerves and blood vessels during surgery should be taken into account when selecting the type of treatment [14].

The motivation for this study was the lack of data on the prevalence of elongated styloid process in Brazilian population [7,11,15]. Leite et al., analysed the occurrence of additional mineralization in the SP in 501 dried skulls [15]. Ninety-eight (19.56%) of them were found to show evidence of elongated styloid process. In another study, Rizzatti-Barbosa et al., investigated the prevalence of stylohyoid ligament complex (STC) elongation in panoramic radiographs of 2252 partially edentulous patients [7]. Four hundred and fifty-one radiographs (20%) displayed mineralization in the area of the ligaments or elongation of the SP. de Andrade et al., investigated the relationship between the intensity of temporomandibular disorders (TMD) and SP elongation and calcification [11]. Fifty patients with TMD were examined clinically and radiographically (digital panoramic and lateral cephalometric radiographs). An incidence of 76% elongation of the SP was observed in the sample.

Panoramic radiography was selected because it is a routine exam requested by the dentist that offers the possibility of extensive visualization of the structures of the maxillofacial complex, including the full length of SP [3,17,20,22]. In addition, panoramic radiographs are a low-cost procedure with lower radiation exposure compared to CT and are easy to interpret [2,11,19]. However, caution is recommended when analysing and performing absolute measurements and relative comparisons for this type of examination because of the possible overlapping of anatomical structures (mandibular bone and teeth) and the occurrence of distortions and magnifications [2,6,9,17,19-21]. The interpretation of imaging exams demands a familiarity with the anatomical structures and anatomical variations and abnormalities that can affect the area. In the present study, two specialists in dental radiology with expertise in the analysis of panoramic radiographs analysed the images. Furthermore, the ESPs were determined according to the method described by Ilgüy et al., [23].

The results of the present study revealed a high prevalence (43.89%) of elongated styloid process in a Central Brazilian population. This prevalence is higher than those recorded by Rizzatti-Barbosa et al., (20%) and Leite et al., (19.56%) and lower than the one recorded by de Andrade et al., (76%) [7,11,15]. However, this figure is consistent with previous panoramic radiographic studies reported in the literature [4,6,8,9,12,19,20], which observed a prevalence of elongated styloid process ranging from 1.4 to 83.6%. The wide variation in the prevalence of elongated styloid process observed in studies conducted in different locations can be

explained by the variations in the diagnostic and image interpretation criteria, geographical location and local population particularities [1,8,17,18].

Regarding gender, elongated styloid process was slightly more frequently found in females than in males (1.39:1). This finding contrasts with the data reported by other authors [5,9,13,22], who identified a higher prevalence of elongated styloid process among the male population. However, Ilgüy et al., observed a female-male ratio of 3:1 when determining the incidence of elongated styloid process in patients referred to a dental clinic [23]. The present study was conducted in a private radiology clinic, and the panoramic exams were undertaken for different diagnoses purposes, such as surgical planning, oral disease diagnosis and orthodontic diagnosis. The higher prevalence of elongated styloid process among women observed in this analysis may be associated with more women than men being referred to the diagnostic imaging service and may not be a true predilection.

In the present study, the age of the patients with radiographic images indicating elongated styloid process ranged from 8 to 88 years. There was statistical difference between age groups in terms of the elongated styloid process prevalence. A high number of elongated styloid process was observed in participants in the 18-53-year-old age group (231/267). It has been reported a progression in the length of calcification with advancing age [9]. Anbiaee and Javadzadeh used panoramic radiographs to measurement of SP length and indicated that SP length was associated with increasing age [21]. Ekici et al., registered the highest rate of elongated styloid process (values over 30 mm) in the groups in the fifth decade of life (65.4%) [19]. Al-Khateeb et al., found a significantly increased mean true length of mineralized stylohyoid complex with advancing age [10]. For the authors, this phenomenon is caused by age-related degeneration of the ligamentous complex and a general tendency toward the deposition of calcium salts. However, Basekim et al., observed that the length and angle values of different age groups were not significantly different [17]. The same was observed by Gözil et al., [5]. It is necessary to be careful at comparing the prevalence among the studies the used different methodologies, due to the absence of a standard in the definition of the age groups to be studied.

The present study aimed to collect information about the prevalence of elongated styloid process in the city of Cuiabá, a town in the Midwest region of Brazil. The standardization of participants with regard to their medical and dental histories, racial characteristics, facial biotype, environmental influences, dietary habits and socioeconomic factors could not be established in the present study. Investigations using other imaging methods, such as cone beam computed tomography, with a greater number of participants should be performed to establish three-dimensional correlations.

CONCLUSION

The prevalence of elongated styloid process was high (43.89%). Females and those aged 18-53 years were the groups with the greatest numbers of cases.

