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Sella turcica anomalies and their association with malocclusion – a lateral cephalometric study

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SUMMARY

The aim of the study is to estimate the prevalence of sella turcica anomalies on lateral cephalograms of individuals with malocclusion, so as to utilize it as a predictive indicator of malocclusion in adolescents. Lateral cephalograms of 224 subjects aged between 8-18 years with good visibility of cephalometric structures including sella turcica were assessed for the variants of malocclusion. The study group consisted of 133 cephalograms with abnormal sella turcica, while the control group consisted of 91 cephalograms without any abnormality. Cramer's V test was applied to find out association of classes of malocclusion and Sellar anomalies, and chi-square test was applied to know the frequency of each sellar anomaly among the class-wise distribution within the subjects.

Males were more associated with sellar anomalies as compared to females. A significant association between skeletal classes of malocclusion and sella turcica with Cramer's V value of 0.365 and significance of 0.001 was observed; so, it is clear that Class I malocclusion is associated with normal anatomy, while individuals with Class II and III are associated with sellar anomalies. An early predictive sign for prompt orthodontic intervention and correlating it with skeletal malocclusion can benefit both patients, as well as clinicians for interventional treatment.

Key words: Malocclusion – Sella túrcica – Radiology – Adolescent – Esthetics

INTRODUCTION

In orthodontics, the aberrant state is called a malocclusion, and it is frequently associated with facial disharmony. Although malocclusion is not a disease, it has both aesthetic and functional implications. There are psychological interferences associated to social acceptance and success from an aesthetic perspective, as well as interference with mastication, speech, and protection of the structures in the whole stomatognathic system from the functional standpoint. In this regard, one or more treatment plans can be identified, which essentially aid in organising the sequence of treatments necessary to achieve the desired goals. The main rationale is to accurately determine the time period during

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which orthodontic treatment would be most beneficial. (Różyło et al., 2010).

Individuals, on the other hand, differ in the timing, extent, and rate of growth. Not only does patient age impacts the circumpubertal growth spurt, but so do gender, genetics, ethnicity, diet, and socioeconomic situation. As a result, before developing a successful orthodontic treatment plan, it is critical to examine each patient's skeletal age and associate it with the patient's dental and chronological ages (Petrovic et al., 1990; Hägg et al., 1980; Coutinho et al., 1993; Hassel et al., 1995). Chronological age, dental development, and eruption sequence are not reliable predictors of skeletal maturation. Menarche (in females), voice changes (in males), hand-wrist ossification sequence, cervical vertebrae morphology, and statural growth curves have all been used to assess overall skeletal craniofacial maturity (Bhalajhi, 2018). Currently there are no methods that can accurately predict the craniofacial size that a patient will achieve at the end of active growth. This predictive inability becomes a problem in young patients with moderate maxillomandibular discrepancies (Thevissen et al., 2012). It is well known that the malocclusion is often multifactorial. Knowing the etiology of malocclusion is of prime importance for the effective treatment. In general, these factors can be categorized into genetic factors, environmental factors, or combination of both. The genetic factors relate to abnormalities in tooth development and its morphology, such as canine impaction, congenitally missing teeth, and abnormalities in shape of tooth (Bhalajhi, 2018). Sella turcica is an important structure in radiographic analysis of the neurocranial and craniofacial complex. In orthodontics, sella point which is located at the center of sella turcica is one of the most commonly used landmarks in Cephalometric Analysis. Such landmarks located within the craniofacial region are used to measure the positions of maxilla and mandible in relation to the cranium and to themselves (Hinck et al., 2012). The benefits gained from studying these structures range from assisting the orthodontist during diagnosis, as a tool to understand the growth in an individual through superimposition of structures on a longitudinal basis followed by evaluation of results. The knowledge about sound structure of the sella turcica is not only beneficial in evaluating cranial morphology, but also aids in assessing later growth changes and its treatment results. Few studies have shown that, at age of 5 years, the anterior sella turcica wall becomes stable and the morphology of the sella turcica does not change significantly after 12 years (Hinck et al., 2012; Sathyanarayana et al., 2015).

