

## Interdisciplinary Management of Congenitally Agenesis Maxillary Lateral Incisors: Orthodontic/Prosthodontic Perspectives

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**Abstract:** The present paper reports the treatment of a young adult woman with congenitally missing maxillary lateral incisors who underwent orthodontic treatment for improvement of teeth alignment and occlusal balance previous to dental implant surgery. This treatment also allowed appropriate space for the future lateral incisors crowns. Then, Implants were positioned and prosthetic abutments installed. Ceramic laminates were planned on central incisors in order to improve anterior aesthetics. All-ceramic crowns and laminates were made using lithium disilicate-based ceramic. The multidisciplinary association of orthodontic, implant and prosthetic techniques resulted in successful functional and aesthetic rehabilitation of the case, which was maintained after 1 year follow up.

**Keywords:** Dental agenesis. Dental implants. Ceramic laminates. Esthetic.

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### I. Introduction

Dental agenesis is defined as congenital absence of one or more teeth in primary or permanent dentition. It is also known as hypodontia and is one of the most frequently encountered of all oral variation that affects a large population. Epidemiological studies reveal that one of the most common congenitally missing tooth is lateral incisor in maxilla causing esthetic and functional impairments in the affected individual.[1,2] It might be associated with Non-syndromic systemic problems, syndromic conditions or other oral anomalies. Management of missing lateral incisors is a challenging procedure that involves a multidisciplinary approach for rehabilitation of impaired esthetics and function. The most common treatment approaches advocated by the clinicians include regaining of the space of missing tooth followed by prosthetic replacement, auto transplantation of developing premolar and space closure with substitution of canine.[1,2,3,4] Several etiological factors have been suggested for the development failure of the permanent tooth germ, thus leading to its absence, such as: physical obstruction, dental lamina rupture, limitation of space or functional anomalies. In spite of recent progress, the etiopathogenesis of hypodontia remains largely unknown. There is evidence that congenital tooth absence can be the result of environmental or hereditary causes, or even of their interaction.[1,2] The development of human dentition in terms of structure and organization is under genetic control and involves several factors, therefore it is logical to assume that mutations in some genes encoding these factors may affect the normal development of teeth and, eventually, may cause their absence.[3] Non-syndromic hypodontia is more common than the syndromic type. The evidence of a genetic cause for non-syndromic hypodontia came from the identification of significant family aggregation of MLIA and suggest microdontia of maxillary lateral incisors as part of the same phenotype, segregating as an autosomal dominant trait with incomplete penetrance; however, modes of transmission linked to X-chromosome and of polygenic or multifactorial type have also been proposed.[1,2,5] Candidate genes in early steps of tooth development regulation (MSX1, PAX9, AXIN2, TGF $\alpha$ , Activin-b A, LEF1, RUNX2, BMP4, MMP1, MMP20), have been screened for putative mutations in affected families. Some mutations associated with tooth agenesis have been identified in humans at the MSX1 and PAX9 genes. Nevertheless, these genes might be fundamentally implicated in the odontogenesis of posterior teeth [5]. Lammi et al., (2004), reported that a nonsense mutation in the AXIN2, an essential component of the WNT/b-catenin pathway, caused familial oligodontia with a severe phenotype. In addition to oligodontia, those authors also found that a mutation in AXIN2 predispose the individual to colorectal cancer.[6] Considering the discrepancy between the high prevalence rate of tooth agenesis and the relatively small number of reported causative mutations in the PAX9, MSX1, and AXIN2 genes, the genetic contribution to hypodontia/oligodontia seems quite heterogeneous. Environmental and epigenetic factors as well as genes regulating odontogenesis require further in vivo and in vitro investigation in order to better explain the phenotypic heterogeneity and to increase our knowledge about the odontogenic process.[5,6]

Polder et al found in their meta-analysis that dental agenesis differs by continent and gender: The prevalence for both sexes from Caucasian populations in North America, Europe and Australia ranged from 3,2

% males and 4,6 % females in North-American to 5,5 % males and 7,6 % females in Australia. The most affected teeth were the mandibular second premolar followed by the upper lateral incisor and the upper second premolar [7,8].

