**Sella Turcica Bridging and its Association with Dental Anomalies - An Update**

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***Abstract***

*The Sella turcica is an anatomical structure shaped explicitly like a saddle, located within the middle cranial fossa on the intracranial surface of the sphenoid bone. This structure is commonly observed on lateral cephalograms, frequently employed for orthodontic diagnosis. The Cephalometric radiographs utilize various landmarks as reference points to examine craniofacial structures and Sella Turcica (ST) is the most significant and reliable cranial landmark. The Sella point, located at the midpoint of the ST structure, is a cranial base point that accommodates the pituitary gland. The cephalometric analysis relies on this factor to identify pituitary gland-related pathologies, making it a valuable source of information for craniofacial syndromes. Facial structure development exhibits comparable characteristics to the Sella turcica. Glandular abnormalities possess the potential to be linked to functional disorders, which can result in altered hormonal levels affecting dental growth. Comprehensive understanding of the radiological anatomy and variations help assess growth and identify changes in various anomalies or pathological conditions. Additionally, it can assist in predicting the potential outcome of orthodontic treatment. The objective of this review is to determine and update whether a correlation exists between the bridging of Sella turcica and various dental anomalies related to the shape, size, structure, number, and eruption of teeth. In conclusion, it was noted that Sella turcica bridging is frequently observed in orthodontic patients measuring a clear correlation between dental anomalies and Sella bridging.*

***Keywords:*** *Sella Turcica Bridging; Dental Anomalies; Genetics; Lateral Cephalogram; Orthodontist.*

**Introduction**

The harmonious relationship between the craniofacial structures mainly dictates facial aesthetics. Anticipating the direction and magnitude of facial growth before pubertal growth is advantageous for evaluating skeletal disharmony and the potential for operational control [1]. Early detection of skeletal malocclusions facilitates prompt conservative treatment using functional/orthopedic devices. The analysis of these structures serves not only to diagnose but also to monitor orthodontic outcomes. The superimposition pattern of cephalometric X-ray is a powerful tool for predicting growth over an extended period [2]. Sella turcica (ST) is an anatomical fossa in the mid-cranial area that incorporates the pituitary gland. This fossa is a saddle-shaped depression present in the body of sphenoid bone that extends from the Tuberculum Sella to the Dorsum Sella [3]. The interdependent relationship is observed in the development of the pituitary gland and Sella turcica because prenatal and postnatal development of the pituitary gland occurs before Sella turcica. According to the literature, the morphological characteristics of Sella turcica change with alteration in the pituitary gland's development [1, 4-7]. Like the Sella turcica, the neural crest and mesodermal cells significantly form facial structures [5]. Mutations in homeobox genes can disrupt signaling pathways and modify the development of the midface, including the sella turcica and teeth [8]. Glandular anomalies can affect dental development by causing functional disorders such as changes in hormonal levels [9]. The anterior region originates mainly from neural crest cells not directly associated with the notochord. The posterior region is developed from the paraxial mesoderm, which depends on the notochord [9, 10]. Research suggests a potential correlation between irregularities in the frontonasal fields and abnormalities in the anterior seller wall. Additionally, malformations in the brain may be associated with irregularities in the posterior wall [2, 11]

Cephalometric imaging and recordings are primarily utilized to assess skeletal and dental patterns and predict facial development. Moreover, they provide additional diagnostic information regarding the skull, face, and upper cervical spine. Several studies have documented skeletal abnormalities and normal variants on cephalometric radiographs, including the calcification of the inter clinoid ligament (ICL) of the sella turcica [1, 6]. Being a central landmark, Sella turcica plays an essential role in cephalometric evaluation. Over the pituitary fossa, two anterior and two posterior clinoid processes project. These processes fuse because of the Interclinoid Ligament (ICL) calcification and are termed a Sella turcica bridge (STB). Based on their radiographic appearances, two types of bridging are observed [12]. The rate of prevalence of STB varies from 1.75-6%. It has been advocated that, those conditions like severe craniofacial deviations, Gorlin–Goltz syndrome, Axenfeld–Rieger syndrome, and Rieger syndrome are linked with STB [10, 13, 14].

Dental anomalies (DA) are frequently observed as developmental irregularities in tooth dimensions, morphology, position, number, and structure. Developmental abnormalities (DAs) may arise due to genetic factors, such as mutations in particular genes, or environmental factors that occur during the prenatal or postnatal periods [7]. Current research has indicated a correlation between STB and a limited number of specific dental anomalies, including the impacted and palatal displacement of maxillary canines and agenesis. This association has been documented in various studies. Tooth transposition is an uncommon and severe condition of ectopic eruption, wherein two permanent adjacent teeth are located at the same quadrant in the dental arch interchange positions. Its incidence in the overall population ranges from 0.2% to 0.38% [14].

