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A cone beam computed tomographic evaluation of the size of the sella turcica in patients with cleft lip and palate

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ABSTRACT

Objective: Changes in the size of the sella turcica are frequently related to pathologies and syndromes. The aim of this study was to compare the sella turcica dimensions in patients with unilateral and bilateral cleft lip and palate and non-cleft subjects.

Methods: Cone beam computed tomography (CBCT) images of three groups consisted of 20 patients with unilateral cleft lip and palate; 20 patients with bilateral cleft lip and palate and a control group consisting of 20 non-cleft subjects were the research population in this pilot study. The sella turcica linear dimensions in terms of length, depth and diameter were measured for all subjects. One-way ANOVA test was used to determine any significant differences among the three groups for the measured parameters.

Results: The length, depth and diameter of sella turcica were found to be significantly smaller in the unilateral and bilateral groups compared with the normal age and gender matched group. No significant differences were found in the measured variables between the unilateral and bilateral cleft patients.

Conclusion: CBCT images showed a greater likelihood of abnormal sella turcica dimensions in patients with unilateral and bilateral cleft lip and palate. Therefore, the sella turcica dimensions may have an intrinsic relationship to the cleft condition.

Introduction

The sella turcica is a saddle-shaped structure located within the body of the sphenoid bone in the middle cranial fossa that contains the pituitary gland. It is considered to be an important anatomical structure for radiographic assessment of craniofacial morphology and inter-maxillary relations (Meyer-Marcotty et al. 2010). Furthermore, the metric analysis of sella turcica is considered to be a significant source of information linked to various syndromes and genetic disorders that affect the craniofacial region. The size of sella turcica varies greatly from person to person and is affected by genetic and local factors. Sella turcica dimensions in humans typically range from 5 to 16 mm in the anteroposterior diameter and 4–16 mm in depth (Brady 1973; Jones et al. 2005). Previously, the correlation between sella turcica size and morphology and different factors, including age (Andredaki et al. 2007), gender (Ruiz et al. 2008) and skeletal pattern (Alkofide 2007) has been evaluated. Deviation in the size of the sella turcica has also been related to pathological conditions of the pituitary gland. Several underlying diseases and syndromes, such as Down syndrome, Williams syndrome and Seckel syndrome, can alter the size of the sella turcica (Andredaki et al. 2007).

Cleft lip and palate is considered to be one of the most common developmental craniofacial anomalies (White and Pharoah 2014) and has been reported to be associated with numerous abnormalities (Horswell 1991). It is suggested that the anatomical dimensions of the sella turcica may be abnormal in patients with cleft lip and palate. Until now, only one investigation has been conducted to determine the relationship between anatomical dimensions of sella turcica and cleft lip and palate, using lateral cephalometric radiographs (Alkofide 2008). However, cone beam computed tomography (CBCT) is a recently developed imaging modality that has several advantages over plain film radiography (Shahidi et al. 2013). CBCT provides accurate and reliable linear measurements of bony components in all three planes and these dimensions can be measured without any superimposition or distortion (Paknahad and Shahidi 2015). This study has investigated...
the size of sella turcica using CBCT images of patients with unilateral and bilateral cleft palate and compared these dimensions with an unaffected control group.

**Method and materials**

The present study was approved by the ethics committee of the Shiraz Dental School (#9211). This pilot study was carried out on the CBCT images of 60 patients (32 males and 28 females) from the archive of the orthodontic department of the dental school. The patient’s age ranged from 20 to 44 years (mean 35.5 ± 3.4 years). The distribution of sample subjects according to age and gender is presented in Table 1. The exclusion criteria were a history of any craniofacial anomalies or systemic disease, the presence of pathology in the region of sella turcica and the pituitary gland and a positive history of previous combined surgical-orthodontic treatment. Patients using hormonal medications or corticosteroids, suffering from nutritional deficiencies or endocrinal disturbances, and having significant facial asymmetry or significant anatomical variations in the sella turcica region were excluded. The patients were divided into three groups of 20 subjects each: subjects without cleft palate who served as controls, those with complete unilateral cleft lip and palate (UCLP), and patients with complete bilateral cleft lip and palate (BCLP). All selected patients had skeletal class III relationships on the basis of ANB angle (Steiner 1953).

