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Dimension of Sella Turcica in Different Skeletal Malocclusion Patterns

A Project
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Certification of the Supervisor

I certify that this project entitled **“Dimension of Sella Turcica in Different Skeletal Malocclusion Patterns”** was prepared by **Zainab Ibrahim Khudadad** under my Supervision at the College of Dentistry/University of Baghdad in partial fulfilment of the graduation requirements for the Bachelor Degree in Dentistry.

Supervisor’s name

Assist. Prof.Dr. Shaymaa Shaker Taha

Date: 2023/5

Dedication

To my god who is always there when i am in need. thank you for guiding me, giving me strength in my everyday life and always looking out for me. thank you for making all these happened and ended it with good outcome.

To the dearest and closest to my heart, to my dear mother and my dear father, who support me all the time, and their blessed prayers had the greatest impact in reaching me this stage.

To that who encourage me and gave me all the love, to my dear husband, who suffered a lot with me, my stay in this place would not have happened without his constant support to me.

To my brothers, sister, and all of my family, who have always been supportive of me in my study career.

To my friends who have always been with me in all moments of my life, I will never forget their love and their constant support for me, thank you for being with me.

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Introduction

The attractiveness of the face depends on harmonious relationships of craniofacial structures **(Nanda, 1995).** It is imperative to diagnose the disharmony in the stomatognathic system, reestablish function and improve overall facial appearance. A balanced facial profile has well-proportioned underlying skeletal structures. Any discrepancy between maxillary and mandibular bony bases may result in sagittal or vertical dysplasia **(Downs, 1948).**

Early identification of developing skeletal malocclusions allows conservative orthopedic management **(Merwin *et al*., 1997; Baccetti *et a*l., 2000).** To measure positions of structures (such as the maxilla or mandible) in relation to the cranium, or to themselves several landmarks within the cranium have been determined to act as reference points when tracing cephalometric radiographs.The benefits gained from studying these structures range from assisting the orthodontist during diagnosis, as a tool to study growth in an individual through superimposition of structures on a longitudinal basis, and during evaluation of orthodontic treatment results. One of the most commonly used cranial landmarks for cephalometric tracing is sella point. This point is located in the centre of the sella turcica, with the turcica housing the pituitary gland in the cranial base **(Pisaneschi and Kapoor, 2005)**.

The morphology of sella turcica is different from person to person. Thus, gaining knowledge in this regard will be a great help in detecting abnormalities in this anatomic area. Since dentists and orthodontists frequently order and evaluate cephalometric radiographs, by learning and knowing the normal variations of the sella turcica, they will be able to recognize abnormalities of this area if there is change in these normal variations, even before the appearance of clinical manifestations. At present, determining the morphology of the human craniofacial region is the focus of attention for researchers in various fields of study i.e. radiology and orthodontics. To assess whether the sella region has a normal or unusual appearance, the normal morphology of the sella turcica should be studied. The shape and sizes of sella turcica may alter greatly from person to person, and the knowledge of this alteration will help the clinician to discriminate any abnormality in this area **(Aine Shabbir *et al*., 2021).**

Anatomically, the sella turcica subdivided into three segments, consisting of an anterior wall, a floor, and a posterior wall. Morphologically, three basic types oval, round, and flat have been classified, the oval and round types being the most common **(Alkofide, 2001).**

Aim of study

To find out the relashionship between the dimensions of the sella turcica and different skeletal malocclusion patterns.

Chapter one

Review of Literature

1.1. Sella Turcica

Sella turcica is a saddle-shaped structure located in the middle cranial fossa on the intracranial surface of the body of the sphenoid bone **(Kjær *et al*., 1999)**. which is variable in size and shape. clearly seen on lateral cephalometric radiograph, Sella turcica gets its name from the Turkish language because of its similarity to the Turkish saddle **(Nagaraj et al., 2015)**.