The absence of teeth, also known as dental agenesis, has been observed to have a potential correlation with compromised masticatory function and reduced alveolar bone density. The absence of primary teeth from birth can delay the emergence of permanent dentition [12, 15-17]. The delayed development of dentition can adversely impact individuals' self-esteem and impede the progress of orthodontic treatment protocols.

Several studies have suggested a correlation between dental anomalies and anatomical variations of the Sella turcica. This association has been extensively discussed as an interest amongst orthodontic and maxillofacial surgeons [6, 7, 15]. It has been suggested that several people exhibit anatomical variations in the Sella turcica that resemble dentofacial anomalies. A thorough understanding of normal skeletal development and pathologies is necessary to prevent misdiagnosis. Proper understanding and development of Sella turcica will lead to accurate treatment planning. Normal variations, developmental abnormalities, and pathological disorders are often linked to significant issues in other physiological systems [13]. Frequently, these findings can be detected early in life and generally occur before additional symptoms of the different syndromes. Hence, understanding the development of Sella Turcica at an early stage could prove valuable [7].

Various observational studies have measured the association between Sella turcica bridging and dental anomalies [5, 12, 13, 16-18]. Still, there is a scarcity of data confirming this relation. Moreover, only limited data are available to measure the deformities related to teeth' shape, size, and structure. Hence the present review aims to dwell on the literature to elaborate the knowledge and understanding of the association of Sella turcica bridging and dental anomalies related to the shape, size, and structure of teeth.

**Sella Turcica Bridging and Dental Anomalies**

**Etiology**

The term “sella [turcica] bridging,” which describes the ossification of the ligaments surrounding the pituitary fossa, is used to describe a variety of craniofacial anomalies. The caroticoclinoid foramen is formed when the anterior and middle clinoid processes of the sphenoid bone fuse, enclosing the internal carotid artery. A seller bridge, also known as a 'roof,' is formed by the ossification of the pituitary diaphragm and/or the inter clinoid ligament between the anterior and posterior clinoid processes (Figure 1). A complete bridge retains a superior foramen for transmitting the pituitary stalk and lateral foramina for communicating with the adjacent cavernous sinus. Therefore, the term "roof" is misleading [1, 14, 19, 20]. The caroticoclinoid foramen may be observed in all the Ford collection's crania with a fully developed sellar bridge.

The exact etiology of sella bridging is speculative as it may arise spontaneously or be associated with underlying pathology. Both the anterior and posterior sella turcica walls have different developmental origins. The anterior wall originates from the neural crest cells, whereas the posterior wall development occurs from the paraxial mesoderm under the direct effect of notochord [21]. Facial and dental abnormalities have been associated with a higher incidence of bridging. [22] found a higher occurrence of sellar bridging in individuals with palatal displaced canines or second molar agenesis compared to those with normal dentition. [7] found a greater prevalence of bridging among patients who underwent surgical treatment for dental malocclusion than those who received orthodontic treatment [3] reported a higher prevalence of bridging in patients with severe craniofacial deviations, such as under or overbite. Bridging is prevalent in individuals with Axenfeld-Rieger Syndrome (ARS), an autosomal-dominant disorder characterized by ocular defects and maxillary and dental hypoplasia [4, 5] Sella turcica bridging and a steepened medullary clivus are observed in the cranium of individuals with ARS. Limited studies have established the link between craniofacial skeleton anomalies and dentition. This association is done based on the contribution of neural crest cells and/or homeobox or hox genes during the stage of development. It is observed that the formation of the tooth and its eruption, calcification of the sella turcica bridge, and skeletal development of the neck and shoulder are affected by neural crest cells [11, 14, 16, 18, 20-22].

**Figure 1.** Normal Anatomical Development and Various Abnormal Anatomical Development of Sella Turcica

**Diagnosis**

Lateral cephalometric radiographs are frequently utilized and analyzed by dentists and orthodontists. It is crucial to comprehend the typical variations of the sella turcica to diagnose any abnormalities before the manifestation of clinical indications [2, 13, 23]. Presently, numerous researchers, including radiologists and orthodontists, are intrigued by ascertaining the morphology of the craniofacial region in humans [3, 9, 21, 24]. One of the current theories pertains to the correlation between the morphology and dimensions of the Sella turcica and the craniofacial classifications of skeletal and dental classes I, II, and III [5, 12], Orthodontic classification of the craniofacial skeleton is based on the anteroposterior relationship of the maxilla and mandible, which is categorized into classes I, II, and III [5, 12]. The approach can potentially facilitate identifying and managing individuals seeking orthodontic treatment. Usually, patients seeking orthodontic treatment pose healthy growth. However, few patients report occult pathology affecting craniofacial growth, and these findings are incidentally found while cephalometric analysis.