During embryological development, the sella turcica area is a key point for the migration of the neural crest cells to the frontonasal and maxillary developmental fields (Bjork, 1965); also, formation and development of the sella turcica and teeth share, in common, the involvement of neural crest cells. In fact, the anterior part of the sella turcica is believed to develop mainly from neural crest cells, and dental epithelial progenitor cells differentiate through sequential and reciprocal interaction with neural crest-derived mesenchyme. In the embryological development of the sella turcica, neural crest cells and mesodermal cells are involved (Miletich et al., 2004) Besides this developmental relationship, no systematic study has been undertaken to examine the presence of any association between sella turcica anomalies and dental malocclusion. Thus, shape anomalies of sella turcica may both be because of functional disorders in the pituitary gland and by morphological abnormalities of the facial bones (Sharpe, 2001). Recent studies indicate that localized dental anomalies such as hypodontia and palatal displacement of the maxillary canine are associated with calcification of the interclinoid ligament (ICL) or sella turcica bridging (most common type of sella turcica 5 abnormality); moreover, it has been concluded that the morphological appearance is established early in embryonic development (Kantor et al., 1987). Additionally, bridging of the sella turcica, or the union of the anterior and posterior clinoid processes, is another anatomical defect that has been associated with various syndromes and skeletal and dental deformities (Becktor et al., 2000). In orthodontics, diagnosis of facial skeletal type is essential for effective treatment planning. Until date, there have been no studies on the prevalence of sella turcica anomalies in a homogenous groups of patients defined by both age and skeletal class of malocclusion. Therefore, this study was planned and designed to establish associations between the prevalence of Sella turcica anomalies on lateral cephalometric radiographs and skeletal malocclusion.

MATERIALS AND METHODS

The study group comprised of 250 subjects, aged between 8-18 years of age visiting the Department of Oral Medicine and Radiology, Jagadguru Sri Shivarathreeshwara Dental College and Hospital, Jagadguru Sri Shivarathreeshwara University, Mysore with malocclusion and enrolled for interventional orthodontic treatment in the Department of Orthodontics. An ethical clearance was taken from the Institutional Ethics Committee (No: JSS/DCH/MD-31/2015- 16(2)), with an informed consent taken from study subjects in accordance with the Declaration of Helsinki.

Sampling method

This prospective observational study comprised 250 subjects in the age group 8-18 years who were selected by simple random sampling technique having both maxillary and mandibular central incisors and all permanent first molars with integrated dentition and good occlusion. The sampling formula employed was:

n (sample size) = z2 pq/d2

= (1.96)2 (0.11) (0.89) / (0.05)2

= 150

(Where n=sample size, Z=1.96 (95% confidence interval), p= proportion of prevalence, q= (1-P), d=margin of error in decimal points)

Exclusion and inclusion criteria

The study did not include subjects with history of facial trauma and/or the presence of a cleft lip and palate and craniofacial syndromes. Lateral cephalographs obtained were assessed for good visibility of cephalometric structures, including the Sella turcica, and the absence of craniofacial congenital deformities and central pathologies. All cephalographs were analyzed as monitor-displayed images according to Segner and Hasund (1994), using a computer program. Subsequently, anomalies of the Sella turcica according to Axelsson et al. (2003) were identified on lateral cephalographs. In order to analyze bridging of Sella turcica as bridge Type A ribbon-like fusion Sella anomalies and bridge Type B- Sella turcica extension of the clinoid process, the classification of Becktor et al. (2000) was used, which also employed lateral cephalographs. Moreover, a classification of the patients in either of the groups based on malocclusion was done. Skeletal malocclusion analysis was done with ANB angle and Wits appraisal. Patients with an ANB angle less than −1 degree and a Wits appraisal less than −2 mm were categorized as skeletal Class III, and patients with ANB 3-5 degree and a wWits appraisal of 2-9 mm were classified as Class II, whereas those with an ANB angle 0–4 degree and a Wits appraisal ±1 mm were categorized as skeletal Class I (Fig. 1 showing Planmeca Romexis software for cephalometry for measurement of ANB angle and the form of sella turcica). The obtained data were analyzed using SPSS software version 22 for the correlation of sella turcica abnormalities and skeletal/dental malocclusions