Högberg et al. impressively describe in their study of 1986 that at the age of 9 years children can realise that they are handicapped. Accordingly psychological help may be necessary, depending on the degree of aplasia.[9]

Missing lateral incisors as well as peg shaped lateral incisors present the clinician with unique and very challenging aesthetic demands [2,3,4]. It is helpful to determine from an early stage which final treatment modality would be utilised. Treatment options include space closure, re-establishment of the space or no treatment at all[4]. These cases are best identified and managed at an early age and usually require a multi-disciplinary approach. If implants are utilised it is important to choose an implant system that is versatile so that any restorative requirement can be addressed. In young patients it becomes important to choose a strong implant design and a system that offers a cone connection and horizontal offset. With modern treatment modalities a very satisfactory outcome can now be achieved [2,4,5].

The patient and parents should be counseled about the complexities of this unfortunate anomaly as soon as it is identified. All the available long-term treatment options need to be discussed as well as the considerable cost implications of each [4,5].

Most patients are diagnosed with hypodontia between the ages of 6 – 12 years. The general dentist is well positioned to manage the case and to make necessary referrals at the appropriate stages of development. Regular consultation visits are thus highly recommended and routine maintenance and restoration of the dentition is important as part of the overall management of the patients [3,4,5]

Generally, maxillary lateral agenesis is diagnosed at an early stage of childhood. Due to the change over time is inevitable in biologic systems, the most important treatment decisions must be linked to the long-term outcome. The results of treatment should preferably be completed when the patients are in their young teens and should be expected to represent a natural dentition over time [1,2]. It is recommended to delay the use of prosthetic restorations until skeletal growth is completed [1,3].

Missing maxillary lateral incisors' conventional space closure is a proper and safe procedure that obtains satisfactory functional and esthetic long-term results [ 9,10]. This treatment alternative is orthodontically space closure with the maxillary canine substituting and camouflaging the canine to mimic the appearance of a lateral incisor. The first premolar tooth can also be reshaped as canine for the durability of esthetics. This camouflaging may be accomplished by the orthodontist with tooth reshaping and positioning and further progress may be attained by individual tooth bleaching, resin composite buildups, or laminates accomplished by restorative dentistry disciplines [10,11 ].

The advantage of space closure using canine substitution is the avoidance of introduction of fixed partial dentures or implants. The prosthetic replacement with fixed partial dentures necessitates intact tooth structure removal and both treatment options are typically more expensively. The parents and the patient should be informed about the damage benefit relation of the course and limited time span of the invasive operative interventions emphasizing the sacrifice of the sound tooth structures. However, in addressing the esthetic concerns of the patient in very severe situations, this treatment might be the most successful alternative [3,4,5]. In addition, while the lateral agenesis patient has gummy smile, the treatment choice should be space closure rather than placing implants [19,11].

In cases with Class 1 skeletal relationships, orthodontic space opening treatment is preferred to treatment by space closing for maintenance of posterior occlusion [3,4]. Color incompatibility between maxillary canines and central incisors is also another factor for the decision for or against space opening [3]. There are several methods to determine the width of space is required for missing lateral replacement. The first one is named the "golden proportion", the second one is to use the opposite lateral incisor as reference, the third method is to use Bolton analysis, the fourth and most appraisable guide for considering the ideal replacement space is to conduct a diagnostic wax-up [3].

When treatment plan involve creating a space for missing lateral incisor, there are 2 treatment alternatives: a tooth-supported restoration and a single tooth implant. Nowadays, tooth supported restorations can be divided into 3 available categories: a resin bonded fixed partial denture (FPD), a cantilevered FPD, or a conventional FPD [10].

Implants are one of the treatment modalities to take place congenitally missing lateral incisors without disturbing the adjacent teeth in orthodontic patients [3,5]. An interdisciplinary point of view should be preferred during the diagnosis, prognosis, and treatment scheme to hinder several potential problems. However, the major drawbacks of this treatment option are the unpredictable prognosis of dental implant treatment and the ambiguous ability of meeting the esthetic and functional expectations of a young patient with high esthetic demand.[12]

The minimum age of the implant patient is more often a concern for maxillary anterior tooth

Replacement, especially for congenitally missing lateral incisors in terms of skeletal maturation level [13]. During the developmental stage vertical and anteroposterior growth changes are substantial in this area. The vertical growth of the maxilla exceeds all other dimensions of the growth in this quadrant; therefore premature implant placement can result in the repetitive need to lengthen the transmucosal implant connection which leads to poor implant-to-prosthesis ratios and the potential to load magnification [3,14,15].