**Associated Dental Anomalies**

Studies indicate that bridging the sella turcica can enhance diagnostic criteria, confirming or predicting susceptibility to various dental abnormalities. Dental anomalies (DA) are frequently observed as developmental irregularities that impact the morphology, quantity, structure, dimensions, and number of teeth. These dental anomalies often result from genetic reasons, including defects in specific genes or environmental factors during the prenatal or postnatal development phases. Several studies have established a correlation between self-inflicted tissue damage and specific dental anomalies, such as impacted and palatally displaced maxillary canines and tooth agenesis, including canines and dental transposition [5, 7, 8, 12, 14, 22] (Table 1).

All the studies mentioned in this review have evaluated the association of Sella turcica with at least one dental anomaly. However, a recent study by Saokar et al. evaluated almost all dental anomalies with sella turcica. The authors reported a positive association with sella turcica bridging and dental anomalies (peg-shaped laterals and rudimentary third molar) related to the number and size of teeth (P value ≤0.05) [25]. However, no association was found between sella turcica bridging and other dental anomalies. Similarly, Ortiz et al. found no significant association between impacted canine and sella bridging [23] (Table 1).

Prevalence of the occurrence of dental anomalies and sella bridging was reported by almost all the included studies and was found highest in the study by [22] (n=33.3%) with congenitally absent premolar and molar. Authors reported that preteens have a higher significance of Sella turcica bridging than controls [26]. In their previous study, Leonardi and colleagues found a positive association between sella bridging and dental anomalies. However, the prevalence was low (7.6%) [22].

A maximum of included studies has evaluated the association between impacted canines and sella bridging and reported a positive relation between these conditions. The prevalence rate noted among the studies was 25.80% by Ali et al., followed by 8.18% by alqahtani et al., 7.60% by Ortiz et al. and 6.45% by Baidas et al., respectively [16-18, 23]. All the included studies were retrospective and observed the association between pre-treatment orthodontic patients. However, Alqahtani et al. observed sella turcica bridging in orthodontically treated individuals having congenitally missing maxillary lateral incisors (CMMLI). The authors found that patients with CMMLI usually have a raised rate of sella turcica bridging and decreased length of sella turcica [17].

Axelsson and colleagues mentioned a description of a typical sella turcica and identified five distinct forms of dysmorphology, including oblique anterior wall, sella turcica bridging, double contour of the floor, irregularity (notching) in the posterior part of the dorsum sellae, and pyramidal shape of the dorsum sellae. The authors [23] extended the classification of sella dysmorphology to include three additional variants: hypertrophic posterior clinoid process, hypotrophic posterior clinoid process, and oblique contour of the floor.

The process of bridging involves the amalgamation of the anterior and posterior clinoid processes, as documented in reference 36. Sella turcica bridges were classified by Becktor et al. into two categories, namely type A and type B. Type A is characterized by a visible, ribbon-like fusion, while type B is characterized by an extension of the anterior and/or posterior clinoid process, with a thin fusion either anteriorly, posteriorly, or in the middle. An alternative categorization method involves the assessment of the level of calcification exhibited by the interclinoid ligament (ICL). The classification system used in this study categorizes sella turcica into three classes based on their radiographic appearance. Class I refers to sella turcica without any calcification, where the length of the sella turcica is longer than or equal to three fourths of its diameter. Class II refers to sella turcica with partial calcification of the internal carotid artery (ICL), where the length of the sella turcica is less than or equal to three quarters of its diameter. Class III refers to sella turcica with complete calcification of the ICL, where the diaphragma sella is radiographically visible. The diaphragma sellae can be defined as a linear structure that corresponds to the measurement between the tuberculum sellae and the apex of the dorsum sellae.