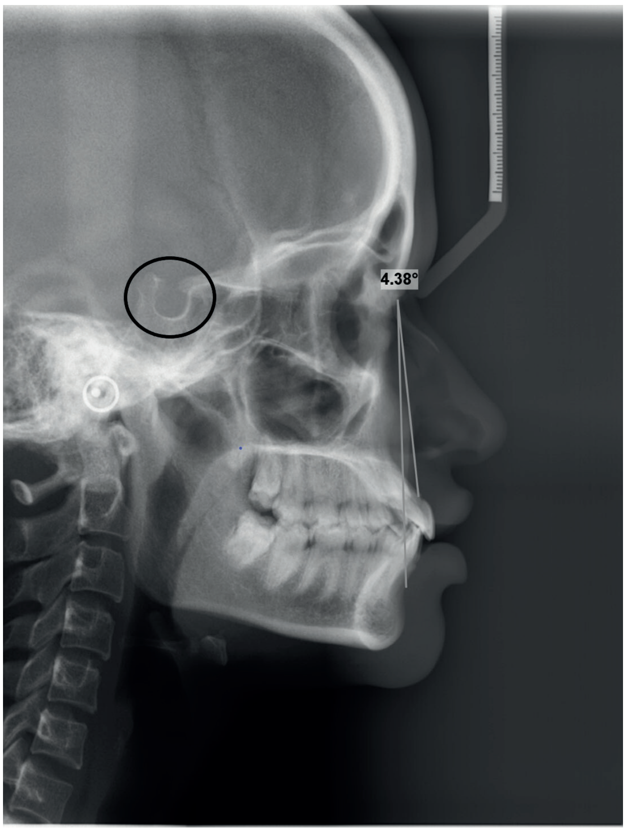


Fig. 1.- Planmeca Romexis software for cephalometry for measurement of ANB angle and the form of sella turcica.

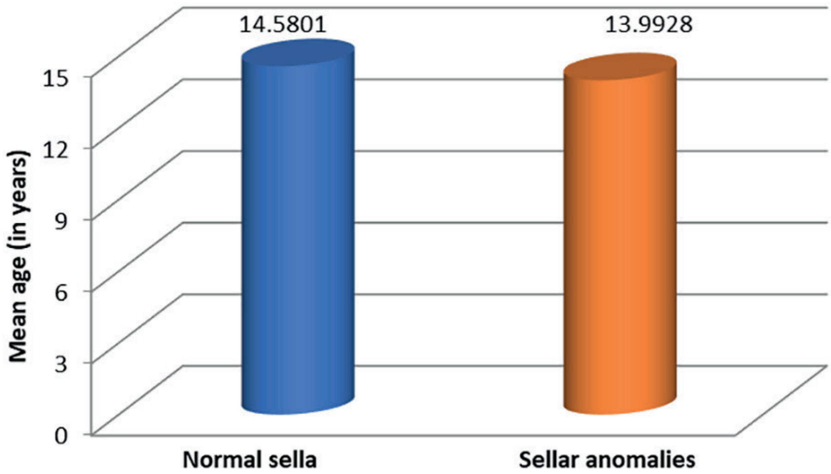
by descriptive statistics, Cramer's V test and chi-square test for determining the frequency among different sella turcica anomalies and skeletal malocclusion.

RESULTS

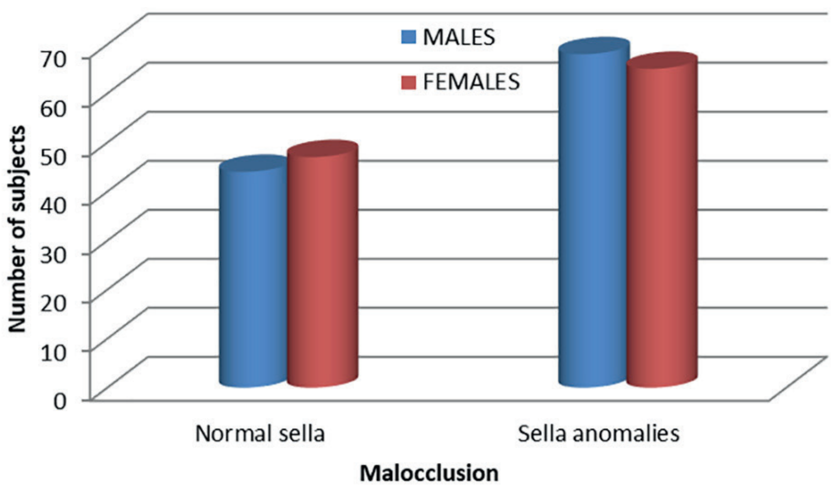
A total of 250 subjects were included in the study. After scrutiny, 26 of them were excluded because of poor diagnostic criteria of lateral cephalograms. Out of 224 radiographs (Males-112, Females-112) evaluated for the sella anomalies, 91 radiographs had normal sella (control group) whereas 133 radiographs displayed sellar anomalies (study group). Study group comprised subjects in the age range of 8-18 years, with a mean age of 13.99 ± 3.65 years in subjects with sellar anomalies and the mean age range of subjects with normal sella was 14.5 ± 3.12 years (Graph 1 shows the mean age of the study population).