1.1.2 Anatomy of Sella Turcica

It has a complex anatomical structure and relationship with various anatomical entities such as the pituitary gland, internal carotid artery, and cranial nerves. The anterior border of the sella turcica is represented by the tuberculum sellae and the posterior border by the dorsum sellae. The pituitary gland is surrounded by the sella turcica, whereas two anterior and posterior clinoid processes project over the pituitary fossa. The anterior clinoid processes are formed by the medial and anterior projections of the lesser wing of the sphenoid bone and posterior clinoid process by the endings of dorsum sellae . The size and shape of clinoid processes may vary: they can be short and blunt or protrude above the pituitary fossa and are some times connected. Any abnormality or pathology in the gland could manifest from an altered shape of sella turcica, to a disturbance in the regulation of secretion of glandular hormones, prolactin, growth hormones, thyroid stimulating hormone, follicular stimulating hormone, and so on **(Alkofide, 2007)**. The anatomy of sella turcica has been described as variable. Sella turcica was divided in to three segments, consisting of an anterior wall, a floor, and a posterior wall **(Sathyanarayana *et al*., 2013).**

1.1.3 Embryology

The prenatal and postnatal formation of pituitary gland and Sella turcica are complex processes. These two important structures are located in the boundary region, separating tissues of different origin and development. Origin of the pituitary gland is a result of interaction between oral ectoderm which gives rise to anterior pituitary and neural ectoderm gives rise to posterior pituitary. During embryological development, sella turcica area is the key point for the migration of the neural crest cells to the fronto nasal and maxillary developmental fields. Formation and development of the anterior part of the pituitary gland, Sella turcica, and teeth share in common, the involvement of neural crest cells, and dental epithelial progenitor cells differentiate through sequential and reciprocal interaction with neural crest derived mesenchyme **(Miletich *et al*., 2004;Morotomi *et al*., 2005).**

A close interrelationship exists between the development of brain tissue and the bones surrounding the Brain neurocranium. Any congenital malformations in the development of brain may be detected by analyses of bones in the neurocranium. Abnormal morphology of the cranial base and the sella turcica should be included in the postnatal evaluation of craniofacial malformations **(Kjaer, 1998).**

1.1.4 Size of Sella Turcica

When the linear dimensions (length, depth and diameter) of sella turcica. were compared with diffirent studies, a difference between measurements was noted. It typically ranges from 4 to 12 mm for the vertical and from 5 to 16 mm for the anteroposterior dimension **(Chilton *et al*., 1983; Choi *et al*., 2001).** Quakinine and Hardy showed that the average width of sella was 12 mm, length (anteroposterior diameter) was 8 mm and height (vertical diameter) was 6 mm **(Quaknine and Hardy, 1987).**

The variations between various measurements are probably due to the use of different landmarks, radiographic techniques, and degree of radiographic enlargement **(Morotomi *et al*., 2005).** Any abnormal or pathologic status in the gland could cause a variation of the sella turcica and the glandular hormones secretion. Clinicians should provide a basis for identifying and effectively investigating changes, even before the onset of symptoms of pituitary or craniofacial syndromes, which may reflect pathologic conditions, the variability of normal radiographic anatomy, and sella turcica. These changes can also occur in some syndromes and craniofacial abnormalities that affect the craniofacial region such as primary hypopituitarism, Williams syndrome, growth hormone deficiency, Cushing's syndrome, lumbosacral myelomeningocele, the presence of intrasellar adenomas, empty sella syndrome,macro adenomas, meningiomas, craniopharyngiomas, and cysts are more probable causes of deformation of the neighbouring bony structures **(Aine Shabbir *et al*., 2021).**

