Content available at: https://www.ipinnovative.com/open-access-journals

Journal of Pierre Fauchard Academy

Journal homepage: https://www.jpfa.in/

Case Report

Heritability of maxillary lateral incisor agenesis and its implications in orthodontic treatment planning: Review of literature and a case report

Aashima Arora[1], Sukhbir Singh Chopra[1], Dhruv Jain[1]*, Manu Krishnan[1], Akshai Kannan[1]

[1]Dept. of Orthodontics & Dentofacial Orthopedics, Army Dental Centre (Research & Referral), Delhi, India

Abstract

Tooth agenesis is a common dental anomaly characterised by the congenital absence of one or more teeth in the primary or permanent dentition. It may occur in isolation or as a part of various syndromic conditions. Among the prevalence of missing teeth, the agenesis of maxillary lateral incisors is common, significantly impacting both aesthetics and function. The management of missing lateral incisors necessitates a collaborative, multidisciplinary strategy to achieve optimal outcomes. This case report highlights the heritable nature of the maxillary lateral incisor agenesis, its genetic implications and the importance of early diagnosis for comprehensive treatment planning.

Keywords: Tooth agenesis, Lateral incisor, Genetics, Orthodontics

Received: 03-05-2025; **Accepted:** 29-05-2025; **Available Online**: 20-06-2025

1. Introduction

Tooth agenesis refers to the congenital absence of one or more teeth in the primary or the permanent dentition.[1] It is the most prevalent developmental dental anomaly.[2,3] The maxillary lateral incisors and mandibular second premolars have been documented to be the most common congenitally missing teeth, after the third molars. Females are 1.37 times more likely than males to have dental tooth agenesis. The prevalence of tooth agenesis has been reported to be higher in Australian (females 7.6%, males 5.5%) and European population (females 6.3%, males 4.6%) as compared to North American Caucasian population (females 4.6%, males 3.2%). Although unilateral tooth agenesis is more prevalent than bilateral tooth agenesis, maxillary lateral incisor is an exception. There is a noticeable variation in the tooth types of the two jaws; the general prevalence of agenesis in the maxilla is similar to that in the mandible.[3]

This case report aims to provide an insight regarding the heritability characteristics of agenesis of maxillary lateral incisor and to highlight the importance of orthodontic treatment planning, taking into consideration the interdisciplinary approach of this dental abnormality.

2. Case of Report

A 14-year female patient in CVMI stage 4 reported to the department of Orthodontics and Dentofacial Orthopaedics of a tertiary dental care hospital with the chief complaint of spacing in the maxillary anterior region.

On extraoral examination, the face was apparently bilaterally symmetrical, well proportionate in horizontal fifths and vertical thirds. The smile analysis revealed a non-consonant smile arc with optimum buccal corridors and an optimum maxillary incisal display. Her profile was convex, with an obtuse nasolabial angle, competent lips, a deep mento-labial sulcus and a prominent chin. Three-quarter analysis showed optimum malar prominence and a normal lip line (**Figure 1**).