The CBCT images were obtained by the same clinician using New Tom VGi (QR SRL, Verona, Italy) with the exposure factors set at 120 kvp, 3.8 mA, exposure time of 3.6 s and 15 × 15 cm field of view. Three parameters including width, height and length of the sella turcica were measured (Silverman 1957) by a single investigator (IK) who was blinded to patient group. In sagittal view, sections of height, width and length with the greatest dimension were chosen as the reference for measurements by going through sections interactively. The length was determined as the linear distance from the most superior point of the tuberculum sellae to the tip of the dorsum sella. The depth was measured as the perpendicular line to the most inferior point on the floor of the pituitary fossa. The anteroposterior diameter was defined as the distance from the most superior point of the tuberculum sellae to the furthest point on the posterior inferior wall of the pituitary fossa (Figures 1 and 2).

Data were analysed using the SPSS software, version 18 (SPSS Inc., Chicago, IL, USA). One-way ANOVA was performed to compare the measured variables among the three groups at a significance level of 0.05. Student’s t-test was used to compare the measurements between males and females in each group.

The CBCT images were measured again with a 2-week interval by the same observer to evaluate the significance of any errors during measurements. The results of the first and second measurements were compared by intra-class correlation coefficient (ICC). Furthermore, CBCT images of 20 patients were randomly selected and measured by another operator (MP) to assess inter-examiner reliability. ICC showed a high level of agreement between dual measurements (r >> 0.85 and p < 0.001). Therefore, the average of the first and second measurements was used in analysing all parameters to minimise the errors in the measurements of the variables. Moreover, the intra-observer agreement

![Figure 1](image1.png)  
**Figure 1.** The reference points used to measure the sella turcica dimensions. SPTS: superior point of tuberculum sella; TDS: tip of dorsum sella; IPF: inferior point on floor; PIP: posterior inferior point of wall.

![Table 1](image2.png)  
**Table 1.** Distribution of subjects according to age and gender in this study.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Control (n = 20)</td>
</tr>
<tr>
<td>Age (mean ± SD)</td>
<td>36.6 ± 2.6 years</td>
</tr>
<tr>
<td>Gender (n)</td>
<td>Male 9</td>
</tr>
<tr>
<td></td>
<td>Female 11</td>
</tr>
</tbody>
</table>

Note: SD: standard deviation.

![Figure 2](image3.png)  
**Figure 2.** Measurement of the length (a), depth (b) and diameter (c) of the sella turcica in the sagittal view of CBCT image.
was almost perfect for all measurements ($r > 0.090$ and $p < 0.001$).

**Results**

Student’s t-test revealed no significant differences in all three dimensions in males and females in each group ($p > 0.05$). Therefore, the data for female and males were pooled for statistical analysis. There were no significant differences among the three groups according to chronological mean age; thus, patients were matched for age in all three groups. As there were no significant differences among the three groups in chronological mean age or gender, group age and sex distribution were considered homogeneous. Table 2 demonstrates the descriptive statistics and comparison of the sella turcica measurements among the three groups. For all measurements, the means of the sella turcica dimensions were significantly smaller in patients with UCLP and BCLP compared to those in the control group. However, no statistically significant differences were found between UCLP and BCLP patients for all sella turcica dimensions investigated ($p > 0.05$).

**Discussion**

Sella turcica measurement is a good source of additional information for the determination of various pathological conditions associated with the pituitary gland and syndromes that affect the craniofacial region (Ruiz et al. 2008). Some previous studies have demonstrated significant cranio-morphological deviations in patients with cleft lip and palate (Hansen et al. 2005; Nielsen et al. 2005). In the present study, it is demonstrated that the diameter, length and depth of sella turcica of the BLCP and UCLP groups tended to be smaller than those in the control group.