Brahmin advised that whenever possible, implant placement must be delayed until the 15th years for girls and 18th for boys. If is placed earlier, it will relatively seem to submerge vertically, because the implant can not erupt like the adjacent teeth [16]. Additionally, Thilander et al. showed that a predetermined chronological age may not be guidance for implant placement. According to the authors [17] During post adolescence, because of a slight continuous eruption of the adjacent teeth, a dental stage, indicating fully erupted permanent teeth and skeletal maturation completed or almost completed, is not sufficient to hinder infraocclusion of the implant-supported restoration. Similarly numerous of studies showed that infraocclusion may occur correspondingly the continuous eruption of adjacent teeth even an implant is placed in adult with skeletal maturation completed or almost completed [17]. Importantly, Thilander et al. emphasized that the mentioned infraocclusion with minor degree was seen in patients with good interincisor stability also. In addition, the osseointegrated fixtures will not be able to be displaced in the transverse and sagittal dimensions during the growing .

On the other hand, in the literature there are some studies which are advocating implant therapy with high success rate for the rehabilitation of unilaterally or bilaterally congenitally missing lateral incisor.[17]

The present paper reports the treatment of a young adult woman with congenitally missing maxillary lateral incisors who underwent orthodontic treatment for improvement of teeth alignment and occlusal balance previous to dental implant surgery.

### **Case Report**

The initial clinical exam revealed diastema, congenitally missing maxillary lateral incisors with the canines located in the lateral incisor positions, and the primary maxillary canines still located in their original positions. These aspects created not only esthetics deficiencies but also malocclusion. Therefore, a multidisciplinary treatment was suggested to restore both esthetics and function.

### **Phase 1: Planning**

All dental professionals involved in the treatment (orthodontist, periodontist, master ceramist, and operative dentist) evaluated the clinical case individually to decide which noninvasive procedures were indicated. Next, the four professionals discussed the prognosis and limitations of the case. The master ceramist performed a diagnostic wax-up to provide a model of the multidisciplinary treatment. After patient approval, the conservative treatment was then split into three restorative phase orthodontic, surgical, and restorative.

### **Phase 2: Orthodontics**

Dental implants have become a common method for restoring missing teeth. However, especially upper lateral incisor implants are esthetically challenging. The orthodontic improvement of the procedure and the final attendance result of these patients can be accomplished best by positioning the remaining natural dentition in the anatomically correct location. This treatment should be closely coordinated with the implant placement and the restorative team. In cases of extensive dento-alveolar and skeletal malformations, occlusion and facial proportions additionally must be improved by orthognatic surgery and sometimes even by esthetic plastic surgery.

The orthodontic treatment used the following parameters for evaluation: sagittal relationship between the dental arches; posterior occlusion; location, shape, and size of the canines; amount of remaining interdental space; and profile and facial skeletal pattern of the patient.

After orthodontic treatment was finalized, the orthodontic brackets were removed and a removable appliance was used to replace the missing maxillary lateral incisors. (Fig.1) Fig.2a, b)

### **Phase 3: Surgical**

After 15 months of orthodontic treatment, exact locations for surgical implant placement were determined by CBCT 3-D positioning system. 12mm implant for 11 and 12mm implant for 21, were placed. The temporary crowns were inserted while waiting for the healing process. (Fig.2c, d) The correct tridimensional positioning of the implants allowed sufficient amount of bone and gingival tissue, which are extremely important for maintenance of supporting tissues on buccal side. The suitable palatal implant approach is crucial on keeping harmonic gingival architecture.(Fig.3a,b)