**Table 1.**Studies Evaluating the Association between Dental Anomalies and Sella Turcica

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| --- | --- | --- | --- | --- |
| **Author/Year** | **Study design** | **Objective** | **Type and analysis of dental anomaly** | **Inference** |
| Leonardi et al. 2006 [22] | Case-control | To investigate the association of Sella turcica bridging with the absence of congenital second mandibular premolar and the presence of palatally displaced canine | Congenital absence of the second mandibular premolar or palatally displaced canine (PDC) | The prevalence of sella turcica bridge in patients with dental anomalies is the overall occurrence of partial and complete bridging (study group 76.5%, control group 43.6%). |
| One author made duplicate tracings of 20 cephalometric radiographs at separate intervals within a 2-week |
| Leonardi et al., 2011 [26] | Case-control | To observe the correlation between sella turcica and tooth transposition | Maxillary and mandibular dental transposition | The occurrence of the partial bridge was observed in patients with changes in sella turcica: study group 42.9%, control group 68.6%, and complete bridging: study group 23.8%, control group 5.7% |
| One author made duplicate tracings of 10 panoramic radiographs at a 2-week interval. |
| Ali et al. 2014 [16] | Case-control | To test the association between sella bridging and impacted canines | Impacted canines. | The occurrence of partial and complete bridging in patients with increased sella turcica bridging (study group 80.6%, control group 51.4%.) |
| 30 randomly selected lateral radiographs were traced and retraced for evaluation by the principal investigator after two weeks of initial analysis |
| Scribante et al. 2017 [27] | Case-control | To find any association between canine impaction, hyperdontia, hypodontia, and sella bridging. | Canine impaction, hyperdontia and hypodontia | The occurrence of vestibular impacted canines was 73%, palatal displaced canines 69%, congenital absence of upper lateral incisors 66%, hyperdontia 59%, lower second premolars hypodontia 58%, and control group 57%. The presence of complete and partial sella bridging was reported. |
| The same operator retraced 20 randomly selected radiographs after six weeks. |
| Baidas et al., 2018 [18] | Case-control | To evaluate the association between sella turcica bridging with canine impaction | palatally impacted canines. | The prevalence of partial and complete bridging: study group 67.8%, control group 26% |
| 15 lateral cephalograms were randomly chosen and traced and then retraced after three weeks |
| Ortiz et al., 2018 [23] | Case-control | To test the association between unilateral/bilateral maxillary canine impaction and sella turcica bridging | Unilateral or bilateral palatal canine impaction | No statistically significant correlation has been confirmed between palatal canine impaction and sella turcica bridging (Study group 59.3% and control group 59%) |
| After a 4-week interval, 21 CBCT scans from the impacted canine and control groups were randomly selected and remeasured by a single investigator. |
| Arcos-Palomino, Ustrell-Torrent 2019 [13] | Case-control | To assess the relationship between the degree of calcification of Sella turcica and the presence or absence of an alteration in the tooth eruption direction | Premolars, canine's impaction, or transposition. | The occurrence of partial and complete bridging: cases 76.6%, controls 40.8% |
| Duplicate tracings on 20 films at two different times were performed by a similar author, with a 15-day gap between tracings, to evaluate the random error. |
| Alqahtani 2019 [17] | Case-control | To compare and evaluate sella turcica bridge among orthodontic patients with congenitally missing maxillary lateral incisors (CMMLI) | Congenitally missing maxillary lateral incisors (CMMLI) | The occurrence of partial and complete bridging: study group 69.4%, control group 46.9% |
| No data on tracing |
| Saokar et al., 2022 [25] | Case-control | To access the relationship between sella turcica and dental anomalies | All dental anomalies, including shapes, size, number of teeth | Dental anomalies of the number and size of teeth are higher in cases with sella turcica bridging. However, no significant association was found with other anomalies. |

**Pathogenesis of Sella Turcica Bridging**

Sella bridging and enlargement of the sella turcica may be linked to different pathological conditions. Table 2 presents data regarding the prevalence of sella turcica bridging across various pathologies. Leonard et al. reported a higher occurrence (17.6%) of complete calcification of the inter clinoid ligament (ICL) in individuals with dental anomalies, such as mandibular second premolar aplasia and palatally displaced canines (PDC), compared to controls (9.9%) without anomalies [22, 26]. A sella turcica bridge in early development may indicate potential tooth anomalies in adulthood; clinicians should note this cranial depression. The study examined the association between sella turcica bridging and dental transposition. The incidence of complete calcification was significantly higher in transposition cases (33%) than in controls (5%) [1, 28]. Pathological issues, such as prolactinoma, have been detected through lateral cephalograms during orthodontic treatment. The lateral cephalometric radiograph should be carefully assessed for possible pathologies, as it can provide initial indications of an underlying issue. Chronic infections may cause pituitary gland enlargement.