REFERENCES

- [1] Andrei F, Motoc AGM, Didilescu AC, Rusu MC. A 3D cone beam computed tomography study of styloid process of the temporal bone. *Folia Morphol.* 2013;72(1):29-35.
- [2] Alpoz E, Akar GC, Celik S, Govsa F, Lomcali G. Prevalence and pattern of stylohyoid chain complex patterns detected by panoramic radiographs among Turkish population. *Surg Radiol Anat.* 2014;36(1):39-46.
- [3] Okabe S, Morimoto Y, Ansai T, Yamada K, Tanaka T, Awano S, et al. Clinical significance and variation of the advanced calcified stylohyoid complex detected by panoramic radiographs among 80-year-old subjects. *Dentomaxillofac Radiol.* 2006;35(3):191-99.
- [4] Sisman Y, Gokce C, Ertas ET, Sipahioğlu M, Akgunlu F. Investigation of elongated styloid process prevalence in patients with torus palatinus. *Clin Oral Invest.* 2009;13(3):269-72.
- [5] Gözil R, Yener N, Çalgüner E, Araça M, Tunç E, Bahçelioglu M. Morphological characteristics of styloid process evaluates by computerized axial tomography. *Ann Anat.* 2001;183(6):527-35.
- [6] Kursoglu P, Unalan F, Erdem T. Radiological evaluation of the styloid process in young adults resident in Turkey's Yeditepe University faculty of dentistry. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod.* 2005;100(4):491-94.
- [7] Rizzatti-Barbosa CM, Ribeiro MC, Silva-Concilio LR, Di Hipolito O, Ambrosano GM. Is an elongated stylohyoid process prevalent in the elderly? A radiographic study in a Brazilian population. *Gerodontol.* 2005;22(2):112-15.
- [8] Gokce C, Sisman Y, Ertas ET, Akgunlu F, Ozturk A. Prevalence of styloid process elongation on panoramic radiography in the Turkey population from Cappadocia region. *Eur J Dent.* 2008;2(1):18-22.
- [9] More CB, Asrani MK. Evaluation of the styloid process on digital panoramic radiographs. *Indian J Radiol Imaging.* 2010;20(4):261-65.
- [10] Al-Khateeb TH, al Dajani TM, AL Jamal GA. Mineralization of the stylohyoid ligament complex in a Jordanian sample: a clinicoradiographic study. *J Oral Maxillofac Surg.* 2010;68(6):1242-51.
- [11] de Andrade KM, Rodrigues CA, Watanabe PCA, Mazzetto MO. Styloid process elongation and calcification in subjects with TMD: clinical and radiographic aspects. *Braz Dent J.* 2012;23(4):443-50.
- [12] Bagga MB, Kumar CA, Yeluri G. Clinicoradiologic evaluation of styloid process calcification. *Imaging Sci Dent.* 2012;42(3):155-61.
- [13] Sudhakara Reddy R, Kiran CS, Madhavi NS, Raghavendra MN, Satish A. Prevalence of elongation and calcification patterns of elongated styloid process in south India. *J Clin Exp Dent.* 2013;5(1):e30-35.
- [14] Natsis K, Repousi E, Noussios G, Papatheanasiou E, Apostolidis S, Piagkou M. The styloid process in a Greek population: an anatomical study with clinical implications. *Anat Sci Int.* 2015;90(2):67-74.
- [15] Leite HF, Niccoli-Filho WD, Liberti EA, Madeira MC, Simões S. Prevalence of elongated stylohyoid ligament complex in human skulls. *Rev Odontol UNESP.* 1988;17(1):145-51.
- [16] Patil S, Ghosh S, Vasudeva N. Morphometric study of the styloid process of temporal bone. *J Clin Diagn Res.* 2014;8(9):AC04-06.
- [17] Basekim CC, Mutlu H, Güngör A, Silit E, Pekkaflali Z, Kutlay M, et al. Evaluation of styloid process by three-dimensional computed tomography. *Eur Radiol.* 2005;15(1):134-39.
- [18] Cullu N, Deveer M, Sahan M, Tetiker H, Yılmaz M. Radiological evaluation of the styloid process length in the normal population. *Folia Morphol.* 2013;72(4):318-21.
- [19] Ekici F, Tekbas G, Hamidi C, Onder H, Goya C, Cetinçakmak MG, et al. The distribution of stylohyoid chain anatomic variations by age groups and gender: an analysis using MDCT. *Eur Arch Otorhinolaryngol.* 2013;270(5):1715-20.
- [20] Öztunç H, Evlice B, Tatli U, Evlice A. Cone-beam computed tomographic evaluation of styloid process: a retrospective study of 208 patients with orofacial pain. *Head Face Med.* 2014;10(2):5.
- [21] Anbiaee N, Javadzadeh A. Elongated styloid process: is it a pathological condition? *Indian J Dent Res.* 2011;22(5):673-77.
- [22] Shaik MA, Naheeda, Kaleem SM, Wahab A, Hameed S. Prevalence of elongated styloid process in Saudi population of Aseer region. *Eur J Dent.* 2013;7(4):449-54.
- [23] Ilgüy M, Ilgüy D, Güller N, Bayirli G. Incidence of the type and calcification patterns in patients with elongated styloid process. *J Int Med Res.* 2005;33(1):96-102.

PARTICULARS OF CONTRIBUTORS:

1. Associate Professor, Department of Oral Diagnosis, School of Dentistry, University of Cuiabá, Cuiabá, Mato Grosso, Brazil.
2. Associate Professor, Department of Endodontics, School of Dentistry, University of Cuiabá, Cuiabá, Mato Grosso, Brazil.
3. Associate Professor, Department of Oral Diagnosis, School of Dentistry, University of Cuiabá, Cuiabá, Mato Grosso, Brazil.
4. Associate Professor, Department of Oral Diagnosis, School of Dentistry, University of Cuiabá, Cuiabá, Mato Grosso, Brazil.
5. Associate Professor, Department of Oral Diagnosis, School of Dentistry, University of Cuiabá, Cuiabá, Mato Grosso, Brazil.
6. Associate Professor, Department of Endodontics, School of Dentistry, University of Cuiabá, Cuiabá, Mato Grosso, Brazil.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:

Dr. Orlando Aguirre Guedes,
School of Dentistry, University of Cuiabá, Av. Manoel José de Arruda, 3100, Bairro Jardim Europa,
Cuiabá, Mato Grosso, Brazil, CEP: 78015-000.
E-mail: orlandoaguedes@yahoo.com.br

FINANCIAL OR OTHER COMPETING INTERESTS: None.

Date of Submission: **Apr 21, 2015**

Date of Peer Review: **Jun 27, 2015**

Date of Acceptance: **Aug 03, 2015**

Date of Publishing: **Sep 01, 2015**