Evaluation of styloid process by 3-dimensional computed tomography in Iraqi samples.

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ABSTRACT

Background: The aims of this study were to measure the length and the anterior angulations of the styloid process (SP) and to study its morphology by 3-dimensional computed tomography reconstruction (3D-CT).

Materials and Methods: 3D-CT scan were performed for 90 Iraqi patients (38 females and 52 males), age range (17-91 years). The length and anterior angulations of SP were measured and its morphology was evaluated on 3D-reconstructed images which were obtained from those patients.

Results: The length of the bony SP on both sides varied from 0.9 cm to 6.2 cm, SPs were longer in males than females and the right SPs were longer than the left SPs. The anterior angulations ranged between 57°-96°. According to the morphological evaluation, absence of the SPs was not seen in this study. The total percentage of fragmented SPs was less in males than females for both sides and the total percentage of the fragmented SPs in males and females for both sides were less than the total percentage of non-fragmented SPs. The total percentage of regular SPs in male on the right side was more than that in female group while the total percentage of regular SPs in male on the left side was less than that in female group.

Conclusion: 3D-images reconstruction obtained with CT were a reliable method in obtaining abases line data for evaluation of the SP, including its length, angulations, and the anatomical variations.

Key words: Morphological variation; length and angulations; three dimensional computed tomography; styloid process. (J Bagh Coll Dentistry 2009; 21(2):63-67)

INTRODUCTION

The styloid process (SP), the thin and long osseous part of the temporal bone, lies caudally, medially and anteriorly towards the maxillo-vertebro-pharyngeal recess, which involves the carotid arteries, internal jugular vein, facial, glossopharyngeal, vagal and hypoglossal nerves (5). The length of the SP is variable. The upper limit for normal SP length is 30 mm (7). The cadaver study on the SP reported that the normal length is between 1.52 cm and 4.77 cm (8). Several imaging modalities have been used for the diagnosis of SP including lateral head and neck, towne, panoramic, lateral oblique plain, antero-posterior head radiographs and computed tomography (CT) (3). Despite the valuable information about the anatomy; there are some difficulties in reading the plain radiograph secondary to super imposed anatomical structures. Super imposition of the mandible and the teeth can cause difficulty in viewing the SP, especially if it is not very long. Super imposition of several osseous structures, distortion and magnifications secondary to angulations are the potential disadvantages of conventional radiographs and, in particular, panoramic radiographs (4).

In CT imaging, those difficulties and disadvantages are eliminated. 3D-CT images reformatted from the raw data obtained with a spiral scanner provide all the information about the SP, including its length, direction, and anatomical relations.

In cross-sectional imaging, even in coronal plane, most of the time the images will not be parallel to the SP, which leads to underestimation of the actual length of the SP. There was no single CT slice completely parallel to the SP, we were able to visualize the entire SP only in 3D-CT and then accurately measure their lengths. So 3D-CT is a valuable diagnostic imaging tool that allows the clinicians to evaluate the SP in spatial geometry, make accurate length measurements, and explain the problem in detail to patients, all of which make this technique superior to conventional imaging modalities (1). The lengths of the bony SP on both sides are variables. In 3D-CT it is between 0 – 62 mm (2). The angulations of the SP ranged between 55° and 90.5° in the transverse plane and between 76° and 110° in the sagittal plane (11).

MATERIALS AND METHODS

This study was based on CT scans taken from 90 Iraqi patients (52 males and 38 females), their mean age was 27.44 years (range 17-91). All patients underwent Para nasal CT evaluation for different reasons (chronic sinusitis, allergic

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sinusitis, lesions of sinuses (inflammatory, tumors etc.), none of these patients had any complaints related to elongated SP or calcified SHL. The length, the anterior angulations and the morphology of the SP were evaluated on 3D reconstructed images that were obtained from these patients.

CT scans were obtained with a spiral computed tomography Scanner Unit, Soma tom plus 4 VC 10C, H-SP CT manufactured by Siemens, AG 2000 in Ibn Al-bitar Hospital for Cardiac Surgery in Baghdad city with 1-mm slice thickness, 140 KV voltage, 94 mA current, Fead / Rot. 3.0 Rot / Time 1.5 s / cycle, (Figure 1).