In normal sella, 47 (51.64 %) radiographs were of female subjects and 44 (48.35%) were of male subjects, whereas, in abnormal sella, 65 radiographs were of females (48.8%) and 68 radiographs were of males (51.12%) (Graph 2 shows the gender distribution of the study population).

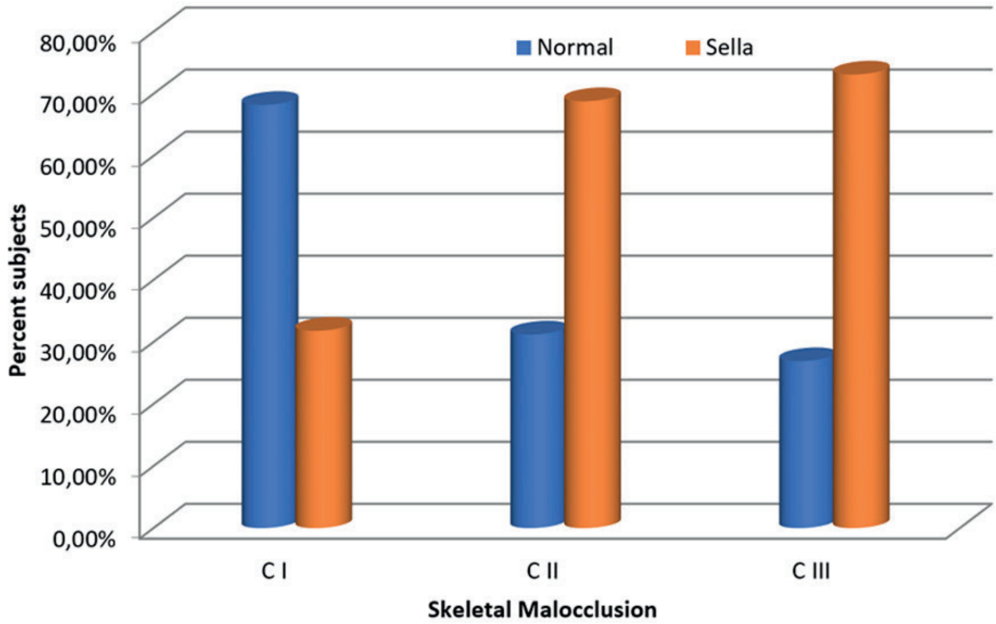
Subjects were classified on the basis of skeletal malocclusion. Normal sella was seen in 45 (68.2%) in skeletal class I, 25 (31.2%) in skeletal class II and 21 (26.9%) in skeletal class III. The



Graph 1. Mean age of the study population.



Graph 2. Gender distribution of the study population.



Graph 3. Distribution of skeletal malocclusion among study subjects.

sellar anomalies were seen in 21 (31.8%) in skeletal class I, 55 (68.8%) in skeletal class II and 57 (73.1%) in skeletal class III (Graph 3 shows the distribution of skeletal malocclusion among study subjects).

Application of Cramer's V test between the groups showed a statistical significance of 0.365 and p value of 0.001, which shows that a significant association was found between classes of skeletal malocclusion and Sella turcica anomalies. Thus it is clear that Class I malocclusion occurs with normal anatomy, and class II and III were associated with sellar anomalies.

Among the sella anomalies observed, maximum prevalence was detected in class III cases (57 subjects) with highest frequency of incomplete bridging (20 subjects; chi-square value=10.32), followed by hypertrophic posterior clinoid process (10 subjects; chi-square value= 4.75) (Table 1 shows the frequency of sella turcica

Table 1. Frequency of sella tursica anomalies among the skeletal malocclusion classes.

