# Correlation between Anatomical Variations Radiological Appearance of Sella Turcica and Mastoid Process Density among Cleft Palate and Non Cleft Palate Individuals

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# الارتباط بين الاختلافات التشريحية المظهرية الاشعاعية للسرج التركي و كثافة القسم الخشائي بين الحنك المشقوق و غير المشقوق

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## Abstract

**Background**: Craniofacial development is complex, and to improve the quality of life and surgical outcomes for individuals with craniofacial anomalies, understanding of the basic cell and developmental biology behind pathological craniofacial development is mandatory. **The aim** of this study is to correlate between the morphology of Sella Turcica and mastoid process density among cleft and non-cleft Iraqi subjects. **Materials and Method**: Cone-beam computed tomography images for 110 Iraqi individuals (80 subjects with cleft palate and control group 30 non-cleft subjects) were analyzed automatically by a software program on desktop computer unit by an expert Oral and Maxillofacial Radiologist. For both groups, Sella Turcica in Sagittal view of CBCT image was zoomed to recognize the type of Sella Turcica bridging and to measure its dimensions (Length, Diameter and Height). In addition, Hounsfield density of mastoid process was recorded by taking mean of measurements in three points (upper, middle, and inferior areas) inside the mastoid process. A statistical analysis was applied to correlate between the parameters measured according to the type of cleft palate and Sella Turcica bridging using Statistical Package for social Science (SPSS version 21, Chicago, Illinois, USA). **Results**: In the control group, dimensions of Sella Turcica were found to be higher than those with cleft palate which are significant in length and diameter and not significant in height. Also it was found that Type 2(Partial calcification in which the length was equal to or less than three fourths of the diameter). ST bridging is higher in this study group than that of the control by 15%. In addition, in this study, an important finding was shown, the density values of mastoid process in Hounsfield Units (HU) are higher significantly in the study than those in the control group alongside a strong correlation with cleft type, the density value of mastoid process will increase according to cleft side. **Conclusion**: Significant differences were observed in the morphology of Sella Turcica between subjects with and without cleft palate which have a strong relation to the density of mastoid process. It is necessary to correlate between the anatomical

variations in growth and development of craniofacial structures to reach the precise diagnosing improving oral and maxillofacial health care.

**Keywords: Sella Turcica, cleft palate, radiograph-mastoid process**.

## المستخلص

ان فهم الخلية الأساسية والبيولوجيا التطورية وراء التطور المرضي للقحف الوجهي أمر إلزامي لان التطور القحفي الوجهي معقد ، ولتحسين نوعي الحياة والنتائج الجراحية للأفراد الذين يعانون من تشوهات قحفيه وجهية ،. الهدف من هذه الدراسة هو الربط بين شكل السرج التركي وكثافة البروز الخشائي بين اشخاص عراقيين ذوي حنك مشقوق وغير مشقوق

المواد والطريقة: تم تحليل صور التصوير المقطعي المحوسب ذات الحزمة المخروطية لـ 110 أفراد عراقيين (80 شخصًا يعانون من الحنك المشقوق، و30 شخصًا سليمين) تلقائيًا بواسطة برنامج على وحدة كمبيوتر سطح المكتب بواسطة خبير أشعة الفم والوجه والفكين. تم تكبير حجم لسرج التركي في عرض سهمي لصورة التصوير مقطعي بالأشعة المخروطية للتعرف على نوع جسر سرج التركي وقياس أبعاده (الطول والقطر والارتفاع) اما البروز الخشائي من خلال أخذ متوسط القياسات في ثلاث نقاط (المناطق العليا والوسطى والسفلى) داخل البروز الخشائي بالإضافة إلى ذلك، تم تسجيل كثافة بوحدة مقياس هاونزفيلد تم تطبيق التحليل الإحصائي للربط بين المعلمات المقاسة وفقًا لنوع الحنك المشقوق، شيكاغو، الينوي، الولايات المتحددة الامريكية (الإصدار 21 من برنامج SPSS).

