Original Article

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Radiographic Length of Styloid Process as Determinant of Eagle's Syndrome in North Indian Population

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Abstract

Introduction: The word styloid process has been originated from the word 'stylos,' which means, the pillar in Greek language. Styloid processes longer than 30mm are called elongated styloid processes. Normal length of styloid process in adults can vary between 20 and 25 millimeters.Styloid processes longer than 30mm are called elongated styloid processes. The elongation of styloid process causes clinical symptoms like neck and cervicofacial pain and described as Eagle syndrome. *Objective*: This research article aims at establishing the Eagle's standard measurement of styloid process as diagnostic tool for Eagle's syndrome in North Indian Population. It also evaluates the age and sex related prevalence of eagle's syndrome. *Materials and Methods*: The orthopantomograms of 200 subjects were taken from planmeca promax-dimax4 OPG machine at 66 Kvp, 8mA and exposure time 16 sec. All the measurements are done on digital orthopantomograms using planmeca Romexis 3.2.0R software. The study parameters are measured using mouse-driven method by moving the mouse and drawing lines using chosen points on the digital panoramic radiograph as follows-From base of styloid process to tip of styloid process. *Results:* The study population consists of 200 subject aged between 9 and 77 years with a mean age of 39.11±16.65 years. The sex ratio in our study population showed that male subject proportion was higher than female i.e. 55.5% and 44.5% respectively. Majority of the patients were between 18 to 35 years of age. According to Eagle, the styloid length greater than 30 mm is considered as pathologic condition, the frequency of occurrence of eagle's syndrome is estimated in study population. It was found that length of right styloid process(> 30 mm) is higher in 81.5% study population than 18.5% study population (<=30 mm). However the length of left styloid process (>30mm) is higher in 80.5% than 19.5%(<=30). However the length of styloid process (>30mm, <=30mm) is co-related in age groups. The length of right styloid process is not associated in age groups and statistically non-significant (P>0.05). However the length of left styloid process is srongly associated in all age groups. This association is statistically significant (P<.01). It was also concluded that Eagle's syndrome is more common in males than females. *Conclusion:* Dentists should recognize the existence of morphological variation in calcified stylohyoid complexes especially in length apparent on panoramic radiographs. The present research paper concludes that the length of styloid process can be used as diagnostic tool in determination Eagle's Syndrome.

Keywords: Styloid Process; Eagle's Syndrome; Panoramic Radiograph.

Introduction

The age and sex estimation is one of the most important steps in identification of the biological profile of the dismembered and skeletal remains. The accuracy of skeletal sex estimation relies on the sexual dimorphism exhibited by the human body. From previous studies, the pelvis and skull have been considered the most reliable for identification of the sex of unknown remains [1]. Additionally, studies on the sex estimation have been conducted on various skeletal elements such as the scapula, sternum, clavicle, patella, hand and foot bones [2,3,4]. However no studies have been focused on the sex estimation using the styloid process.

The word styloid process has been originated from the word 'stylos,' which means, the pillar in Greek

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language [5]. This process belongs to the temporal bone of the skull and it lies anterior to the stylomastoid foramen. Being cylindrical in shape, the styloid process gradually tapers towards the apex just like a pinnacle. Its apex is located next to the tonsillar area in the lateral wall of pharynx, between external and internal carotid arteries. Its tip provides attachment to the stylohyoid ligament. There are few structures blended to the stylos process, which are in relation to the nerves and vessels. The stylopharyngeus, stylohyoid and styloglossus are the muscles which attach to the base, middle part and tip of the styloid process respectively. These muscles get the innervations from the 9th, 7th, and 12th cranial nerves [6]. Spinal accessory and vagus nerves run medial to the styloid process. The facial nerve runs anteromedial to this process before piercing the substance of the parotid gland. Glossopharyngeal nerve curves in close proximity to the stylos process. The styloid process is a cylindrical bony projection extending from the petrous portion of the temporal bone. It lies in front of the stylomastoid foramen and projects downwards, forwards, and slightly towards the medial side. The location of the apex of the styloid process is clinically important, which is located between internal carotid and external carotid arteries, posterolateral to the tonsillar fossa and laterally from the pharyngeal wall. There are many structures surrounding the styloid process, such as the facial nerve crosses to the base and external carotid artery crosses its apex of this process before embedded in the parotid gland. In addition, three muscles and two ligaments are attached to the styloid process. Stylopharyngeus, stylohyoid and styloglossus muscles are attached to the base, middle part and tip of the styloid process, respectively. The stylohyoid and stylomandibular ligaments extend from the tip of the styloid process to the hyoid bone and the angle of mandible, respectively [7].