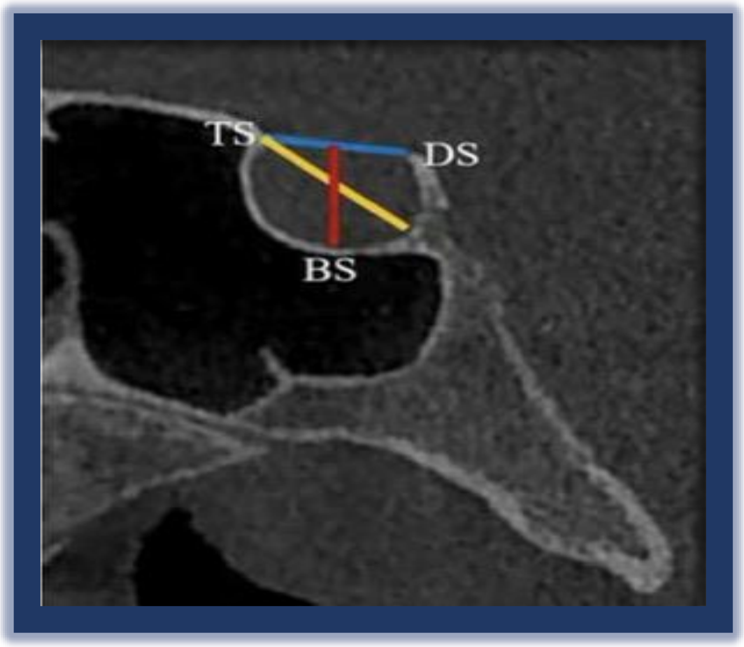

Fig.1.1 : Measuring the sizes of sella turcica. TS, tuberculum sella; DS, dorsum sella; BS, base of sella turcica; blue line, the length of sella turcica; yellow line, the diameter of sella turcica; red line, the depth of sella turcica **(Keşkek, 2021).**

1.1.5 Shape of Sella Turcica

Morphological appearance of sella turcica is established in early embryonic structure. The morphological variations in sella turcica has been reported by many researchers through time **(Tetradis and Kantor, 1999).** Gorden and Bell (1922) classified sella into shapes (circular, oval or flat/saucer shaped but they concluded that not all the cases could easily be put into such a broad three way classification **(Gordon, Bell, 1922).**

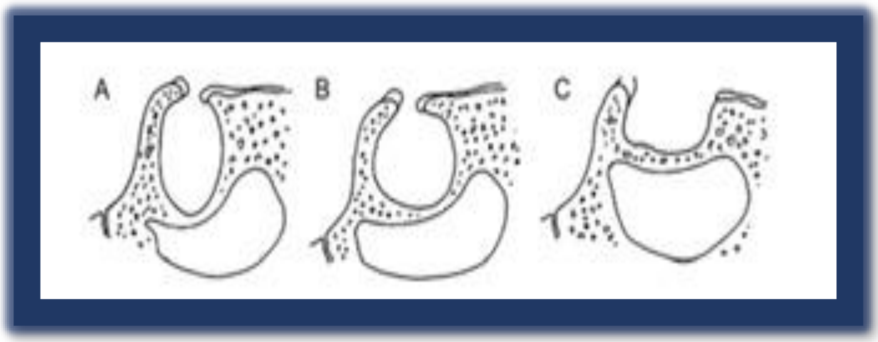

Fig.1.2 : Classification of the three types of the sella turcica: (A) oval, (B) circular, (C) flat **(Reuther , 2009).**

Then in 1950 David and Epstein used the term J shaped sella while omega shaped sella was given by Pournier and Denizet in 1965. However in 1969 Kier termed these definitions radiographical myths, advising that both should be disregarded since they were used to characterize abnormal pathology as well as normal developmental patterns **(Kier, 1969).**

Other descriptions of the sella turcica have been proposed based on the appearance of flatness or concavity of the contours of the sella floor, the angles made by the contours of the tuberculum sella, the contours of the anterior and posterior clinoid processes, and the fusion of both processes which is termed a 'sella turcica bridge **(Becktor *et al.*, 2000)**.

Axelsson et al in 2004, shape of the sella turcica was divided into six main types; **(Axelsson *et al*., 2004)**

1-normal sella turcica

2-oblique anterior wall

3-double – contoured sella

4-sella turcica bridge

5- irregularity (notching) in the posterior part of the sella

6-pyramidal shape of the dorsum sellae.