**النتائج**: في المجموعة السليمة ، وُجدت أبعاد السرج التركي أعلى من تلك المصابة بالحنك المشقوق والتي تعتبر معنوية في الطول والقطر وليست معنوية في الارتفاع. كما وجد أن النوع 2 (تكلس جزئي يكون فيه الطول مساوياً أو أقل من ثلاثة أرباع القطر). يعتبر جسر السرج التركي أعلى في مجموعة الدراسة هذه من مجموعة التحكم بنسبة 15٪ بالإضافة إلى ذلك ، في هذه الدراسة ، تم عرض نتيجة مهمة ، وهي أن قيم كثافة عملية الخشاء في وحدات أعلى بشكل ملحوظ في الدراسة من تلك الموجودة في المجموعة السليمة إلى جانب ارتباط قوي بنوع الشق ، وقيمة كثافة الخشاء. ستزداد العملية وفقًا للجانب المشقوق..

**الاستنتاج**: لوحظت فروق ذات دلالة إحصائية في شكل السرج التركي بين الأشخاص الذين يعانون من شق الحنك وبدونه والتي لها علاقة قوية بكثافة عملية الخشاء. من الضروري الربط بين الاختلافات التشريحية في نمو وتطور الهيكل القحفي الوجهي للوصول إلى التشخيص الدقيق لتحسين الرعاية الصحية للفم والوجه والفكين.

**الكلمات المفتاحية: السرج التركي، الحنك المشقوق، القسم الخشائي والاشعة.**

## Introduction

The development of the craniofacial apparatus runs a highly regulated and a sophisticated course, requiring a harmonized interaction of signaling involving tissues and cells with two separate embryonic origins. Throughout the embryonic period, the location of the Sella Turcica is regarded to be the location for neural crest cell to migration from and to the nasomaxillary developmental area, because of the common origin, a change in the morphology of these Sella Turcicae from an individual to another will have an impact on the palate and mastoid process accordingly, It has been considered as a key diagnostic measure, Dental practitioners must be highly knowledgeable about the morphology of these boney structure not only to study the craniofacial and teeth morphology but to have a diagnostic tool to study changes in craniofacial growth and evaluation of orthodontic treatment. (*Sathyanarayana et al.,2013*) The cleft of the lip and palate is the most common congenital anomaly affecting the cranio-facial region (*Vanderas,1987*), (*sayetta et al.,1989*). The etiology of CLP is said to be multi-factorial having both genetic and environmental causes. Clefts may be localized defects or may be associated with widespread structural changes in other parts of the skull (*Ross,1965*) During the studying and analysis of the craniofacial and neurocanial apparatus, the Sella Turcica has been regarded as a really valuable anatomical structure, the Sella point which can be spotted at the center of the Sella Turcica is most frequent landmark to be considered during orthodontics cephalometrics, it has been employed to study the position of the maxillo-mandibular system in relation to the cranium and to measure the relationship of the maxilla to the mandible, studying these parameters facilitate orthodontist during diagnosis and

enabling them in studying growth in population by superimposing these structure in longitudinal basis and during treatment and result assessment. Given these facts it's at utmost value to study this structure and with its variations in morphology from an individual to another, and with escalating interest in the field of human craniofacial dysmorphology, with little resources available as cephalometric standards in growth and development, setting up normal standards would contribute in the elimination size and shape abnormalities(*Alkofide,2007*). There is an increasing interest in the study of human craniofacial dysmorphology, but there are few cephalometric standards available in growth and development (*Axelsson et al.,2013*) The development of the anterior part of the pituitary gland, Sella Turcica and teeth share the involvement of neural crest cells. Also the dental epithelial progenitor cells differentiate through sequential and reciprocal interaction with neural crest derived mesenchyme (*Morotomi et al.,2013*).

## Aim of the study

The aim of this study is to correlate between the morphology of Sella Turcica and mastoid process density among cleft and non-cleft Iraqi subjects

## Materials and Methods

the current study had been conducted to compare between two major study groups cleft palate patient group and normal individuals (10-23 years). Totally, 110 subjects were chosen to participate in this research .A descriptive comparative study between 80 individuals , who apparently Iraqis cleft palate patients attending the AL-flah dental specialized center in Baghdad – Iraq, for investigation and treatment if there is any need. 30 individuals, who

apparently Iraqis normal persons. The CBCT scans were obtained by 3D Kodak 9500, Carestream, France, 2012, (FOV) was large mode (18 cm × 20.6 cm) full skull, 10 mA, 90 Kv, exposure time 10.08 sec. voxel size 300. The radiographical images were analyzed automatically by program software on desk top computer unit, and examined by an expert Radiologist. from Sagittal view of CBCT image area of ST were zoomed to determine the anatomical land marks ST height horizontal line from TS to DS, ST depth vertical line from middle length to deepest point of BPF and ST diameter oblique line from TS to the farthest point on inner wall of ST. These measurements were used to assess the level of bridging of ST length according to the standard scoring scale 4 as follow The bridging was classified into 3 groups as follows

1. No calcification: This was assigned as type 1, in which the length was either equal to or greater than three fourths of the diameter. Fig. 1A.
2. Partial calcification: This was assigned as type 2, in which the length was equal to or less than three fourths of the diameter. Fig. 1B.
3. Complete calcification: This was assigned as type 3, in which only the diaphragm Sella was visible on the radiograph. Fig. 1C.