The prevalence of sella turcica bridging was evaluated in the included studies. These studies have noted that many sella turcica bridges were detected in the control groups. A possible explanation for these findings could be incorporating individuals with varying skeletal developments. [23] reported a potential correlation between malocclusion and anomalies of the sella turcica. Their study has demonstrated that children with sella turcica irregularities (primarily bridge) exhibit more significant protrusion of incisors and a more distal location of the maxilla and mandible compared to a control group of patients with typical sella turcica morphology. Motwani et al. [25] has corroborated a correlation between the morphology of the sella turcica and the malocclusion type.

The emergence of hypodontia and oligodontia is predominantly linked to diverse genetic factors. Syndromic tooth agenesis is associated with genetic mutations. MSX1 and PAX9 mutations have been associated with sporadic and familial forms of tooth agenesis [29]. [21], peg-shaped lateral incisors and rudimentary third molars may be attributed to incomplete expression of a gene defect that causes tooth agenesis. Tooth agenesis represents a prevalent developmental dental anomaly primarily inherited through an autosomal dominant pattern [21]. The increase in dental anomalies associated with tooth size may be attributed to variability in expression and incomplete penetrance.

While genetics significantly contribute to the development of dental anomalies, local environmental factors may also influence such anomalies. Ortiz and colleagues asserted that it is essential to examine local factors when evaluating the incidence of maxillary canine impaction and its correlation with sella turcica bridging [23]. The mere presence of shared embryological origins and genetic mutations may not suffice to establish a causal relationship, and it is plausible that these two phenomena may manifest independently.

**Table 2.** Prevalence of Sella Bridging and Dental Anomalies

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| --- | --- |
| **Dental anomalies** | **Prevalence** |
| Congenital absence of the second mandibular premolar or palatally displaced canine (PDC) [22] | 17.6% |
| Maxillary and mandibular dental transposition [26] | 33.30% |
| Impacted canine [23] | 25.80% |
| Canine impaction, hyperdontia and hypodontia [18] | 9.20% |
| Palatally impacted canines [16] | 7.90% |
| Unilateral or bilateral palatal canine impaction [27] | 6.45% |
| Congenitally missing maxillary lateral incisors (CMMLI) [17] | 8.16% |

**Clinical Implications**

As Sella turcica and the pituitary gland have a significant vascular and neurologic relationship, Sella bridges are significant from a clinical and surgical perspective. Several researchers have suggested that sella turcica bridging may serve as a diagnostic indicator, prompting healthcare providers to remain vigilant regarding the potential emergence of additional dental anomalies [3, 15, 27, 29-32]. Agenesis of teeth is an essential concern amongst clinicians and patients. Individuals without permanent teeth suffer from various issues, including compromised aesthetic appearance, impaired chewing ability, and psychological disturbance [4, 7]. Early diagnosis and treatment of dental abnormalities reduce orthodontic therapy’s complexity, time, and cost.

Accurate diagnosis of rare normal variants and incidental pathology is crucial to prevent patients’ improper management. The lateral cephalometric radiograph is a primary diagnostic tool for various dental pathologies. The orthodontist must carefully examine and evaluate the lateral cephalometric radiograph to diagnose craniofacial and dental anomalies.

**Limitations**

This review is an update to establish an association between Sella bridging and dental anomalies. This is not a comprehensive review and has not provided evidence of the findings. However, current reviews have highlighted the importance of evaluating Sella turcica as a landmark finding on the lateral cephalometric radiograph to access dental and skeletal anomalies. Moreover, included studies utilizing lateral cephalograms, which is a two-dimensional representation of three-dimensional structure. It is important to note that this method has lots of limitations, as it may be subject to errors in the identification of landmarks and tracing. Cone-beam computed tomography, a form of three-dimensional imaging, has the potential to provide a more accurate representation. Nevertheless, the utilization of imaging modalities in orthodontic patients is contraindicated due to the increased radiation exposure associated with their routine application. Increasing the sample size and incorporating a diverse range of dental anomalies would likely lead to more statistically significant findings. The findings of this review support research on this correlation to diagnose the condition early and provide comprehensive treatment.

**Conclusion**

The positive association between Sella turcica bridging to dental anomalies has the following implications:

1. Sella turcica bridge is elevated in adolescents with dental anomalies, especially peg-shaped laterals, and impacted canines.
2. The presence of Sella turcica bridge at an early stage of life may indicate the likelihood of tooth anomalies in the future. Clinicians need to be aware of this association. However, future observational studies with the latest advancements should be planned to rectify the findings of this review.

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