Introduction

Styloid process (SP) is derived from the Greek word “Stylos” meaning a pillar. It is usually a cylindrical bone which arises from the temporal bone and located anteriorly to the stylomastoid foramen\(^1\). Embryologically the SP, lesser cornu of hyoid bone and stylohyoid ligament are derived from the second brachial arch known as the Reichert’s cartilage\(^2\). According to Magotra and Radzan (2008)\(^3\), the stylohyoid chain consists of four parts:

- The tympanohyal which forms the base of SP.
- The stylohyal which forms major portion of the SP.
- The ceratohyal part, which forms the stylohyoid ligament.
- The hypohyal which forms the minor horn of the hyoid bone.

Due to the cartilaginous nature of the stylohyoid ligament, it has the potential to ossify causing variations.

Normal range of the SP length differs in cited literature. According to Eagle (1949)\(^4\), the normal SP measures between 2.5 and 3cm respectively. However, according to Jung et al., (2004)\(^5\), SP showing lengths between 3cm and 3.8cm is not considered as elongated as about 20% of normal subjects exhibit such lengths and 30% even greater.

Eagle was the first person to describe the clinical signs of elongated SP, thus the name “Eagle’s syndrome”. It is often diagnosed based on thorough clinical examination which includes proper history, palpation of the tonsillar fossa and radiological imaging to depict the SP\(^6\). The symptoms include throat pain, referred otalgia, dysphagia, pain aggravated by head and neck movement, foreign body sensation, pain on extension of the tongue and on opening mouth, discomfort during chewing and change in voice\(^7\). Clinical symptoms of Eagle’s syndrome vary and are often misdiagnosed. Although only small percentages (between 1% and 5%) of patients with elongated SP were reported to actually be symptomatic, the clinicians need to be aware of this diagnostic possibility in a patient\(^8\).

Over the years, conventional radiographic imaging such as orthopantomogram (OPG) and lateral oblique view of the mandible has been used to detect elongated SP; however difficulty in accurate estimation of the SP length poses a problem in diagnosis and management of patients with Eagle’s syndrome\(^9\). Thus, cone beam computed tomography (CBCT) has been recommended for evaluation of these anatomical structures as it allows creation of images not only in the axial plane, but also two dimensional images in the coronal, sagittal and oblique planes; a process referred to as multiplanar reformation\(^10\). Although there have been many studies that aimed to establish SP length using CBCT and OPG, the significance of measurement difference between 3D image in comparison to 2D is hazy.

The aim of this study was to compare between OPG and CBCT measurement of SP length and determine whether it is necessary to perform CBCT for accurate measurement of SP. A total of 21 subjects (13 Female and 8 Male) were included in this study. The mean age of the patient was 24.48 ± 7 years. All patients came for dental treatment in Hospital Universiti Sains Malaysia (HUSM) and indicated for OPG. The length of the SP was measured as the distance from the point where the SP left the tympanic plate to the tip of the process using Planmeca Romexis software. Mean length of SP as measured on OPG is 23.70 ± 1.46 mm on the right side and 24.09±1.54 on the left side and on CBCT is 27.60 ±1.52mm and 27.91±1.58mm on the right and left side respectively. No disparities between the measurements of SP using OPG and CBCT as well as between right and left side were observed. OPG provides reliable measurement and can still be used to measure this anatomical structure. CBCT is a valuable diagnostic imaging tool which makes accurate length measurements of SP presents with complex anatomy such as tortuous, angulation and segmentation.

Materials and Methods

A total of 21 subjects (13 Female and 8 Male) were included in this study. The mean age was 24.48 (SD = 7.00) years (Age range 18-67 years). All patients came for dental treatment in HUSM and indicated for OPG. The consent to participate in study was obtained. Patients who are pregnant, has fracture or pathology in the region of SP, or with symptoms of orofacial pain since no data is available as yet.
For standard horizontal placement of the OPG, the patients’ Frankfurt plane is placed parallel to the floor and to the laser light and the canines coincide with the laser for the mid-sagittal placement.

OPG radiographs were taken with a digital panoramic system under standard exposure factors as recommended by the manufacturer using 62-66 kV, 13 mA and 15 seconds exposure time according to the patient’s size. While the CBCT examinations had been taken using 90 kV, 10 mA and 12 seconds exposure time and by positioning the reference points on the face of the patients (centre line, frankfurt horizontal plane, and condyle guide light).

Planmeca Romexis 2.9.2.R. software was used to measure CBCT and OPG of 21 patients. Two qualified authors measured all the radiographs. Each authors were measured radiographs twice in a 24 hours interval between the first and second measurement. All the individuals’ results are discussed and a mean value was taken.