The scan were performed in the coronal plane (supine –position) high resolution using threshold window values for bone (upper 1100-2200 Hounsfield units (HU), lower 200-370 (HU), total scan time was (55.5–58.5 seconds) with (15 minutes) required for reconstruction. An average of 115-120 images was obtained from each patient. The images were reconstructed with a real-time 3D (RT3D) interactive volume-rendering module of a workstation. The length and the anterior angulations were recorded separately for each side since there were some differences between the right and left sides. The length between the attachment point of the SP to the tympanic plate of temporal bone and the tip of the SP was measured; while the calcification of SHL that joined to SP was not added to our measurements (Figure 2).

The angle between the line perpendicular to the base of the SP and the axis of the SP (the most central part of SP) was also measured. The same method of measurement was used in cases with irregular and fragmented SPs. (Figure 3).

The morphologies of SP were also evaluated (Figure 4-6): These were including:
1- Presence or absences of the SP.
2- Fragmented or non – fragmented SP.
3- Regular or irregular SP.

The samples were divided into 4 age groups according to age and gender. These are:
1. Group I: (0 – 20) years old, which comprised 9 % of the total sample.
2. Group II: (21 – 40) years old, which comprised 61 % of the total sample.
3. Group III: (41 – 60) years old, which comprised 25.5 % of the total sample.
4. Group IV: (Over 60) years old, which comprised 4.5% of the total sample.

Data were translated into a computerized database structure. An expert statistical advice was sought for statistical analyses with computer assisted using SPSS version 13 (Statistical Package for Social Sciences). Frequency distribution for selected variables was done first.

RESULTS
1- SP length measurements: According to the values of the length of the SP, the patients were divided into 3 length groups, these were:
1- Length < 2.00 cm.
2- Length 2.01- 4.00 cm.
3- Length > 4.00 cm.

The mean length ± SD values of the right and left SP in males were (3.192 ± 0.778 cm), (3.029 ± 0.692 cm) respectively, and in females were (2.9 ± 0.792 cm), (2.868 ± 0.707 cm) respectively, and if both genders were considered together, the mean value in the right side was (3.069 ± 0.793 cm) and in the left side it was (2.961 ± 0.699 cm). The SPs were longer in males than females, and the right SPs were longer than the left SPs in both genders. The length of the SPs for both sides and gender ranged from 0.9 cm to 6.2 cm (Table2)

2- Anterior angle measurements: According to the values of the angulations of the SP, the samples were divided into 5 angle groups these were:
1- Angle < 65.0°.
2- Angle 65.1° - 70.0°.
3- Angle 70.1° - 75.0°.
4- Angle 75.1° - 80.0°.
5- Angle > 80.0°.

For males, the mean angle ± SD for the right side was (75.69 ± 7.97°) and for the left side was (76.02± 8.47°). For females, the mean angle ± SD for the right side was (78.24±7.31°) and for the left side it was (78.13±7.67°). For males the smallest angle on the right side was 58° and the largest one was 90°, for the left side the smallest and the largest angles were 57°, 96° respectively. For females, the smallest angle for the right side was 60°, and the largest one was 91°, on the left side the smallest and the largest angles were 61°, 93° respectively. In the present study the mean angle ± SD values of the right and left SPs in males were (75.69 ± 7.97°), (76.02± 8.47°) respectively, and in females were (78.24±7.31°), (78.13±7.67°) respectively, and if both gender were considered together, the mean values in the right side was (76.77 ± 7.76°) and in the left side it was (76.91 ± 8.19°). The anterior angulations of the SP for males on the right side ranged from 58° to 90°, for the left side it ranged from 57° to 96°. For females, the angle ranged from 60° to 91° for the right side, for the left side it ranged from 61° to 93°. For the whole samples the anterior angulations ranged between 57°-96°. (Table3).
Absence of the SP was not seen in this study.

B- Fragmented or Non-Fragmented of SP:

By comparing the morphology (fragmented and non-fragmented) of the SP on the right side among different age groups and gender, the total percentage of the fragmented SP in males was less than that in females group. By comparing the morphology (fragmented and non-fragmented) of the SP on the left side among different age groups and gender, the total percentage of the fragmented SP in males was less than that in females group.

C- Regularity of SP: By comparing the morphology (regular and irregular) of the SP among different age groups and gender of the right side, the total percentage of the regular SP in males was more than that in females group. By comparing between the morphology (regular and irregular) of the SP among different age groups and gender of the left side, the total percentage of the regular SP on males was less than that in females, so the total percentage of the irregular SP on males was more than that in females.