*Corresponding author: Dhruv Jain
Email: drdhruvjain08@gmail.com

https://doi.org/10.18231/j.jpfa.2025.004

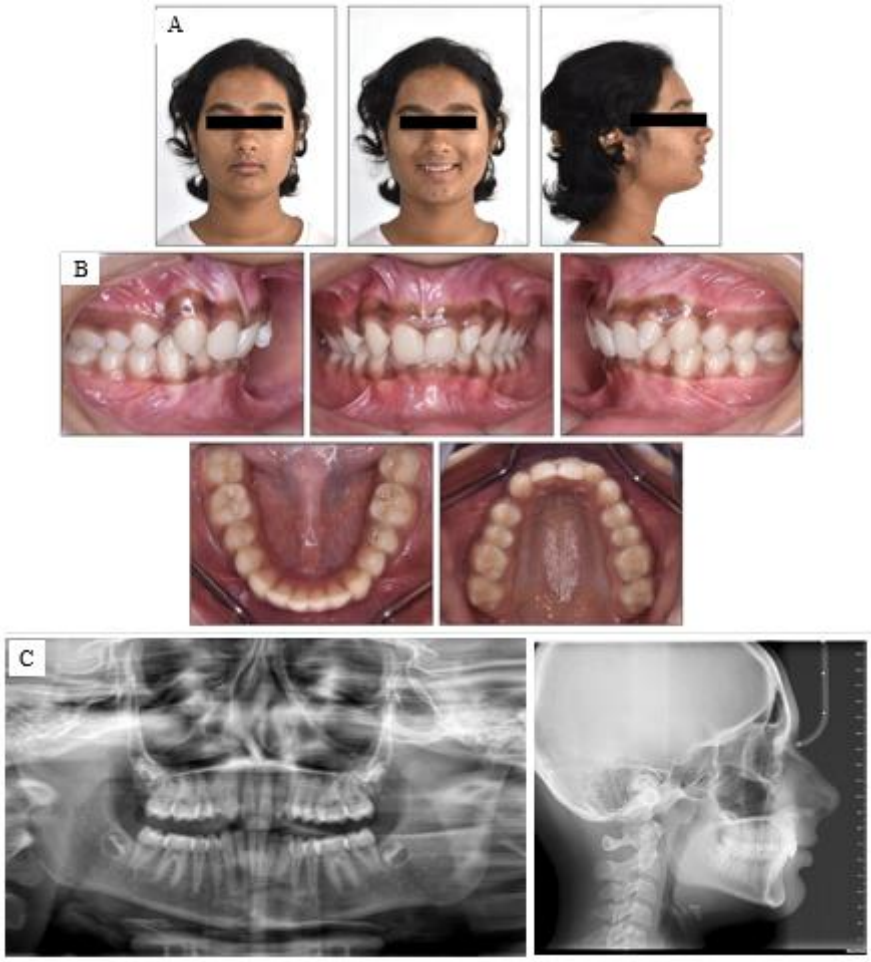

Figure 1: A): Extraoral and intraoral photographs; **B**): Orthopantomogram of patient showing agenesis of 12; **C**): Lateral cephalogram depicting skeletal Class II Division 2 pattern with anterior deepbite.

Intraoral examination revealed thirteen permanent teeth in the maxillary arch and fourteen permanent teeth in the mandibular arch, with a clinically missing maxillary right lateral incisor (tooth #12) and a peg-shaped maxillary left lateral incisor (tooth #22) with mesial migration of the maxillary right canine. The molar relationship was Class II bilaterally, and the canine relationship was Class I on the right and end-on on the left side with retroclined maxillary incisors, reduced overjet, impinging deepbite and an exaggerated curve of the Spee. The maxillary dental midline was deviated to the right by 3 mm. Model analysis revealed Bolton's discrepancy of 8 mm signifying deficient tooth material in the maxillary arch. The patient was clinically diagnosed as a case of Angle's Class II Division 2 Type B malocclusion (**Figure 1**).

The clinical findings were confirmed radiographically through orthopantomogram which revealed twenty-seven erupted teeth and four unerupted teeth (tooth #18, 28, 38, 48) in various stages of development, with maxillary right lateral incisor ((tooth #12) being congenitally missing (**Figure 1**). On analysis of lateral cephalogram, patient was diagnosed as a case of skeletal Class II malocclusion due to an orthognathic maxilla and a retrognathic mandible with reduced collum angle and an average growth pattern (**Figure 1**).

On eliciting familial history, the mother of the patient presented with similar findings. She had fifteen permanent teeth in the maxillary arch and sixteen permanent teeth in the mandibular arch with a clinically missing maxillary right lateral incisor (12), spacing mesial to 14 and 13 and a rotated 14. The patient had a Class I molar relationship on the left side and end-on molar relationship on the right side, with an optimum overjet, 50% deepbite and coinciding maxillary and mandibular dental midline. The clinical findings were confirmed radiographically on OPG, which revealed a congenitally missing maxillary right lateral incisor (tooth #12) (**Figure 2**).

The hereditary presentation of missing lateral incisors in subsequent generations depicts the genetic inheritance of missing maxillary lateral incisors.