Normal length of styloid process in adults can vary between 20 and 25 millimeters [8]. Styloid complex includes three chief sections; styloid tuberocity, styloid ligament, and little horn of hyoid bone [9]. Styloid tuberocity is situated in the parapharyngeal cavity in the purlieu of vascular and neural constructions which could be motivated by lengthened or inappropriate styloid tuberocity and grounds several complications [10]. Calcification of the styloid tuberocity begins before birth and continues up to eight years of age [10]. The length of this tuberocity varies significantly in various populations and also differs among people of the same population [10,11,12]. Furthermore, the normal length of the tuberocity seems to be in the range from 20 to 30 mm [13,14,15], while there are also studies that described this range as between 20-25 mm [14]. However Eagle has outlined that the normal length of styloid tuberocity is in a range from 25 to 30 mm [10]. In the cases that the length of the tuberocity is higher than 30 mm, it is called an elongated tuberocity [13,11]. Some studies have reported that almost four percent of world population is suffering from an elongated styloid tuberocity [12,16]. Nevertheless, some studies have explained that the prevalence of this type of styloid tuberocity is as high as 28 percent [13]. In addition, it is observed that the prevalence of elongated styloid tuberocity is higher on the right side in comparison to its prevalence in the left side which can be attributed to a higher activity of the right hemi mandible in right-hand people during chewing [10].

Styloid processes longer than 30mm are called elongated styloid processes (ESP) [17,18,19]. Incidence of elongation of styloid process is around 4–7% however only 4% of patients with elongated styloid process show the symptoms [17,20]. The elongation of styloid process causes clinical symptoms like neck and cervicofacial pain and described as Eagle syndrome [18,21]. This sign and symptoms are believed to be formed due to styloid process pressure on nerve and vascular structures situated around the styloid process like facial nerve or internal or external carotid arteries. More occasionally, dysphagia, tinnitus and otalgia can occur in Eagle syndrome.

Materials and Methods

The orthopantomograms of 200 subjects were taken from planmeca promax-dimax4 OPG machine at 66 Kvp, 8mA and exposure time 16 sec. All the measurements are done on digital orthopantomograms using planmeca Romexis 3.2.0R software.The subject was positioned properly in the panoramic machine set up so that the jaws were within the focal trough as per the methodology described by Langland, Langlais and Morris (1982). The subject was made to stand erect with back straight. The height was adjusted by pressing the adjustable knob. The subjects were explained about the working of the machine. The operation of the panoramic machine was demonstrated to the subjects and the subjects were apprised of the need to be still during the procedure. Jacket, sweater and bulky dress materials were removed so that there could be sufficient space between the bottom of the cassette holder and patients shoulder. The subject was made to wear a lead apron and was positioned carefully in the focal through with the help of bite block covered with occlusal disposable envelope and head holder of the machine so that the lower border of mandible was equidistant

on each side from the chin support and perpendicular to the Frankfurt horizontal plane. Frankfurt horizontal plane was maintained parallel to the floor of the clinic. The patient's midsagittal plane was positioned in the center of the focal trough of the x-ray unit by asking the patient to bite with his central incisors (upper and lower). The patient was asked to close the lip and place the tongue against the palate. Automatic exposure parameters were selected. After all the adjustments were made, appropriate 66 Kvp and 8mA were selected and exposure were made at 16 sec of exposure time by depressing the control switch of the panoramic machine.

The orthopantogram is displayed on console computer. The image is saved and stored in computer. Then image of orthopantogram is opened with inbuilt planmeca Romexis 3.2.0R software for measurement of study parameters. The study parameters are measured using mouse-driven method by moving the mouse and drawing lines using chosen points on the digital panoramic radiograph as follows (Figure 1)- From base of styloid process to tip of styloid process.