#### **Phase IV - Prosthodontic Treatment**

Waxing analysis was used to plan minimally invasive ceramic laminates for the central incisors since their shape need improvements. Minimal wear was performed to ensure direction of insertion and resistance to the restorative materials (ceramic laminates). During preparation, all angles were rounded using extrafine tapered-cylinder round-end diamond burs , silicone rubbers , abrasive disks , and felt disks to smooth the prepared surfaces. Impression of the prosthetic abutments and prepared teeth was performed using polyvinylsiloxane-based material and retraction cords . The accuracy on coping gingival groove favors determining cervical finishing for the ceramic laminates, which must be perfectly adapted to tooth enamel. The ceramic laminates and the prosthetic crowns were made with lithium disilicate-based ceramic . High fracture resistance and good aesthetic performance are some of the properties of lithium disilicate ceramics , what guided the material choice. All functional and esthetic adjustments should be ideally performed on the mock-up restoration previous to laminate confection, since thin restorations are delicate pieces that cannot be worn. Checking of both full crown and ceramic laminates was carefully performed since direction of insertion of the restorations and fit must be verified before luting. Ceramic laminates can also be influenced by the luting agent color due its reduced thickness, so testing the luting agent shade before final luting also becomes an important step. (Fig.4) The internal surfaces of the crowns and laminates were etched with 9.5% hydrofluoric acid for 20 seconds . The surfaces were washed with water and 37% phosphoric acid was applied for 60 seconds followed by cleaning. The ceramic restorations were silanized with a silane coupling agent actively applied for 1 minute. Etching of enamel was performed with 37% phosphoric acid for 30 seconds followed by application of a total-etch single component adhesive system . Light-curing resin cement was used to lute the ceramic laminates. Excess cement was removed with a disposable brush applicator, and each surface was photoactivated for 60 seconds by a LED-curing unit with 1200 mW/cm<sup>2</sup> light output . The full all-ceramic crowns were luted using self-etching dual cure resin cement according to the manufacturer's instructions. Occlusal contacts were marked, and protrusive and lateral movements were checked. (Fig.5) (Fig.6.a,b)

#### **II. Discussion**

Missing lateral incisor leads to an obvious asymmetry in the patients smile, shift in the dental midline. In addition the peg shaped lateral incisor further adds to the unsightliness of the smile. There seems to be an association between hypodontia and malformation of the maxillary laterals which may be reduced in size or simplified in shape, often becoming peg-shaped. It may even provoke an unfavorable response from others in society. The canine can drift mesially into an end-on or Class II relation which is functionally undesirable.[3,4,10,11] Single tooth implants are a good treatment option for replacing the missing teeth provided that the subject's dental and skeletal development is complete and it has several improvements over resin bonded prosthesis: preparation of adjacent teeth is not needed; the tooth replacement will function individually; a conventional oral hygiene technique can be used; preservation and stimulation of existing bone and soft tissues occur, including recreation of the interproximal papillae; and stability and function are improved because of the implant supporting the crown.[17,18] When planning for the placement of a single tooth implant, the orthodontist must ensure adequate space between the crowns and roots. Both the quantity and quality of alveolar bone must be assessed before implant placement is considered.[16]To accommodate a standard implant there should be a minimum of 10 mm of incisio-gingival bone and a minimum of 6.0 mm of facial-lingual bone.1 In cases where there is insufficient alveolar bone for implant placement, ridge augmentation may be necessary in addition to orthodontic repositioning of adjacent teeth.[16] Adequate space for the implant is also required between the adjacent roots.[17,18,19] The average dental implant fixture is 3.75 mm wide, and 1 to 2 mm of space is necessary between the fixture and the adjacent roots. Typically, between 6 and 8 mm of bone between the central and canine roots is recommended. Creating adequate space between the roots must be specifically addressed since the central and canine roots may be brought into closer proximity when the teeth are initially aligned orthodontically.[3] To create adequate space for the implant, further orthodontic treatment may be necessary to move the roots further apart. Space for the coronal restoration must also be assessed. The average implant platform, which is 4.0 mm wide, requires a space of 1.0 mm mesially and distally between the platform and the adjacent tooth to facilitate proper healing and the development of a papilla postoperatively.[12,15]Thus, a minimum of 6 mm of space for the lateral crown is required be based on a comprehensive evaluation of the age, occlusion, and space requirements of the patient as well as the size and shape of the adjacent teeth [20]. Treatment for children with several congenitally missing teeth is challenging because the growth and development of the oral structures have to be taken into account.[17,18,19,20]

One of the treatment options is the use of implants [3]. However, because of the residual facial growth in young patients, infraocclusion of the implant may occur as the implant becomes ankylosed to the alveolar bone [3]. The other treatment options include maintaining the deciduous teeth, extracting the deciduous teeth and allowing the space to close spontaneously, prosthetic replacement, and orthodontic space closure [21]. On

the other hand, if donor teeth are available, autotransplantation is a viable option. If the autotransplanted teeth do not ankylose, they will promote alveolar growth along with the eruption process [22].