Sella Anomalies	Skeletal Class I	Skeletal Class II	Skeletal Class III	Total	Chi Square	P value
Sella turcica Bridge Type A Ribbon-like fusion	1	1	2	4	-	-
Sella Turcica bridge Type B - extension of the clinoid process	2	5	2	9	2.0	.368
Incomplete Bridge	4	14	20	38	10.32	.006
Hypertrophic posterior clinoid process	3	11	10	24	4.75	.093
Hypotrophic posterior clinoid process	3	6	3	12	1.50	.472
Irregularity (notching) in the posterior part of the sella turcica	1	3	2	6	-	-
Pyramidal shape of the dorsum sellae	1	1	2	4	-	-
Double contour of the floor	1	2	3	6	-	-
Oblique anterior wall	1	3	5	9		
Oblique contour of the floor	4	9	8	21	2.00	.368
Total study group	**66**	**80**	**78**	**224**		
	100%	**100%**	**100%**	**100%**		

anomalies among the skeletal malocclusion classes). For very low frequencies, statistics cannot be applied. In Table 1, p value of less than 0.05 (typically ≤ 0.05) is statistically significant; so, p value of 0.006 is highly significant in the present study: i.e., incomplete bridging followed by p value of 0.093, i.e., hypertrophic posterior clinoid process. Moderate significance with p value of 0.368 was found in sella turcica bridge Type B- extension of clinoid process and oblique contour of floor (Fig. 2 shows the different forms of sella turcica anomalies as they appear in lateral cephalograms).