The length of the SP was measured as the distance from the point where the SP left the tympanic plate to the tip of the process, regardless of whether or not the SP was segmented. If the cranial part of the SP is not visible, the length between the probable attachment point to the calvaria and the tip of SP is measured.

Statistical analysis
Data was statistically analyzed by using IBM SPSS statistics version 22.0 (SPSS Inc, Chicago, IL, USA). Descriptive statistics showed distribution of data and independent t test was performed to compare the
mean radiographic length of SP between OPG and CBCT. A p value of <0.05 was considered statistically significant.

Results

Table 1 shows the mean length of SP as measured on OPG is 23.70mm (SD = 1.46) on the right side and 24.09 mm (SD = 1.54) on the left side. Meanwhile, the mean length of SP on CBCT is 27.60mm (SD =1.52) and 27.91mm (SD = 1.58) on the right and left side respectively.

Table 2 revealed that there was no statistically significant difference between CBCT and OPG, regarding measurement of SP length on both the right (p=0.072) and left side (p=0.091).

Table 3 shows there was no side disparities of length of SP, which also not significant in statistical analysis.

Discussion

OPG has long been used as a diagnostic tool for assessment of SP due to its advantages over other views such as lateral oblique view of the skull, Towne’s view and trans-oral view. However, previous studies done by More et al., (2010)12 and Piagkou et al., (2009)13, have suggested that CBCT provides precise linear measurements for reconstruction and imaging of oral and maxillofacial structures. With the introduction of this new technology, increasingly higher number of researchers have utilised 3D CBCT as a diagnostic tool for assessment of SP to get a more accurate reading. This is because some cases have shown that patients with normal 2D measurement of SP presented with similar orofacial pain symptom as the one with elongated SP. Therefore, the use of 3D CBCT to confirm the measurement of SP length obtained from OPG is of interest. The present study aimed to establish the difference in measurement of SP length between the two radiographic modalities of OPG and CBCT and to justify the need to perform CBCT when assessing patients with orofacial pain. This study revealed that there was no statistical significant difference of length of SP measurement using CBCT and OPG for both the right (p=0.072) and left side (p=0.091) respectively. Moreover, it was observed that some SP appeared to be tortuous, segmented and calcified when viewed using CBCT but this anatomical variation could not be appreciated in OPG, thus leading to misinterpretation of SP length. A similar study conducted by Mohamed et al., (2014)8, which compared the length of SP between OPG and CBCT in Iraqi population also showed no significant difference between these two imaging techniques. It was observed that measurement of SP in CBCT is bigger than OPG which is in conformity with the observation done in our study. Upon measurement of SP on OPG, it was found that the basal part of temporal bone was slightly obscured leading to under measurement of SP length on OPG. In a separate study by Nayak et al., (2006)9, states that OPG is fairly accurate in assessing elongated SP but skeletal over-projection and radiographic enlargement of 11% in that region prevents accurate measurement. This is a possible explanation as to why there are difference in measurements obtained between OPG and CBCT. Furthermore, a research done by Ramadan et al., (2007)10 shows that although OPG has the ability to determine the variations of SP, they are unable to show the orientation and dimensions of this bone. In Figure 1, Figure 2 and Figure 3 showing measurement of right and left SP in OPG and CBCT. There were not much difference in the measurement of length of SP in OPG and CBCT. But in case of angulation and orientation of the SP which could not be appreciated in OPG. In accordance with Zaman et al., (2016)14 comparison between OPG and CBCT, OPG is more commonly recommended because CBCT exposes higher doses of radiation to the patient.

Present study revealed that the mean length of SP in OPG was 23.90 (SD=6.8) mm. This finding is consistent with the study done in India by Phulambrikar et al., (2011)15, which reported 23.20 (SD=10.70) mm as the mean length but is not in accordance with Monsour and Young (1986)16, whose found the mean length of SP on OPG was 29.20 (SD=4.85) mm. As for the CBCT, the mean length of SP in the present study was 27.76 (SD=6.9) mm which was in conformity with the results of a study done by Ilguy et al., (2013)17. Moreover, in a study Andrei et al., (2013)18 reported a longer mean length of SP using CBCT which was 35.09 (SD=8.9) mm.

This study shows that there is no significant difference between CBCT and OPG in terms of measurement of SP length, therefore OPG provides reliable measurement and can still be used to measure this anatomical structure. However the 3D CBCT technique should be considered to confirm the finding from OPG as a few cases of SP presents with complex anatomy such as tortuous, angulation and segmentation.

Conflict of Interest

The authors have declared that no COI exists

References