Fig. 1 from Sagittal view of CBCT image, full boundaries of mastoid process were adjusted and the following measurements were done

1. A horizontal line was drown from anterior to posterior border of upper base of mastoid process.
2. Three points were selected at upper, middle, and inferior areas inside mastoid process and the number of gray value at these points were recorded, Fig. 2.

3. Mean for these three points was calculated to represent the mean radiographic density of mastoid process.

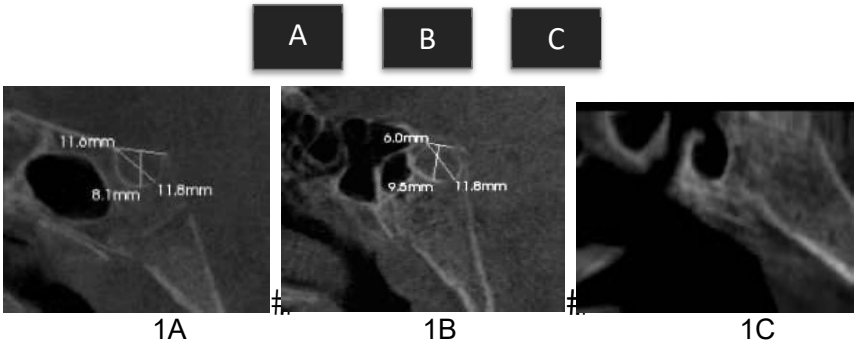


**Fig. 1. Sagittal view of CBCT image**

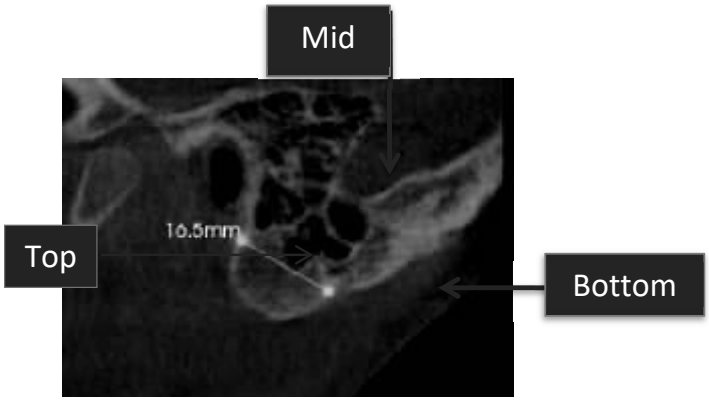


**Fig. 2. Radiographic density**

## Results

110 subjects included in this study (80 study and 30 control) aged 10 - 23 years with mean ± SD (15.39±3.29) and the first age group is the most common than that second one and both age groups find in the study group more than that of in control, regarding gender, males are most common than

females also both males and females find more in study than those in control, but all these results not significant association. All dimensions of Sella find higher in the control more than those in the study and significant difference between groups in length and diameter but not significant difference in height Table 1 and Figure 3.

**Table 1. Descriptive and statistical test of Sella (length, diameter and height)(mm) among groups.**

| Variables (mm) | Groups | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Study | | | | Control | | | | | |
| | Min. | Max. | Mean | ± SD | Min. | Max. | Mean | ± SD | T test | P Vale |
| SL | 2.000 | 11.700 | 8.363 | 1.869 | 6.000 | 11.600 | 9.290 | 1.412 | 2.464 | 0.015* |
| SD | 6.000 | 14.300 | 10.308 | 1.919 | 9.000 | 14.800 | 11.467 | 1.288 | 3.056 | 0.003* |
| SH | 4.000 | 12.000 | 7.604 | 1.480 | 5.300 | 9.500 | 7.803 | 1.017 | 0.680 | 0.498 ^ |