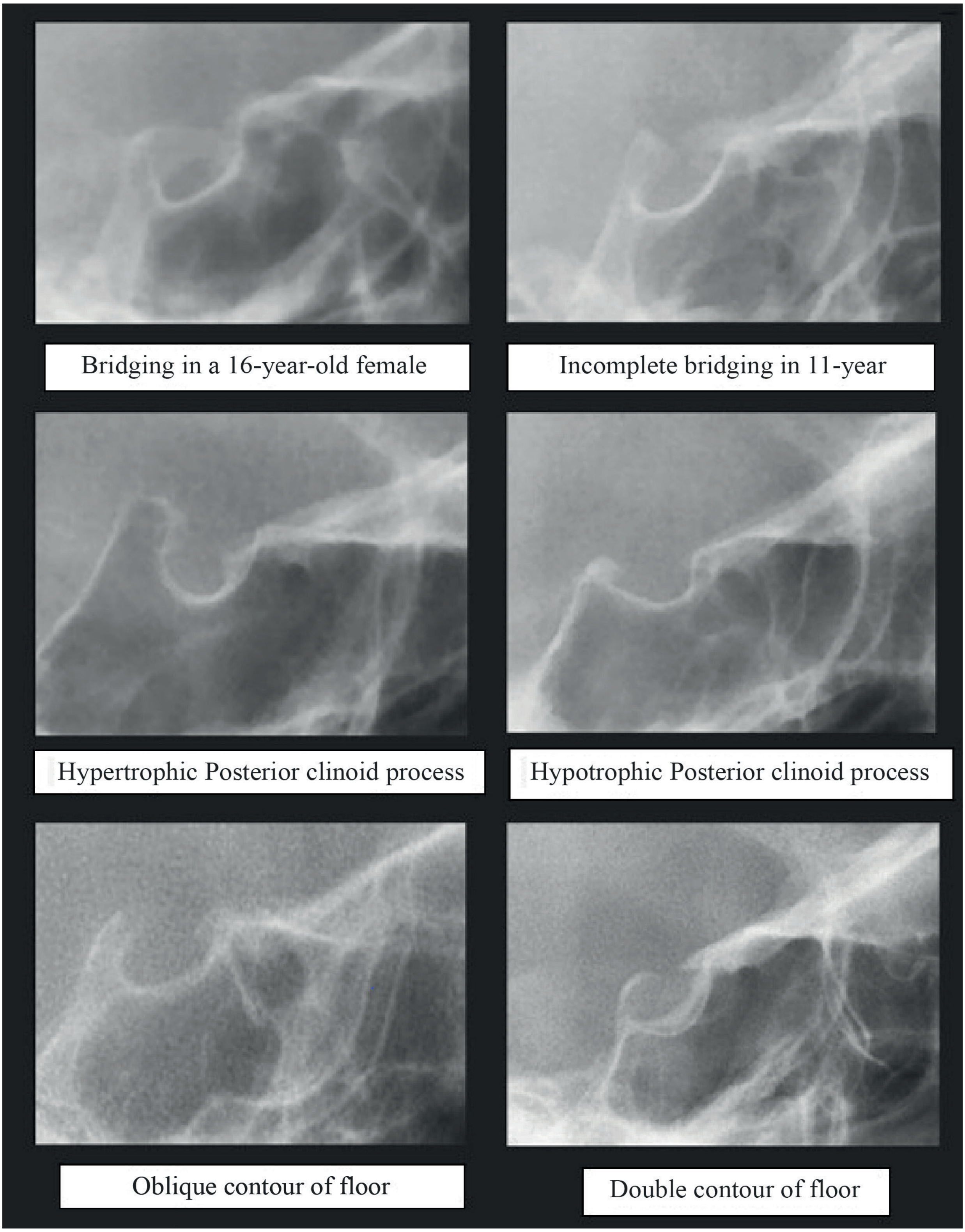


Fig. 2.- Different forms of sella turcica anomalies as they appear in lateral cephalograms.

DISCUSSION

A prompt and early diagnosis of any skeletal condition needs to be assessed in the patient by utilizing all the information available to us with the least amount of radiological intervention. In 1931, Broadbent pioneered a precise technique for taking standardized head radiographs, thus providing a valuable means for the investigation of facial and cranial growth. In the present study, an attempt was made to analyze and differentiate various types of sellar anomalies and their relationship with classes of malocclusion, so as to utilize this as an adjunct to diagnostic armamentarium (Broadbent et al., 1934; Hans et al., 2015). Sella turcica is a readily recognized structure on lateral cephalometric radiographs, and routinely traced in cephalometric analysis.

Calcification of interclinoid ligament, also known as sella turcica bridging, is found to be more prevalent in patients with severe craniofacial deviations and tooth anomalies, and is positively associated with complex craniofacial malformations that require combined surgical and orthodontic treatment protocols (Leonardi et al., 2006). This includes naevoid basal cell carcinoma syndrome, along with calcification of the falx cerebri and vertebral anomalies. This might be attributed to the shared embryogenic origin of sella turcica, many midfaces skeletal fields, and progenitor cells of the dental epithelium (neural crest cells), as well as shared genes involved in their development (e.g., HOX or sonic hedgehog genes) (Miletich et al., 2004). The mean diameter of sella turcica at the age of 8 years is 10 mm, and at the age of 16 years is 11 mm. It is stringently dependent on hypophyseal morphology, and thus the size alterations may be the signs of glandular pathology, which suggests that the individual should undergo further evaluation. (Neha et al., 2016). Axelsson et al. (2003) classified the sella turcica shapes into normal sella turcica, oblique anterior wall, double contoured sella, sella turcica bridge, irregularity (notching) in the posterior part of the sella, oblique contour of the floor, and pyramidal shape of the dorsum sellae. However, it should be kept in mind that two-dimensional representation of a three-dimensional structure using conventional radiography has its limitation in identifying these sellar anomalies.

A recent study conducted among Japanese female patients undergoing orthodontic treatment (Kashio et al., 2017) found that interclinoid distance decreased with advancing age. The combination of increase in sella turcica dimension and a slight decrease in interclinoid distance results in greater degree of interclinoid ligament calcification in the subjects over 19 years of age than in the subjects between 7-12 years of age.

A similar observation was also made in our study, with only 38.45% individuals presenting with sella turcica bridging and incomplete bridging in the study group accounting to a mean age of 13.99 ± 3.65 yrs., which was lesser than the average age of the overall study population being 14 years. The reported prevalence of bridging is highly variable: 4 % - 8.68% on dry skulls, 1.54 % - 6% in autopsy specimens and 3.74% - 11.1% on cephalograms (Axelsson et al., 2003; Camp, 1924; Kjær, 2015). In this study, sella turcica bridge was found in 13 subjects and seems to be "5.80%" (13 out of 224 subjects of the study sample). This is in accordance with the previous studies and research data (Axelsson et al., 2003; Camp, 1924; Kjær, 2015).