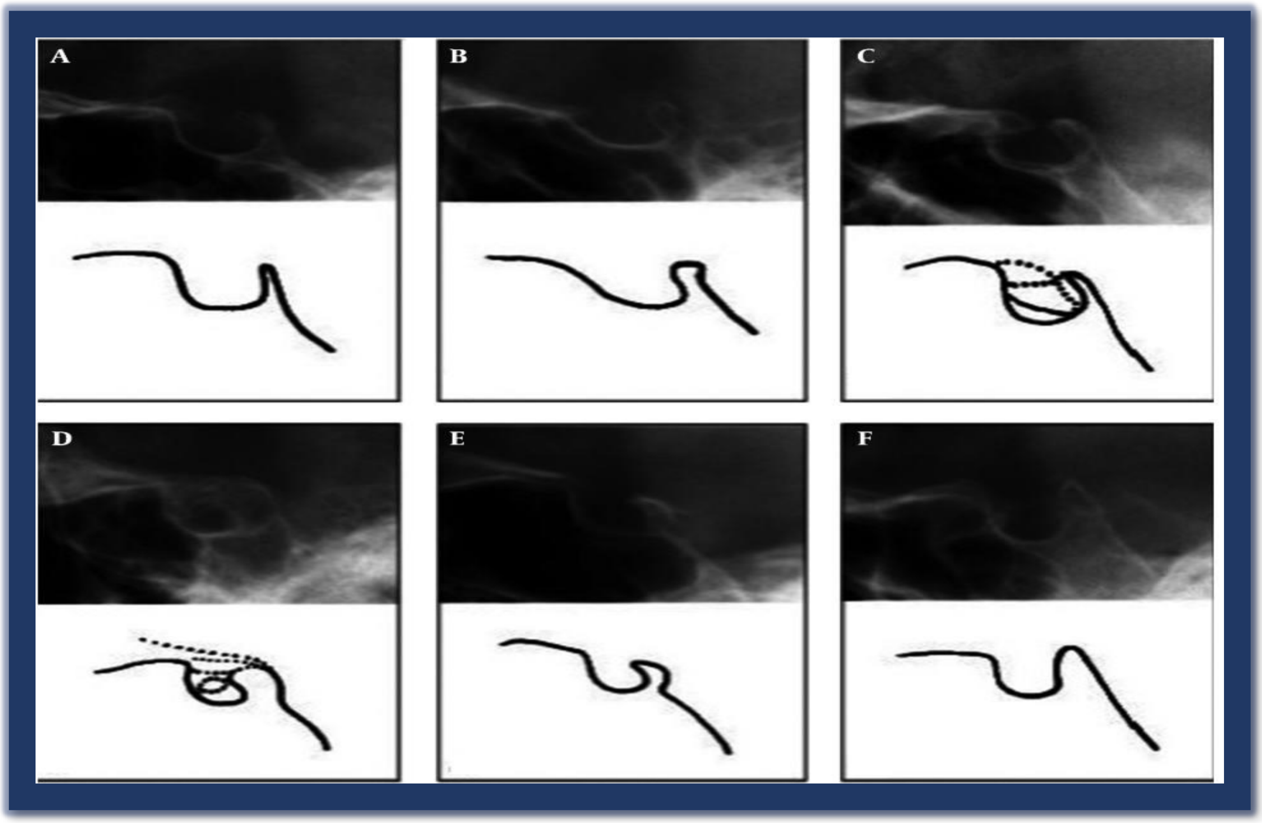

Fig.1.3: Different morphological types of sella turcica: (a) Normal sella turcica, (b) oblique anterior wall, (c) double contour of the floor, (d) irregularity (notching) in the posterior part of sella turcica, (e) sella turcica bridge, (f) pyramidal shape of dorsum sellae **(Valizadeh *et al.*, 2014).**

Bridging of the sella turcica is a common morphological variation of the sella turcica, caused by the fusion of the anterior and posterior clinoid processes (Excessive ossification of the ligaments stretched between the anterior and posterior clinoid processes of the sphenoid), is a further anatomical abnormality, which has been reported to occur in distinctive syndromes or skeletal and dental malformations **(Leonardi *et al.*, 2006; Meyer-Marcotty *et al.*, 2008).**

The occurrence of a sella turcica bridge has been described as a radiographic feature in basal cell carcinoma (Gorlin– Goltz) syndrome, Rieger syndrome, and other disorders and syndromes **(Koshino *et al.*, 1989; Meyer-Marcotty *et al* ., 2008).**

However, altered sella turcica morphology or bridging of the sella turcica seems to be related to a symptom of a syndrome. Becktor et al and Jones et al. analysed the frequency of a sella turcica bridge in patients with severe craniofacial deviations They found a higher prevalence of a sella turcica bridge of 18.6 and 16.7 per cent, respectively, in patients who required combined surgical–orthodontic treatment **(Becktor *et al.*, 2000 ; Jones *et al.*, 2005)** .