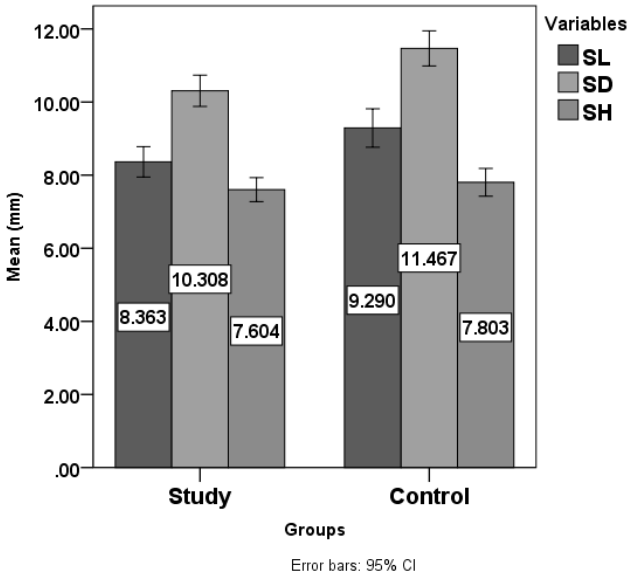


**Fig. 3. Correlation of Sella (length, diameter and height)(mm) among groups.**

subjects with right cleft have higher length of Sella followed by those with bilateral while the lowest with left, regarding height and width of Sella , subjects with left have higher dimensions of both width and height followed by followed by those with bilateral while the lowest with right cleft, but all these findings are not significant. Table 2 and Figure 4.

**Table 2. Descriptive and statistical test of Sella dimension among cleft types.**

| | | Minimum | Maximum | Mean | ± SD | ± SE | F | P value ^ |
|---|---|---|---|---|---|---|---|---|
| SL | Right | 5.900 | 11.200 | 8.845 | 1.618 | .362 | 0.906 | 0.408 |
| | Left | 2.000 | 11.700 | 8.167 | 2.127 | .341 | | |
| | Bi | 5.500 | 10.900 | 8.267 | 1.549 | .338 | | |
| SD | Right | 7.000 | 12.000 | 10.190 | 1.418 | .317 | 0.049 | 0.952 |
| | Left | 6.000 | 13.900 | 10.349 | 2.217 | .355 | | |
| | Bi | 7.200 | 14.300 | 10.343 | 1.813 | .396 | | |
| SH | Right | 4.800 | 10.500 | 7.500 | 1.424 | .318 | 0.072 | 0.931 |
| | Left | 4.000 | 12.000 | 7.656 | 1.640 | .263 | | |
| | Bi | 5.300 | 10.300 | 7.605 | 1.267 | .277 | | |

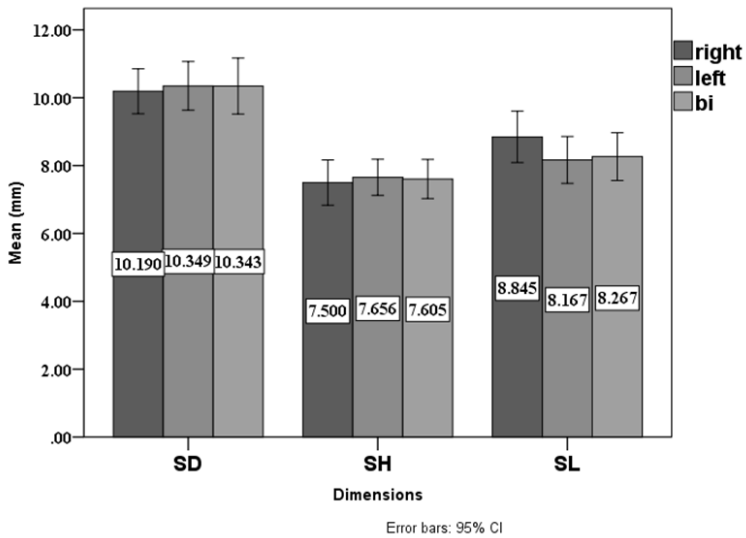


**Fig. 4. Correlation of Sella (length, diameter and height)(mm) among cleft type.**

type 1 is most predominant than type 2 and that although both type 1 and type 2 are higher in study than that in control but with no significant association. Type 2 (Partial calcification in which the length was equal to or less than three fourths of the diameter). ST bridging is higher in this study group than that of the control by 15%. Table 3.