Becktor et al (2000) reported that one third of the sella bridges were Type A in Caucasians, and the rest were Type B. In our present prospective observational study, the sex difference among the study population is not significant. However, it was found from our study that there was strong association of male subjects and sellar anomalies as compared with females. The strong association of the male subjects and sella tursica anomalies could be attributed to the homogenous group of study population belonging to same ethnicity, race and nationality.

According to our findings, normal sella was found in 68.2 % of skeletal class I individuals,31.2% of skeletal class II respondents, and 26.9% of skeletal class III subjects. Sellar abnormalities were seen in 31.8 percent of skeletal class I patients, 68.8% of skeletal class II patients, and 73.1 percent of skeletal class III patients. As a result, a substantial link was discovered between skeletal malocclusion classes and sella turcica abnormalities, indicating that class I malocclusion is related with normal anatomy while class II and III malocclusion are connected with sellar anomalies. As a consequence, this study serves as a foundation for future research, indicating that the presence of a sellar abnormality is a predictor of skeletal malocclusion.

Ghadimi et al. (2017), while observing cephalographs of 35 orthodontic patients with palatally displaced canines (PDC) and 75 patients without them, found that the presence of ponticulus posticus and sella turcica bridging (STB) might be associated with increased odds of PDC occurrence. They found correlation between degree of calcification of ICL and skeletal growth in patients has not been established, but it can be used as a guide for detection of craniofacial deviations ranging from palatally displaced canine to atlas posterior arch deficiency.

Busch et al. (1951) had assessed 343 skulls of deceased individuals with a slightly higher (2.1%) prevalence for incomplete bridging than complete bridging (1.2%). Kucia et al. (2014) and Abdel-Kader (2007), while observing cephalograms of patients for orthodontic treatment, had noted a frequency of only 2.5-3.5% for bridging in the study population. Details regarding incomplete bridging or any other signs of calcification of interclinoid ligament were not studied by Abdel-Kader (2007), but a higher prevalence of incomplete bridging (6.8%) was observed by Kucia et al. (2014).

Also, the age group of the study was 9-16 years, so it can be attributed to the slower progress happening in the sellar region for calcification.

Kashio et al. (2017), in the observation of 232 Japanese female orthodontic subjects in the age group of 7-35, had observed the highest frequency of 65.1% (150 Individuals) for incomplete bridging. They were further classified into Type II A (half calcified) based on the extent of bridging. It was found that subjects >19years had a larger extent of these calcification than those in 7-12 years age group. They had observed that sella turcica morphology and bridging were associated with tooth impaction, but not with maxillofacial skeletal deviation.

Limitations and future study prospects

In the present study, there was a higher association of sellar anomalies with skeletal malocclusion, class II and III. Hence, sella anomalies were taken as an indication for the predisposition of skeletal malocclusion, and all patients were advised for interventional orthodontic treatment. The morphology of sella is also determined genetically at an early period of time; any evidence of increased calcification of interclinoid ligament should alert the diagnostician for further follow up and recall. In the present study, all patients desiring orthodontic correction for malalignment of teeth were randomly selected, and no specific attempt to segregate them based on skeletal malocclusion was done employing random sampling. Hence, a small discrepancy was seen among the distribution pattern of the sample.

This can also be attributed to facts like population included were residents of single city- Mysuru in South India. Race and ethnicity of the populace included in the study should also be considered. Our study forms the basis on which further studies could be conducted on larger samples for better understanding of the relationship of skeletal malocclusions and sella turcica prevalence. This study has extended the scope for analyzing different types of sella anomalies and its correlation with malocclusion, as studies on similar grounds have not been performed.

CONCLUSION

In the current orthodontic scenario, many people seek orthodontic treatment for betterment of occlusion, improved oral function and harmonized facial appearance. To recapitulate, we conclude by stating that any evidence of Sella turcica anomaly should be considered as evidence for impending craniofacial malformations. Diagnosing any disease at the earliest stages has been a perpetual attempt by researchers all over the world. In this study, an attempt was made to predict malocclusions before they actually manifest clinically. A positive association of malocclusion in young male population aged between 8-18 years with sella turcica anomalies was observed.

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