Figure 2: A): Extraoral and intraoral photographs; **B**): orthopantomogram of patient's mother showing agenesis of 12; **C**): lateral cephalogram depicting skeletal Class II pattern

3. Discussion

Tooth agenesis is one of the most prevalent developmental defects in human dentition. When a tooth fails to erupt in the oral cavity, is not apparent on radiographic examination, does not have any history of extraction or has not been inadvertently lost, it is said to be congenitally missing.[4] The complete lack of teeth in either the primary, permanent, or both the dentitions is known as "anodontia". Witkop tooth-nail syndrome, Fried syndrome, Böök syndrome, hair-nail-skin-teeth dysplasia, Rieger syndrome, Holoprosencephaly, Down's syndrome (Trisomy 21), Wolf—Hirschhorn syndrome (Deletion 4p), and Kabuki syndrome are among the syndromic disorders that typically present with anodontia.[5] The absence or underdevelopment of one or more teeth is known as "partial anodontia" which has been further subdivided into two categories - oligodontia i.e., congenital absence of six or more teeth (excluding third molars) and hypodontia i.e., congenital absence of less than six teeth (excluding third molars).[5]

The presented case report highlights the genetic inheritance of same sided unilateral maxillary lateral incisor agenesis in mother and daughter. Hans Grahnén in 1956 has first documented hypodontia as an autosomal dominant genetic trait, with variable expressivity and incomplete penetrance.[6] According to Brook's studies in 1984, sex differences in tooth size and number were associated with good correlation between microdontia and tooth agenesis, with increased female predilection. The study findings highlighted that each anomaly was more common in first-degree relatives than in the community sample, indicating that the likelihood of the relatives having hypodontia increases with the severity of the hypodontia.[7] The pattern in dental anomalies were better explained with Butler's field theory which divides the mammalian dentition into multiple developmental areas. The canine, incisor, and molar/premolar fields are all included in the developmental field. Variability and diversity are more pronounced in the distal direction within each morphogenic class than the mesial direction among the respective fields.[8,9] Accordingly, among the incisors, lateral incisors are more prone to variations as compared to central incisors.

Although the exact etiopathogenesis of tooth agenesis is unknown, yet there exists role of interplay between hereditary and environmental factors.[4] Numerous interactions between the epithelium and the mesenchymal tissue result in the

formation and morphogenesis of a tooth. Focal clusters of migrating neural crest cells just under the oral epithelium of the future alveolar ridge are the initial indications of tooth formation.[10] The oral epithelium synthesizes and secretes diffusible growth factors, which trigger the production of transcription factors such as MSX1 and PAX9 which plays an essential role in the differentiation of the underlying ectomesenchyme hence initiating tooth development.[11] The signalling of epithelial-mesenchymal interactions in tooth formation also involves a variety of molecules, including those belonging to the hedgehog (Hh), fibroblast growth factor (FGF), and bone morphogenic protein (BMP). A disorder like hypodontia may be brought on by changes in one or more of the signaling pathways, which may also have an impact on dental development.[12] Mutations in MSX1 and / or PAX9 may result in the congenital absence of maxillary first premolars, incisors, second premolar or third molars.[13,14]

The ectomesenchyme expresses another important WNT regulator protein called AXIN2. A severe form of autosomal dominant familial tooth agenesis has been reported due to mutations in AXIN2. This mutation is also linked to a significantly increased risk of colorectal cancer. Therefore, patients with familial tooth agenesis are recommended to undergo genetic testing to rule out AXIN2 involvement due to the association with colorectal cancer. Familial tooth agenesis may also be caused by certain genes related to early tooth development as a part of broader syndrome, such as Rieger syndrome, or ectodermal dysplasia.[15]

Environmental factors have also been suggested as probable etiology for tooth agenesis. Pregnancy-related rubella infection, children born with thalidomide embryopathy, children treated with early-life chemotherapy or radiotherapy, traumatic alveolar process fractures have also been linked to hypodontia. Maternal smoking and alcohol consumption causes oxidative stress which could be a major risk factor for hypodontia as well.[16]

3.1. Orthodontic implications

The key to successful orthodontic treatment is the methodical and organized course of action. Achieving optimal occlusion, good intercuspations, ideal overjet and overbite with an appealing profile should be the "goal of orthodontic treatment."