Statistical Analysis

Categorical variables will be presented in number and percentage (%) and continuous variables will be presented as mean and SD. Quantitative variables will be compared using Unpaired t-test between two groups and ANOVA between three groups. The data were analyzed by the discriminant function analysis using Fischer exact test. Pearson correlation coefficients were used to determine the relationship between two scale parameters. A p value of <0.05 will be considered statistically significant. The data will be entered in MS EXCEL spreadsheet and analysis will be done using Statistical Package for Social Sciences (SPSS) version 21.0.

Results

The study population consists of 200 subject aged between 9 and 77 years with a mean age of 39.11±16.65 years (Table 1). The sex ratio in our study population showed that male subject proportion was higher than female i.e. 55.5% and 44.5% respectively (Table 2). Majority of the study subjects were between 18 to 35 years of age. There were 67 patients 18 to 35 years (33.5%), 23 patients below 18 years (11.5%) and 58 patients 36 to 50 years (29%) and 42 patients 51 to 65 years (215%) and rest 10 patients above 65 years (5.0%) (Table 3).

According to Eagle the styloid length greater than 30 mm is considered as pathologic condition characterized by Sharp, shooting pain in the jaw, back of the throat, base of the tongue [22], ears, neck, and/or face [22], *Difficulty swallowing* [22], Sensation of having a foreign object in throat [22], Pain from chewing, swallowing, turning the neck, or touching the back of the throat [23], *Ringing or buzzing in the ears.*

Keeping the above standards in mind the frequency of occurrence of eagle's syndrome is Estimated in study population. It was found that length of right

Table 1:

	N	Minimum	Maximum	Mean	Std. Deviation
Age	200	9.00	77.00	39.1100	16.64763

Table 2:

Sex	Frequency	Percent
Male	111	55.5
Female	89	44.5
Total	200	100.0

Table 3:

Age intervals	Frequency	Percent
Below 18 years	23	11.5
18 to 35 years	67	33.5
36 to 50 years	58	29.0
51 to 65 years	42	21.0
More than 65 years	10	5.0
Total	200	100.0

Table 4:

Length of Right Styloid process	Frequency	Percent
<=30	37	18.5
>30	163	81.5
Total	200	100.0

Table 5:

Length of Left Styloid process	Frequency	Percent
<=30	39	19.5
>30	161	80.5
Total	200	100.0

Table 6:

Age Intervals	Length of Right Styloid process <=30	>30	Total
Below 18 years	7 18.9%	16 9.8%	23 11.5%
18 to 35 years	16 43.2%	51 31.3%	67 33.5%
36 to 50 years	6 16.2%	52 31.9%	58 29.0%
51 to 65 years	8 21.6%	34 20.9%	42 21.0%
More than 65 years	0 .0%	10 6.1%	10 5.0%
Total	37 100.0%	163 100.0%	200 100.0%

P value=0.081

Table 7:

Age intervals	Length of Left Styloid process <=30	>30	Total
Below 18 years	8 20.5%	15 9.3%	23 11.5%
18 to 35 years	14 35.9%	53 32.9%	67 33.5%
36 to 50 years	8 20.5%	50 31.1%	58 29.0%
51 to 65 years	4 10.3%	38 23.6%	42 21.0%
More than 65 years	5 12.8%	5 3.1%	10 5.0%
Total	39 100.0%	161 100.0%	200 100.0%

P=0.010

styloid process (> 30 mm) is higher in 81.5 % study population than 18.5% study population(<=30 mm) (Table 4). However the length of left styloid process (>30mm) is higher in 80.5% than 19.5%(<=30) (Table 5). However the length of styloid process (>30mm, <=30mm) is co-related in age groups (Table 6). It was found that length of right styloid process is not associated and statistically non-significant in all age groups(P>0.05) (Table 6). However the length of left styloid process is srongly associated in all age groups.

This association is statistically significant (P<.01) (Table 7).

The lenghth of styloid process is also studied in males and females. The right styloid process length (>30mm) was more in male population (55.8%) than females (44.2%).

However this association is statistically non-significant (P>0.05) (Table 8). In left side, the length (>30mm) of styloid process was more in male population (56.5%) than females (43.5%) (Table 9). So it can be concluded that eagle's syndrome is more common in males than females.