When different skeletal classes were analyzed for bridging, Abdel Kaber studied the prevalence of a sella turcica bridge in relation to the three skeletal classes in Saudi subjects and found a higher percentage of sella turcica bridges in orthognathic-surgical patients with a skeletal class III malocclusion (10.71%) as well as in orthodontic patients with a class III malocclusion **(Abdel-Kader, 2007)**. However, the aetiology and pathogenesis of increased sella turcica bridging in patients with severe craniofacial malformations still remains to be evaluated.

Fig.1.4 : Sella turcica bridging on a lateral cephalometry image **(Sobuti, 2018)**

1.2 Skeletal Malocclusions

Skeletal malocclusion is a common birth defect that occurs due to the distortion of the maxillary and/or mandibular development that will have a huge impact on the positioning, alignment and health of the primary and permanent teeth **(Vettraino *et al.*, 2003).** Skeletal patterns and malocclusions are heterogeneous conditions affecting populations worldwide **(Claudino *and and Traebert,* 2013).** The World Health Organization (WHO) considers malocclusion to be among the most important oral health problems after caries and periodontitis **(dos Santos *et al.*, 2012).**

Micrognathia, a small mandible or maxilla, is the most common cause of skeletal malocclusion **(Vettraino *et al.*, 2003).** On the other hand, macrognathia is characterized by the overgrowth of the mandible or maxilla above the normal values where the manifestation becomes more prominent at the peak of jaw growth around the age of 12.2 years in females and 14 years in males **(Buschang *et al*., 2013).**

There are a handful of reports showing that skeletal malocclusion can affect the general health of patients through their role in causing airway obstructions, sleep apnea, gastric disturbance, immune deficiencies and delayed developmental growth **(Paladini 2010; Bollhalder *et al*., 2013**).

Besides these physiological disorders, it has been reported that skeletal malocclusion leads to adverse influences on intellectual wellbeing, social skills, economical and psychological status **(Martins-Junior *et al*,. 2012; Masood *et al*,. 2013**). Psychological distress is more readily found to be associated with malocclusion especially in the younger and university educated people **(Masood *et al.*, 2013) .** Orthodontic malocclusions and skeletal deformities have multiple etiologies, often affected and underlined by environmental, genetic and social aspect **(Lone *et al*., 2023).**

Severity of skeletal malocclusion is indirectly proportional to the quality of life in regards to social and emotional fronts as well as speech and mastication efficiency **(Masood *et al*., 2013).** Bruxism, dental trauma and dental caries are significantly more prevalent in skeletal malocclusion cases compared to normal occlusion cases **(Baskaradoss *et al*., 2013; Bendgude *et al*., 2012**

facial skeletal type is classified into three types (class I, II, and III) based on the anteroposterior relationship of the maxilla and the mandible. The most complex and difficult orthodontic problem to diagnose and treat is class III malocclusion **(Garner and Butt, 1985).** The prevalence of this type of malocclusion ranges from 0.2% in the white population.

1.2.1 Skeletal Class I

These malocclusions were purely dental (the problem is dental malrelationships) with the bones of the face and jaws being in harmony with one another and with the rest of the head. The profile is orthognathic **(Gill and Naini, 2011).**

1.2.2 Skeletal Class II

1.2.2.1 Skeletal Class II, Division 1 Malocclusion

Skeletal Class II malocclusion, either division 1 or 2, is characterized by a mandibular retrusion, a maxillary protrusion, or a combination of both **(Mossey 1999; Chou *et al.*, 2011).** The maxillary incisors have been reported to be normal or proclined, and the mandibular incisors can be in a normal, proclined, or even in a retroinclined position **(Proffit *et al*., 2013; Uribe *et al*., 2014).**