**Table 3. Distribution of bridging type among groups.**

| | | | Groups | | Total |
|---|---|---|---|---|---|
| | | | Study | Control | |
| Bridging | type1 | N. | 44 | 21 | 65 |
| | | % | 55.00 | 70.00 | 59.09 |
| | | % T. | 40.00 | 19.09 | 59.09 |
| | type2 | N. | 36 | 9 | 45 |
| | | % | 45.00 | 30.00 | 40.91 |
| | | % T. | 32.73 | 8.18 | 40.91 |

Findings below show that the mastoid density in both right and left are higher in study than those in control with significant difference Table 4 and Figure 5.

**Table 4. Descriptive and statistical test of mastoid density (right and left) among groups.**

| Variables | Groups | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| (mm) | Study | | | | Control | | | | | |
| | Min. | Max. | Mean | ± SD | Min. | Max. | Mean | ± SD | T test | P value |
| MDR | 114.300 | 932.300 | 355.890 | 110.239 | 118.000 | 514.000 | 258.360 | 100.080 | 4.234 | 0.000* |
| MDL | 131.300 | 777.000 | 344.930 | 119.396 | 121.300 | 511.000 | 245.110 | 106.878 | 4.014 | 0.000* |

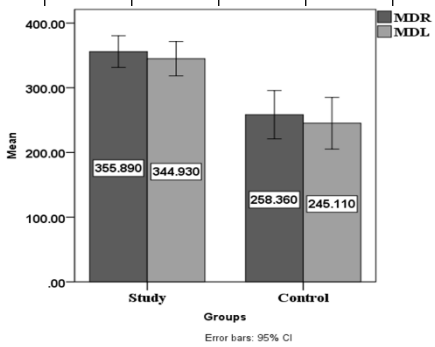


**Fig. 5. Correlation of mastoid density (right and left) among groups..**

mastoid density in right side, subjects with left cleft have higher MDR followed by right cleft while lowest in those with bilateral cleft but with no significant difference while about Mastoid density in left side, subjects with cleft in left side have higher MDL followed by those with bilateral cleft while lowest in those with cleft in right side with significant difference further more multiple pairwise comparisons, only between right and left , MDL has the significant difference while other comparisons are not significant. Table 5 and Figure 6.

**Table 5. Descriptive and statistical test of mastoid density (right and left) among cleft types**

| | | Minimum | Maximum | Mean | ± SD | ± SE | F | P value |
|---|---|---|---|---|---|---|---|---|
| MDR | Right | 199.000 | 547.300 | 350.405 | 92.047 | 20.582 | 1.564 | 0.216^ |
| | Left | 210.000 | 932.300 | 375.862 | 129.173 | 20.684 | | |
| | Bi | 114.300 | 441.600 | 324.024 | 79.857 | 17.426 | | |
| MDL | Right | 147.000 | 449.000 | 301.815 | 90.956 | 20.338 | 3.544 | 0.034* |
| | Left | 131.300 | 777.000 | 379.479 | 138.094 | 22.113 | | |
| | Bi | 131.300 | 522.300 | 321.829 | 86.428 | 18.860 | | |

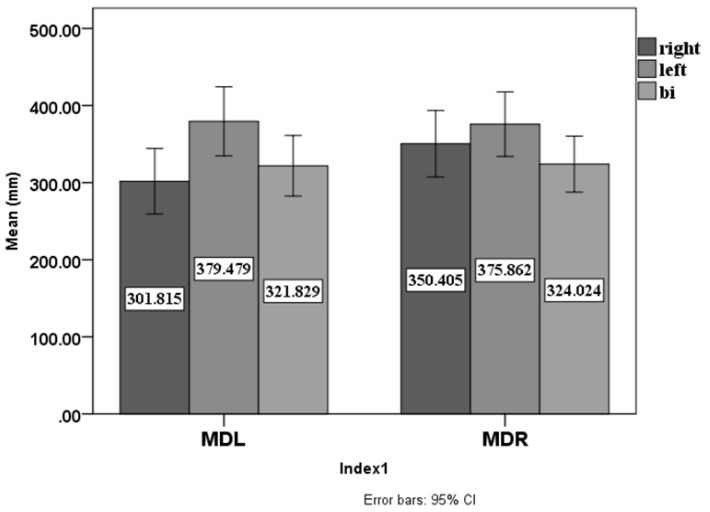


**Fig. 6. Correlation of mastoid density (right and left) among cleft type.**

## Discussion

Cone-Beam Computed tomography CBCT was introduced as an emerging modality for maxillofacial imaging, due to the limitation provided by other 2-Dimentional available modalities and for the requirement of our research topic to evaluate 3-Dementional objects within the human body being the Sella turcica and the mastoid process CBCT proved to be the modality of choice for its functionality and ability to analyses structures and as recent studies have validated this technique to study specific areas with significantly lower radiation than CT. (*Leonardi et al.,2006*).