When Andrews's six keys of occlusion are realized, these objectives can be accomplished.[17] These six keys were thought to be the best until Mc Laugin and Bennet suggested that the seventh key, "Bolton's tooth size ratio," must be met in order to produce a perfect anterior and posterior fit.[18] There must be a clear proportionality of tooth size for the maxillary teeth to fit the mandibular teeth for aesthetics, occlusal stability, and functional harmony. To help identify the size disparity between maxillary and mandibular teeth, Bolton proposed the inter-maxillary ratio. The anterior ratio with a mean of 77.2%, is the percentage relationship between the mandibular anterior teeth and the maxillary anterior teeth (canine to canine). The overall ratio, which has a mean of 91.3%, represents the percentage relationship between mandibular and maxillary teeth (first molar to first molar).[19,20]

In cases of tooth agenesis, a Bolton discrepancy is often observed, posing challenges in restoring the patient's function and appearance, especially when addressing missing maxillary lateral incisors. The literature highlights the following as the most effective management methods:

1. Regaining space by fixed orthodontic mechanotherapy
2. Orthodontic space closure
3. Premolar auto-transplantation

The primary goal of regaining space with orthodontic therapy is to provide enough room for the replacement of congenitally missing lateral incisor. The amount of space required can be calculated using Bolton discrepancy and taking "golden proportion" into consideration. The tooth can be rehabilitated later using fiber-reinforced composite, fixed partial dentures, removable dentures, fixed cantilever bridges, resin-bonded fixtures, or implant supported restorations.[21]

Orthodontic space closure with respect to congenitally missing lateral incisors can also be planned for patients presenting with Class II malocclusions with noncrowded lower arches, Class I malocclusion necessitating extractions, and those with proclined upper anterior teeth.[22] The canines and premolars are protracted and prepared to resemble the lateral incisor and canine respectively in both esthetics and functionality following orthodontic space closure. The mesial protraction of teeth into the available space preserves the natural gingival and alveolar bone architecture, preventing the need for prosthetic replacement and lowering the risk of third molar impaction.[23] Through this approach, canine-guided occlusion would be replaced by anterior group function during lateral excursions.[24]

Auto-transplantation of premolar at the site of missing lateral incisor has also been recommended to achieve functional adjustment with success rate ranging from 79% - 90%. Following three months of successful auto-transplantation, the premolar crown can be altered to resemble the maxillary lateral incisor both aesthetically and functionally.[25,26]

4. Conclusion

The heritability of tooth agenesis, as presented in the case report, underscores the importance of genetic predisposition in dental anomalies. Maxillary lateral incisor agenesis, often influenced by genetic factors, presents both functional and aesthetic challenges in the orthodontic management. Often, a multidisciplinary treatment approach is required to ensure functional restoration of the occlusion along with an aesthetic

outcome. Continued research into the genetic basis of dental agenesis can further potentiate orthodontic diagnosis, treatment strategies and may serve as a guide for genetic counselling for affected individuals and their families.

5. Source of Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

6. Conflict of Interest

There are no conflicts of interest.