Although studies have supported the concept of polygenic mode of inheritance for the skeletal Class II malocclusion, the environment has also been described to play an important role on this malocclusion. Adverse parafunctions, such as digital sucking, lip incompetence, protruding tongue, and nasal airway obstruction have been also associated with the induction of a clockwise rotation of the mandible and an overgrowth of the maxillary alveolar process in these patients **(Mossey 1999; Chou *et al*., 2011).**

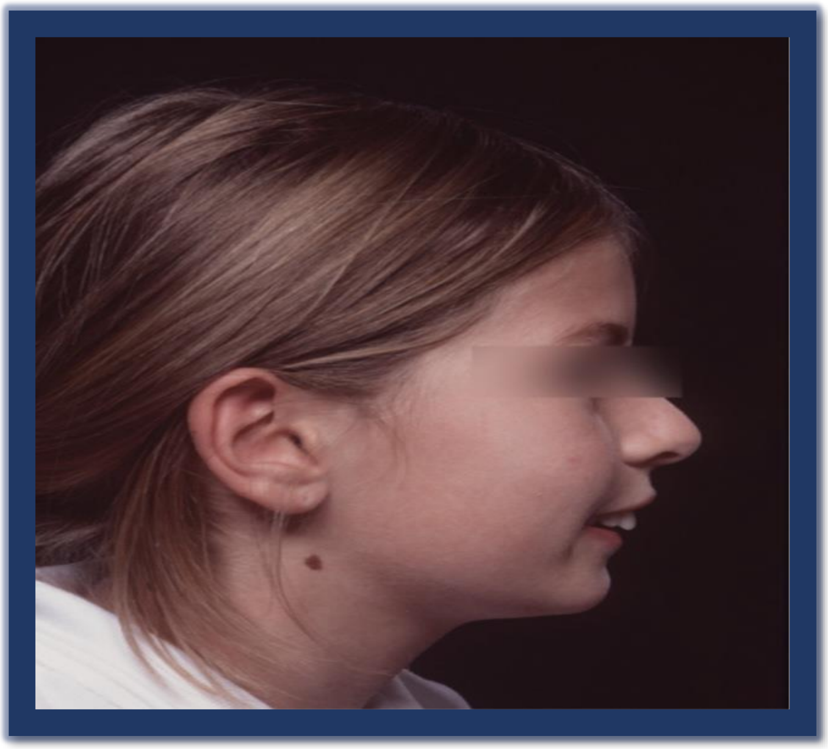

Fig.1.5 : Typical facial profile associated with Class II skeletal pattern **(Gill and Naini, 2011).**

1.2.2.2 Skeletal Class II, Division 2 Malocclusion

The skeletal Class II, division 2 malocclusion is characterized by a distinct and consistent clinical phenotype, which includes a combination of retroinclined incisors, deep overbite, high lip line with a lower lip trap, and high activity of the mentalis muscle. These patients often present a counter-clockwise rotation of mandibular development, prominence of the chin, and reduced lower face height **(Proffit *et al*., 2013; Mossey 1999)**. some studies have described the mode of inheritance of this type of malocclusion as autosomal dominant with incomplete penetrance and variable expressivity; a polygenic model with expression of a number of genetically determined morphological traits has also been correlated to the Class II, division 2 **(Mossey 1999).**

Fig.1.6 : Class II skeletal pattern **(Gill and Naini, 2011).**

1.2.3 Skeletal Class III Malocclusion

Among all the types of sagittal skeletal discrepancies, the skeletal Class III is the malocclusion the most studied genetically. Class III malocclusion is caused by a deficiency of the maxilla growth, excessive mandibular growth, or a combination of both **(Mossey 1999; Chou *et al.*, 2011) .**

It is characterized by a composite of a dentoskeletal pattern consisting of a forward positioning of the mandibular teeth in relation to the maxillary teeth and a concave facial profile, a retrusive nasomaxillary area, and a prominent lower third of the face. The lower lip is often protruded relative to the upper lip **(Uribe *et al*., 2013)**.