**The Esthetic Outcome Of Implant Restorations Are Influenced By Many Variables Including:**[23,24,25,26,27,28]

- A. Patient's expectation and smile line:** Patients' esthetic expectations must be evaluated together with the smile posture. Previous photographs may assist in determining the natural position of the lip when smiling. A high smile line poses considerable challenges because the restoration and gingival tissues are thoroughly displayed. The low smile line is a less critical situation due to the gingival display will be hidden behind the upper lip.
- B. The bony anatomy of the implant site:** For successful esthetic restoration, the bony housing must have a three dimensional foundation that permits placement of an implant in a relatively ideal position. The bone graft procedure is necessary if the bony anatomy is inadequate. The most crucial dimension remains the apicocoronal dimension. The patient must understand that the missing hard and soft tissue architecture will need to be rebuilt so that optimum esthetics can be achieved.
- C. Implant position:** The implants need to be evaluated in three dimensions: apicocoronal, faciolingual, and mesiodistal prior to the surgery since these positions will significantly influence the performing gingival architecture. Placing the implant close to adjacent root creates a great risk of the bone resorption.<sup>4</sup> The surgical and radiographic guide along with a computerized tomography scan is essential to evaluate the required precision in implant placement, and to determine the proper diameter size and length of implants.
- D. Implant Restoration:** Successful dental restorations on implant in the esthetic area are usually the result of close interdisciplinary cooperation between dental clinicians and technicians. The restorations need to be painstakingly fabricated in the laboratory to mimic the natural translucent appearance. In addition, several issues such as porcelain natural shade layering techniques, precision of margins, accuracy of framework, proper dental anatomy, and optimal occlusion are also a principal focus
- E. Gingival Biotype:** The healthy appearance of the gingiva is a crucial issue. Characteristics of the gingival soft tissue biotype will play a prominent role in the final planning for the implant.<sup>4</sup> A thick gingival biotype is more favorable since the thin biotype has a delicate soft tissue curtain, and reduced quantity and quality of keratinized mucosa. Therefore, the thin biotype will require the implant to be placed more palatal and deeper to allow a proper emergence profile and mask any metal show through.

Restoration of congenitally missing maxillary lateral incisors treatment could include removable partial dentures, tooth supported restorations, resin bonded fixed partial denture, canine substitution or a single tooth implant<sup>8</sup>. Space conditions and patient's age as well as on the patient's dental, skeletal and occlusal conditions, should be taken into consideration when selecting the proper treatment for each individual case. Wax set-up study models are helpful involve the patient in the treatment plan.[3].

Implant supported fixed partial prosthesis is the most conservative way of treatment because of protection of the supported teeth, preventing of the alveolar bone resorption and esthetic outcomes. In this case report the patients were evaluated both radiographically and clinically at each appointment.

The appropriate multidisciplinary rehabilitation of congenitally missing lateral incisors with previous orthodontic treatment, followed by correct tridimensional implant positioning and well fit lateral incisor implant-supported crowns associated to ceramic laminates on central incisors was effective in successfully restoring function and aesthetics for the case reported. (Fig.5) (Fig.6.a,b)

### III. Conclusion

The importance of communication between interdisciplinary team members increases with the complexity of the case. When orthodontics is indicated and severe wear or malformation of the dentition also is present, the intermediate restoration of the anterior teeth may be necessary, thereby requiring communication 3-dimensionally and precisely between the restorative dentist and orthodontist. It is the practitioner's or dental institution's obligation to explain the limits and risks of extensive orthodontic, restorative, and implant therapy to other dental professionals so all can mutually agree while planning treatment.

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## **Lgendes**

Fig.1; Patient with missing upper lateral incisors

Fig.2a; X-ray showing minimal space between adjacent teeth- right side

Fig.2b; X-ray showing minimal space between adjacent teeth- left side

Fig.2c; A CBCT (Cone Beam CT Scan) done to precisely measure amount of space and bone and perform 3-D digital work up as simulation

Fig.2d; A digital 3-D model created that shows position of implants and proposed position of the crowns.

Fig. 3a; Implant #7 was placed with a precision guide using our virtual / 3-D work up

Fig. 3b; Implant #10 was placed with a precision guide using our virtual / 3-D work up

Fig. 4; after healing and a 3-month period of temporization, final crowns were placed: A terrific new smile for the patient

Fig.5; New crowns and supporting gum tissue look very natural

Fig.6a; The final X-ray with crown on implant #10

Fig.6b; The final X-ray with crown on implant #7