the Sella Turcica is a crucial landmark in the base of the skull. It not only provides a stable reference point for the cephalometric analysis, it also houses the pituitary gland. (*Zain-alabdeen et al.,2012*). Various investigations have been done on the morphology of ST with varying techniques(*Hasan et al.,2019*),( *Yasa et al., 2017*). In the current study, no significant gender disparities of the ST morphology in all seven parameters were found

Cleft lip and palate (CLP) is the greatest frequent congenital malformation in the craniofacial region. Majority of CLP appears to be arise from combination of genetics and environmental factors(*Cura et al.,2016*). Thus identifying landmarks and diagnostic measures for specialist to help in the diagnosis, treatment and prognosis for these patients is essential.

Throughout the embryonic period, the location of the Sella Turcica is regarded to be the location for neural crest cell to migration from and to the nasomaxillary developmental area, because of the common origin, a change in the morphology of these Sella Turcicae from an individual to another will have an impact on the palate and since mastoid process development is also derived from the same embryonic arch and with one of its function being the

equalizing of middle ear pressure with the atmospheric with knowing that cleft palate patients having a disturbion in the pressure system of the cranium (*Imija et al.,2019*). One can anticipate abnormalities with such structure in patient with cleft palates. In this study, dimensions of Sella find higher in the control more than those in the study and significant difference between groups in length and diameter but not significant difference in height. These results attributed to a common origin was supported by other researchers *Cinnamon (2009)* and (*shah et al.,2011*). The angles produced by the outline of the tuberculum Sella, the shape of both the clinoid processes and their fusion which is often known as 'Sella Turcica Bridge' (*Becktor et al.,2000*) , (*Choi et al.,2001*). In this study type 1 is most predominant than type 2 and that although both type 1 and type 2 are higher in study than that in control but with no significant association. Type 2 (Partial calcification in which the length was equal to or less than three fourths of the diameter). ST bridging is higher in this study group than that of the control by 15%. Recent studies demonstrated that alterations of Sella Turcica morphology can be related to canine impaction (*Baidas et al.,2018*),tooth transposition (*Leonardi et al.,2011*) and teeth agenesis Our results showed a correlation of between cleft palate and bridging which can be of relevance to the previous studies showing the correlation of the bridging to other oral structure anomalies. (*Scribante et al.,2017*). Changes in bone density and hard tissues that may indicate the presence of any pathological alteration, Mastoid density in both right and left are higher in study than those in control with significant difference mastoid density in right side, subjects with left cleft have higher MDR followed by right cleft while lowest in those with bilateral cleft but with no significant difference while about Mastoid density in left side, subjects

with cleft in left side have higher MDL followed by those with bilateral cleft while lowest in those with cleft in right side with significant difference further more multiple pairwise comparisons, only between right and left , MDL has the significant difference while other comparisons are not significant. These results supporting the previously stated that the pathological issues associated with cleft palate and the disturbance in cranial pressure system influence the size of mastoid air cell system during the childhood (*Trotic et al.,2012*).

## Conclusions

Significant differences were observed in the morphology of Sella Turcica between subjects with and without cleft palate. Dimensions of Sella turcica where higher in normal individuals when compared to cleft patients with significant length and diameter changes. Sella bridging were observed much frequently in cleft palate patients with type 1 being more prominent, and type 2 being 15% more present among cleft patient when compared to normal individuals. Mastoid density was higher in cleft patients when compared to normal individuals. It is necessary to correlate between the anatomical variations in growth and development of craniofacial structures to reach the precise diagnosing improving oral and maxillofacial health care. We suggest to do further research to fully understand the correlation between cleft palate and different anatomical landmarks  We also suggest studying the relation between mastoid density and Sella Turcica in the diagnosis and treatment of other craniofacial anomalies

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