

Esthetics Congenitally Missing Lateral Incisors: Single-Tooth Implants

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Abstract: Congenitally missing teeth are frequently presented to the dentist. Interdisciplinary approach may be needed for the proper treatment plan. The available treatment modalities to replace congenitally missing teeth include prosthodontic fixed and removable prostheses, resin bonded retainers, orthodontic movement of maxillary canine to the lateral incisor site and single tooth implants. Implants are a viable option for replacement of congenitally missing lateral incisors and should be considered before the commencement of definitive treatment plan. Early diagnosis, and proper planning can achieve excellent aesthetics. Interdisciplinary treatment plays a vital role to achieve an excellent, esthetic result for a most predictable outcome. This article aims to present a case report of replacement of bilaterally, congenitally missing maxillary lateral incisors with dental implants.

Keywords; Congenitally missing teeth, Orthodontics, dental implants, Interdisciplinary approach

I. Introduction

Teeth are commonly absent from the dental arch either congenitally or as a result of disease, of which caries and periodontal breakdown are the most common.[1] While it is not axiomatic that a missing tooth should always be replaced, there are many occasions where this is desirable to improve appearance, masticatory function or speech, or sometimes to prevent harmful changes in the dental arches, such as the overeruption or tilting/drift of teeth. [1,2,3] Tooth loss is also followed by resorption of the alveolar bone, which exacerbates the resultant tissue deficit.[1]

The maxillary lateral incisor is the second most frequently missing tooth after the mandibular second premolar even though Muller et al. found that maxillary lateral incisors experience the most agenesis (not including third molars).[4] Agenesis of the maxillary lateral incisor is also linked with anomalies and syndromes such as agenesis of other permanent teeth, microdontia of maxillary lateral incisors (peg laterals), palatally displaced canines and distal angulations of mandibular second premolars.[5,6]

Congenitally missing maxillary permanent lateral incisors often lead to an unattractive appearance and difficulty in treatment planning. Age, location, space limitations, alveolar ridge deficiencies, uneven gingival margins, occlusion, and periodontal factors often necessitate an interdisciplinary approach. [3,4]

Several studies have shown that MSX1 and PAX9 genes play a role in early teeth development. PAX 9 is a paired domain transcription factor that plays a critical role in odontogenesis. All identified mutations of PAX 9 and MX1 have been associated with nonsyndromic form of teeth agenesis.[7] Hypodontia creates significant challenges to the clinicians in both diagnosis and management. Comprehensive management often requires a multidisciplinary approach.[7]

Agenesis, the absence of permanent teeth, is a common occurrence among dental patients. The total incidence of tooth agenesis is about 4.2% among patients that are seeking orthodontic treatment; and with the exception of third molars, the maxillary lateral incisors are the most common congenitally missing teeth with about a 2% incidence. [8,9] Esthetically correcting congenitally missing maxillary lateral incisors is a common challenge that every orthodontist and dental team will face, and dentists must consider the treatment options that are most appropriate for each patient.[1,3,4,5]

There are different treatment alternatives for patients with a missing lateral incisor because of congenital reasons [1-8]. Esthetic and functional problems can arise when an orthodontic space closure is realized and the canine is moved into the missing lateral incisor's space [2-9].

The two major alternative treatment options are orthodontic space closure or space opening for prosthetic replacements. But they both can compromise aesthetics, periodontal health and function. Treatment alternatives for restoring edentulous spaces resulting from congenitally missing permanent lateral incisors include removable partial dentures, conventional fixed bridges, resin-bonded bridges, autotransplantation, orthodontic repositioning of canines to close the edentulous space and single-tooth implant.[1,2,5]

The first step to the successful, long-term management of a congenitally missing lateral incisor case is early detection and referral to the orthodontist. The role of the orthodontist in the early mixed-dentition stage of development is to monitor and guide the eruption of the permanent canine. If the crown of the permanent canine is erupting apical to the primary canine root as it normally does, it may be necessary to selectively extract the

primary lateral incisor to encourage the permanent canine to erupt adjacent to the central incisor. The reason for this is two fold. A mesially positioned canine not only provides a natural means for augmenting the supporting tissues, but it also allows for greater flexibility in future treatment planning.[1,3,4, 6,7,8]

Since the maxillary lateral is in the anterior esthetic zone, details of the total smile and individual dental esthetics need to be considered. Recent literature ranks esthetics high in orthodontic patient diagnosis. “Wylie emphasized that the goal of orthodontic treatment should be to attain the best possible esthetic result, both dentally and facially . Studies have shown the importance of having an attractive smile; attractive people are perceived to be kinder, more sensitive, interesting, modest, sociable, exciting, obtain better jobs and lead more fulfilling lives.[10]