Various approaches have been used in previous studies to study and characterise the normal anatomy of the sella turcica including direct observation on dry skulls, conventional radiographies (Andredaki et al. 2007), computed tomography (CT) (Ruiz et al. 2008) and magnetic resonance imaging (MRI) (Venieratos et al. 2005). The method used is an important factor that influences the results of different studies, as the accuracy of these methods is different. Traditionally, conventional radiography, in particular, lateral cephalometry was used to assess sella turcica dimensions. However, lateral cephalometry has certain limitations such as superimposition, distortion and magnification. Conventional radiographs should be corrected for radiographic magnification, which is most often not compensated for in some studies. CBCT, the most recently developed imaging modality, has several advantages over plain film radiography. CBCT provides accurate and reliable linear measurements of bony components in all the three planes. The dimensions can be measured without any superimposition or distortion (Shahidi et al. 2013). CBCT has a much lower radiation dose, lower cost and shorter scanning time compared with CT (Paknahad and Shahidi 2015). Therefore, in the present study, CBCT was preferred for measurement of sella turcica dimensions.

Previous studies that measured sella turcica dimensions on CT images used the closest sagittal section of the medium sagittal plane as the reference section (Ruiz et al. 2008). Furthermore, images obtained with a thickness of 2 mm have been used (Alkofide 2007). The accuracy of measurements on reconstructed sections depends on the slice thickness chosen. It seems that the use of lower slice thickness would increase the accuracy of the measurements. However, we assessed the reconstructed coronal and axial sections by going through all sections interactively to analyse the section with maximum dimensions of the considered variable. This method seems to be more accurate than using only one section of the sella turcica.

It has been reported that sella turcica dimensions increase with age until skeletal maturation (Alkofide 2007); therefore, only adult patients aged 20 years and above were included in this study. Moreover, sella turcica dimensions are larger in older subjects (Alkofide 2007; Andredaki et al. 2007) so it was important that subjects in all the selected groups were homogenous. Abnormal sella turcica dimensions have also been reported in subjects with combined surgical-orthodontic treatment (Jones et al. 2005), which is why patients with a positive history of surgical-orthodontic treatment were excluded.

Alkofide concluded that sella turcica was smaller in all linear dimensions (length, depth and diameter) in cleft subjects compared to non-cleft ones. In the present study, no significant differences were found in the dimensions of sella turcica between ULCP and BCLP patients, which is consistent with previous work (Alkofide 2008). However, ULCP subjects showed smaller depth
values than BCLP subjects. Similarly, Axelsson et al. found that the sella turcica had smaller dimensions in subjects with Williams syndrome than the normal group. Several investigators have shown that a relationship exists between cleft of the lip and palate and pituitary function (Laron et al. 1969; Zuppinger et al. 1971; Sultan et al. 1996). Previous reports have identified that in children with clefts, especially those involving the palate, a shorter stature is present more so than in their unaffected peers (Rudman et al. 1978). Possible explanations for this height difference have been attributed to pituitary insufficiency, which can vary from isolated growth hormone deficiency to complete panhypopituitarism associated with congenital aplasia of the pituitary (Laron et al. 1969; Rimoin 1975). Owing to this association, investigators have recommended a complete pituitary evaluation in short children with cleft lip and palate and growth retardation, in addition to incorporating hypothalamic and endocrinologic evaluations of cleft subjects under study (Rimoin 1975; Kjaer and Hansen 2000).

Considering the limitations of this cross-sectional investigation, in the present study similar to the study conducted by Axelsson et al and Alkofide (2008), the anteroposterior diameter of sella is measured from TS to the most distant point on the opposite side of the outline. This technique may not be reliable between subjects, since the orientation of the measurements was dependent on the shape of the sella being measured that is not consistent between subjects. Therefore, it is suggested to use an external reference plane such as Frankfort Horizontal (FH) in future studies so that the vertical and anteroposterior measurements would not be reliant on sella shape.

**Conclusion**

The size of the sella turcica was found to be smaller in patients with cleft than non-cleft group. However, no difference was found in the size of the sella turcica among cleft types.

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**Disclosure statement**

No potential conflict of interest was reported by the authors.

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