The Habsburgs, one of Europe's royal families is an example of Mendelian inheritance of mandibular prognathism, which was observed in several generations of this family, so called "Hapsburg jaw." Although some authorsconsider that the X chromosome might have some role in mandibular prognathism, some other studies have verified that this trait is not X-linked since both genders are equally affected. It has been observed for many years that mandibular prognathism and probably maxillary deficiency contains not only a genetic component, but also an the influence of environmental factors. The mandibular prognathism has been reported to be a multifactorial and polygenic trait, with a threshold for expression **(Cruz *et al*., 2008) .**

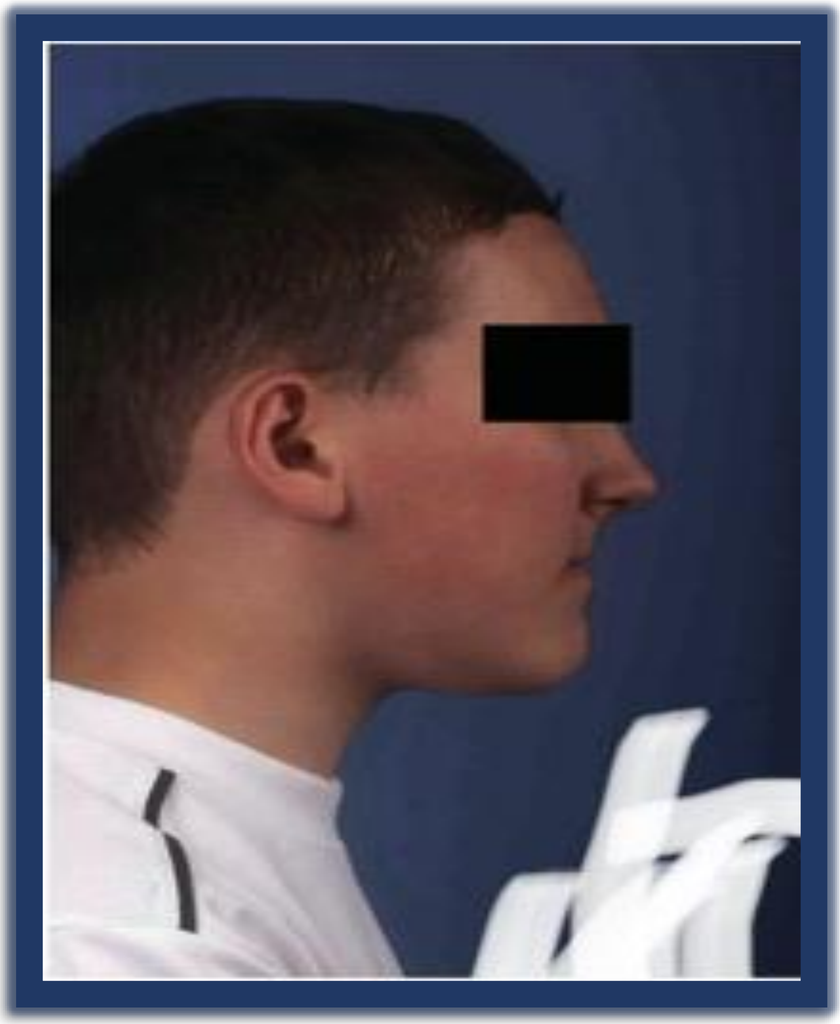

Fig.1.7 : Typical facial profile characterised by a retrusive maxilla in a severe Class III malocclusion **(Gill and Naini, 2011).**

1.3 Relationship between dimensions of sella turcica and classification of skeletal malocclusion

The association between sella turcica dimension and morphology and skeletal malocclusions will help in early diagnosis of these skeletal patterns increasing the probability of interceptive management. This may also reduce the future treatment burden and may lead to less complicated treatment modalities. neural crest cells contribute to the formation and development of the sella turcica, teeth, and all parts of the face, there may be a relationship with the abnormalities of this area **(Leonardi *et al.,* 2006).**

In 2000, Bektor assessed sella turcica bridging in patients with severe craniofacial problems **(Becktor *et al.,* 2000).** In 2005, Jones assessed bridging and dimensions of the sella turcica in patients who had been treated with orthodontic surgery or other orthodontic methods **(Jones *et al.,* 2005)** .