DISCUSSION

In our study, it was shown that 3D-CT image reconstruction made it possible to visualize the exact length of the SP, measuring the anterior angulations, evaluating the morphology of the Sp as well as the relation between the SP and the surrounding structures. Both axial and coronal planes in CT sinuses are recommended in the examination, the coronal plane are used in demonstration 3D-CT of the SP. About 115-120 images were used to achieve reconstructed images in each case and if the aim were to reveal the SP only, a smaller number of images may be enough.

1- SP Length Measurements:

From the results, the SPs were longer in males than females, and the right SPs were longer than the left SPs in both genders. These results were disagree with the study of (6) who found that the mean value of SP length in the right side for both gender was shorter than the left side and this is may be because of the different in the radio graphical procedure that they were used, and disagree with the patient's group of the study of (15). This may be due to the different in the type of patients that they were used (patients operated for Eagle's syndrome) and disagree with (14) which may be due to the different type of CT scanner they were used with a different specification, also the sample ratio was females more than males. Our results were in agreement with (14) (13), (15) (the control group), and (2). The length of the SPs of the present study ranged from 0.9 cm to 6.2 cm. This range of length was wider than that of (8) and this is may be due to the different type of studying of the SP that they were used and also wider than that of (14) results which may be due to the different type of imaging and to different race of the sample that they were used. Our results nearer were to the results of (12) and (11).

We found that in all cases, the 3D-CT showed the exact full length of the SP and this was in agreement with the study for (9) and (11). There were many variations in the measurements of the length of the SP in various studies; the reason for these variations could be due to the different imaging methods that were used in those studies, which could not demonstrate SP accurately. In the present study any symptoms in cases had elongated SP was not observed so that it was concluded that these symptoms not only depend on the length, but also on some other reasons.

2- Anterior Angle Measurements of SP:

Because of the anatomical position and the angulations of the SP, there were many studies measure the angulations from different views, different terms and with different methods of measurements and different modalities of imaging. There were only a few studies regarding 3D-CT about SP. In our study, for females, the angle ranged from 60° to 91° for the right side, for the left side it ranged from 61° to 93°. For the whole samples the anterior angulations ranged between 57°-96°. These results were different than that of (12), they founded that the anterior deviations for the right and left sides were 30° and 28°, respectively and this is may be due to the different of measurement that was used. Also they were different than (2) who evaluated 269 SPs of 138 patients with spiral CT, the angle between the line connecting the base of the SP and its long axis (medial angulations) was between 60.6° and 84.1°, this difference may be due to the different type of CT scan with a different specifications, different type of angulations of the SP, different method of measurements and also different race of the samples that were used. Also (11) founded that the angulations on both sides ranged from 55° to 90.5° with mean (72.7°) in the transversal plane (the angle between the long axis of the SP and a line connecting the bases of both SPs), and from 76° to 110° with mean (93.5°) in the sagittal plane (the angle between the long axis of the SP and the skull base line connecting the nasion). There was no significant difference between males and females in term of angulations of SP, no differences were observed between the left and right sides in term of angulations of SPs which were disagreed with our results and this is may be due to the different type of CT scan with different specifications, different type of angulations of the
SPs, different method of measurements and also different race of sample.

3- SP Morphological Evaluations:
   a) Presence or Absence of SP:
      Several studies were the only studies which reported the absence of SP, which disagreed with our study and this, is may be due to small size of the sample which may decrease the chance for finding an absence of the SP. (2,11)
   b) Fragmented or Non-Fragmented of SP and Regularity of SP: Our results was disagreed with (27) this is may be due to the different type of classification of the morphology of the SP that were used.

Figure 1: Spiral computed tomography scanner Soma tom plus 4, Siemens AG 2000.
Figure 2: Length measurements of the SP.
Figure 3: Measurements of the anterior angulations of SP.

Table 1: Distribution of participating patients according to age and gender.

<table>
<thead>
<tr>
<th>Groups</th>
<th>Age</th>
<th>M.</th>
<th>F.</th>
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</thead>
<tbody>
<tr>
<td>Group I</td>
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<td>4</td>
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<tr>
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<td>21 – 40</td>
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<td>Group III</td>
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<td>Group IV</td>
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<tr>
<td>Total</td>
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Table 2: Descriptive and Inferential Statistics of Length distributed according to different side and gender.

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<th>Max</th>
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<tr>
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<td>0.699</td>
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Table 3: Descriptive and Inferential Statistics of Angle distributed according to side and gender.

<table>
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<td>Angle-Right</td>
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<td></td>
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<tr>
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