References

1. Hobkirk JA, Goodman JR, Jones SP. Presenting complaints and findings in patients attending hypodontia clinic. *Br Dent J*. 1994;177(9):337–9.
2. Zhu JF, Marcushamer M, King DL, Henry RJ. Supernumerary and congenitally absent teeth: a literature review. *J Clin Pediatr Dent*. 1996;20(2):87–95.
3. Polder BJ, Van't Hof MA, Van der Linden FP, Kuijpers-Jagtman AM. A meta-analysis of the prevalence of dental agenesis of permanent teeth. *Community Dent Oral Epidemiol*. 2004;32(3):217–26.
4. Pinho T, Maciel P, Pollmann C. Developmental disturbances associated with agenesis of the permanent maxillary lateral incisor. *Br Dent J*. 2009;207(12):E25.
5. Fauzi NH, Ardini YD, Zainuddin Z, Lestari W. A review on non-syndromic tooth agenesis associated with PAX9 mutations. *Jpn Dent Sci Rev*. 2018;54(1):30–6.
6. Grahnén H. Hypodontia in the permanent dentition: a clinical and genetic investigation. *Odontologisk Revy*. 1956;7:1–100.
7. Brook AH. A unifying aetiological explanation for anomalies of human tooth number and size. *Arch Oral Biol*. 1984;29(5):373–8.
8. Butler PM. Studies of the mammalian dentition. Differentiation of the post-canine dentition. *Proc Zool Soc Lond B*. 1939;109:1:1–136.
9. Kieser JA. Odontogenic polarity and Butler's field theory. *Med Hypotheses*. 1986;20(1):103–7.
10. Lumsden AG. Spatial organization of the epithelium and the role of neural crest cells in the initiation of the mammalian tooth germ. *Development*. 1988;103(Suppl.):155–69.
11. Tucker A, Sharpe P. The cutting edge of mammalian development; how the embryo makes teeth. *Nat Rev Genet*. 2004;5(7):499–508.
12. Fleischmannova J, Matalova E, Tucker AS, Sharpe PT. Mouse models of tooth abnormalities. *Eur J Oral Sci*. 2008;116(1):1–10.
13. Kim JW, Simmer JP, Lin BP, Hu JC. Novel MSX1 frameshift causes autosomal-dominant oligodontia. *J Dent Res*. 2006;85(3):267–71.
14. Nieminen P. Genetic basis of tooth agenesis. *J Exp Zool B Mol Dev Evol*. 2009;312B(4):320-42.
15. Al-Ani AH, Antoun JS, Thomson WM, Merriman TR, Farella M. Hypodontia: An update on its etiology, classification, and clinical management. *Biomed Res Int*. 2017;2017:9378325.
16. Butler PM. Studies of the mammalian dentition. Differentiation of the post-canine dentition. *Proc Zool Soc Lond B*. 1939;109:1.
17. Andrews LF. The six keys to normal occlusion. *Am J Orthod*. 1972;62(3):296–309.
18. Benenett JC, McLaughlin RP. Orthodontic management of the dentition with the pre-adjusted appliance. ISIS Medical Media, Oxford, UK. 1997.
19. Bolton W. A. Disharmony in tooth size and its relation to the analysis and treatment of malocclusion. Angle Ortho. 1958.
20. Wayne A. Bolton. The clinical application of a tooth size analysis. *Am J Orthod*. 1962;48:504–29.
21. Bukhary SM, Gill DS, Tredwin CJ, Moles DR. The influence of varying maxillary lateral incisor dimensions on perceived smile aesthetics. *Br Dent J*. 2007;203(12):687–93.
22. Zachirsson BU. Improving orthodontic results in cases with maxillary incisors missing. *Am J Orthod*. 1978;73(3):274–89.
23. Kokish-Jr VO, Kinzer GA. Managing congenitally missing lateral incisors part I, Canine. J Esthet Restor Dent. 2005;17(1):5–10.
24. Zachirsson BU. Improving the esthetic outcome of canine substitution in cases for missing maxillary lateral incisors. *World J Orthod*. 2007;8(1):72–9.
25. Zachirsson BU, Stanvic A, Haanae HR. Management of maxillary anterior teeth with emphasis on auto-transplantation. *Am J Orthod Dentofacial Orthop*. 2004;126(3):284–8.
26. Smargada S, Sofia P, Loannis P, Lazaros Z. Agenesis of maxillary lateral incisors: a global overview of the clinical problem. *Quintessence Int*. 2011;12(4):296-317.

Cite this article: Arora A, Chopra SS, Jain D, Krishnan M, Kannan A. Heritability of maxillary lateral incisor agenesis and its implications in orthodontic treatment planning: Review of literature and a case report. *J Pierre Fauchard Acad.* 2025;39(1):20-24.