Valizade reported the prevalence of sella turcica bridging of 13.8% in class I, 12.9% in class II, and 43.3% in class III **(Valizadeh et al., 2015).** Mayer-Marcotty et al. reported the prevalence of sella turcica bridging of 9.4% in class I and 16.8% in class III patients **(Meyer-Marcotty et al.,2010).**

the left or right side of the sella turcica cannot be distinguished in lateral cephalometric radiographs, and false positives can result from structure overlapping. Therefore, true bridging (fusion of anterior and posterior clinoid process) is difficult to distinguish from pseudobridging (superposition of ntraclinoid ligament) in 2D lateral cephalometric images **(Ortiz *et al.,* 2018).**

Recently, due to the advancement in craniofacial imaging technology, cone beam computed tomography (CBCT) can be used to reconstruct 3D structures, thus making the shortcomings of 2D lateral cephalometric images more critical in comparison with 3D CBCT scans. Compared to conventional CT, the technology of CBCT can achieve high-quality images with lower-cost equipment and at a lower radiation dose **(Ortiz *et al*., 2018 ; Yasa *et al*., 2017).**

Up to date, only two studies **(Akay *et al.*, 2020; Silveira *et al.*, 2020**). have studied the sella turcica dimensions and shape via CBCT specially focused at different skeletal relations. Akay et al. (**Akay *et al.*,2020**) reported that interclinoid distance and dimensions of sella turcica did not differ significantly in different skeletal relation in Turkey subjects. Silveira et al studied differences only between Class II and III relations of Brazil patients and indicated that there is no significant difference in size of anterior cranial base between Classes II and III, but large size of anterior cranial base in male subjects was founded. Neither of these two studies have mentioned about the analysis of Sella turcica bridge **(Silveira *et al.*, 2020).**

Chapter Two

Discussion

Malformations in the facial area have been associated with abnormalities of the sella turcica which can be attributed to the fact that the craniofacial complex is primarily derived by migration of neural crest cells to branchial arches **(Kjaer, 2015 ;Cordero *et al.*, 2011).** The neural crest cells migrate from the tuberculum sellae to the frontonasal, maxillary and palatine fields through the sonic hedgehog gene pathway **(Kjaer, 2015).**

Point mutations in the signaling pathway may result in deformities in the craniofacial region. Due to a common embryological origin, alterations in the sella turcica dimensions and morphology may be linked to skeletal aberrations **(Cordero *et al.*, 2011).** Thus the focus of this study was to find an association between sella turcica dimensions with skeletal malocclusions.

Various studies in the past have correlated malocclusion to other craniofacial structures. The past studies have shown that the sella size can be correlated to the malocclusion like the study by Alkofide In 2007, who reported a significant relationship between class II or III skeletal patterns and the diameter of sella turcica and reported a larger diameter of the sella turcica in subjects with skeletal class III malocclusion a compared to class I and II **(Alkofide, 2007).**

Moslemzade et al. reported a significant difference between class I and class III patients with respect to the length of sella turcica **(Moslemzadeh *et al.*, 2016).** Valizade et al. reported that the length of sella turcica in class III patients was higher than in those in class I and II, while the diameter and depth of sella turcica were the same in all three groups **(Valizadeh *et al.*, 2015).**

Unlike this, Sobuti et al reported that the length, diameter, and depth of sella turcica were the same in all three craniofacial skeleton pattern. Likewise, Preston did not find a significant relationship between craniofacial skeleton pattern and the size of pituitary fossa **(Shah *et al.*, 2011 ; Preston, 1979).**

Chapter Three

Conclusions and suggestions

3.1. Conclusions

In skeletal Class III or prognathic mandible, the anteroposterior dimensions of the sella turcica, that is, the length and the diameter are the largest as compared to Class I and Class II. however, Some researches has shown that there is no relationship between different skeletal malocclusion types and diameter and depth of Sella Turcica.

3.2. Suggestions

For future studies we suggest:

- Conducting a study of sella turcica dimensions and maxillary growth in patients with unilateral cleft lip and palate.

- Conducting a study of the association of posterior nasal spine to sella turcica measurement and skeletal malocclusions.

- Conducting a study of the sella turcica dimension in different vertical growth patterns.

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