Discussion

Embryologically the styloid process, stylohyoid ligament and the lesser cornu of the hyoid bone are developed from the second brachial arch called as the Reichert's cartilage because it is of cartilaginous origin [24]. The ligament has the potential to mineralize. Anatomical variation in the length of the styloid process and its stylohyoid chain is of profound anatomical, anthropological as well as clinical importance. Styloid process elongation can occur unilaterally or bilaterally [25].

There are investigators claiming that the phenomenon is most common unilaterally but others are contrary to these claims. It has been suspected that an elongated styloid process could be caused by: congenital elongation of the styloid process due to persistence of the cartilaginous analogue of the Styloid, calcification of the stylohyoid ligament by unknown mechanism and growth of osseous tissue at the insertion of the stylohyoid ligament [26].

Elongation of styloid process was described by Eagle for the first time as clinical symptoms and signs seen with structural changes in styloid ligament. there were some studies done using a panoramic radiograph and a three-dimensional computed tomography scan on length of styloid Process [27,28,29].

Thot et al [7] have reported that left styloid process length is between 0.7 and 1.6 centimeters and right styloid process length is between 0.8 and 2.4 centimeters. In the same study, average styloid process length is reported to be 1.49 cm on the right and 1.52 cm on the left [30]. Jung et al [31] have stated that, in order for the styloid process to be deemed elongated, the length should exceed 45 millimeters.

On the other hand Balbuena et al [32] suggested that the styloid process with its length larger than 30 mm is generally regarded as the elongated styloid process and a representative of Eagle's syndrome. The Engle's syndrome characterized by the elongated styloid process was first described by Eagle et al [33] and it is a rare disease in which the elongated process compresses neurovascular structures surrounding it. This syndrome is classified into 2 types; one of the two, termed the classical type is characterized by a persistent pain in the throat and ear, and a foreign body sensation in the throat. The other type is characterized by dizziness and headache probably due to the compression of the carotid artery by the elongated processes.

Regarding gender, Woolery et al [34] stated that the elongated styloid process or Eagle's syndrome occurred more frequently in females. In contrast, Bozkir et al [35] reported that styloid processes were elongated more in males than females.

Ilgüy et al [36], observed a female male ratio of 3:1 when determining the incidence of elongated styloid process in patients referred to a dental clinic. Keur et al [37] states that, if the length of the process or the mineralized part of ligaments appear radiography is 30 mm and more, this can be considered as elongated styloid process.

W Sakaew et al [38] founded that the unilateral elongated styloid process was more frequently found on the left than the right side in both males and females.

Krenmair et al [39] also found a positive correlation between the age and styloid process. As age increases, styloid would undergo calcification, which can be considered as a possible explanation of observing a higher length of styloid in elders. However, he did not observed a significant association between gender and the length of this tuberocity.

But in our study we concluded that the male patient proportion was higher than female i.e. 55.5 % and 44.5% respectively.

We also stated that out of 200 subjects percentage of occurrence of the length of Right styloid process (>30mm) was higher than (<=30mm) i.e. 81.5% and 18.5% respectively and on left side out of 200 subjects percentage of occurrence of length of Left styloid process (>30mm) was higher than (<=30mm) i.e. 80.5% and 19.5% respectively.

A higher percentage were obtained in 18 to 35 years of age in <=30mm group i.e. 43.2% and 36 to 50 years of age and slightly lower in 18 to 35 years of age in >30 mm group. Statistically this association was not significant (P>0.05)as far as right styloid process is concerned. On contrary higher percentage were obtained in 18 to 35 years of age in <=30 group i.e. 35.9% and also in >30mm group i.e. 32.9% and statistically this association was significant (P<0.05).

On evaluation of gender with right styloid process, a higher percentage were obtained in males compared with female in <=30mm group i.e. 54.1% and also in >30mm group i.e. 55.8%. Statistically this association was not significant (P>0.05).

On contrary evaluation of gender with left styloid process, higher percentage were obtained in males compared with female in <=30mm group i.e. 51.3% and also in >30mm group i.e. 56.5%. Statistically this association was not significant (P>0.05).

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