Besides achieving the best possible functional occlusion and healthiest position of the teeth, dentists have the demanding task of creating an esthetic result for patients that will effect the rest of their life. Dental professionals must always strive to treat to the highest esthetic standards known to the profession.[1-6]

The smile arc allows dental professionals to correlate the upper anterior teeth to the lower lip . If the maxillary anterior incisal edges follow the curvature of the lower lip while smiling, it is called consonant. A flat smile arc is characterized as nonconsonant. Research has shown that flatter smile arcs are less attractive . [11] From an anterior view, the maxillary teeth should follow the guide of the golden proportion: the maxillary lateral incisor appearance in the smile should be 2/3 or 62% the width of the central incisor. The maxillary canine should be about 62% of the lateral incisor width; thus a tooth will show 62% of the tooth mesial to it in an anterior view.[11,12]

Buccal corridor spaces have recently become more important to smile esthetics. The buccal corridor is the space between the facial surfaces of the posterior teeth and the corners of the lips when smiling . While researchers like Hulsey (1970) did not believe that this buccal corridor contributed to smile esthetics,[13] research by Moore et al (2005) and Parekh et al (2006) show that decreasing the buccal corridor space is more esthetic.[14,15] Researchers and clinicians now consider larger buccal corridors as part of the problem list during diagnosis. One study confirmed that orthodontists and lay persons thought that a broader arch form produces a more attractive smile, and lay persons think it is more attractive to have a greater number of teeth displayed while smiling than having fewer teeth visible .[13,14,15]

The shape of an individual’s anterior teeth varies enough to influence dental esthetics. Anderson (2005) researched the different tooth shapes of male and female patients. He divided the shapes of anterior teeth into: square, square-round, and round. For female patients, general dentists preferred round incisors while orthodontists preferred round and square-round incisors. For the male patient, dentists and orthodontists both preferred square-round incisors. [10]

Tooth color also reflects the attractiveness of a smile. In general, posterior teeth tend to have a more yellowish color than the anterior teeth, which are whiter. Yellow teeth are deemed to be unattractive by dental professionals and lay persons alike . The color shade of each tooth and how they blend with the adjacent teeth is crucial to dental esthetics. A study showed that orthodontists, general dentists, and laypeople all thought a dark shade of an anterior tooth was less attractive than an unesthetic gingival margin, crown width, or incisal shape .[16]

As one smiles, the height of the gingiva displayed between the maxillary central incisors and the upper lip is important. An ideal amount of gingival display is 2.1mm , while too much gingival display is unesthetic and called a ‘gummy smile’.[1,2,3,4]

Gingival shape and contour are determined by the osseous contour . The gingival margin of the maxillary central incisor and the canine should be one to two millimeters higher than that of the lateral incisor. The bony projection over the labial surface of the canine root is called a canine eminence. [1,3] The gingival zenith is the most apical point of the gingival tissue on the facial cervical area of a tooth . For mandibular centrals and maxillary laterals, the gingival zenith is in line with the long axis of the tooth. The gingival zenith for the maxillary central incisors is located distal to the longitudinal axis .[11,12]

For patients with a congenitally missing maxillary lateral incisor, multiple factors should be considered when formulating a treatment plan. [17] These should include available space for the crown and root, canine position, molar occlusion, smile/dental/gingival esthetics, bone quality and quantity, age, facial profile, lip posture, and finances. [17,18] Whatever treatment option is chosen will depend primarily on two factors: occlusion and anterior esthetics. In the past, orthodontists thought the presence or absence of a major malocclusion was the most important factor, but with anterior esthetics as a more recent major orthodontic goal this may not always hold true. [19] Currently, treatment planning is becoming more directed toward the importance of anterior esthetics and the position of the maxillary incisors, the best treatment may be one that provides the best esthetic outcome. [20]Anterior esthetics and occlusion must both be considered together; since a less favorable treatment plan may be implemented if only one is considered. [17-21]

However, finances also factor into the decision making process and resulting treatment. Unfortunately, not every patient will follow through with ideal treatment, or any treatment at all due to

monetary constraints.[1,3,18,19]This interdisciplinary approach may involve preprosthetic orthodontic treatment following consultations with an oral surgeon and prosthodontist to ensure orthodontic alignment will facilitate the surgical, implant and restorative treatment. Early investigation is especially important due to the higher association of congenitally missing or pegshaped lateral incisors with these anomalies. In addition, early investigation will give the patient time to explore all possible treatment options including implant restorations.

II. Case Report

The patient's main concerns were that her teeth were not properly aligned, two upper lateral incisors were missing, and the canines in the lateral incisor position did not present the proper appearance. She said it was important to have "normal" lateral incisors. **Figure 1**

The patient was a healthy 14-year-old with no current significant medical concerns. She had partial paralysis of the left maxillary lip as a result of minor facial surgery as a young child. **Temporomandibular Joints:** Within normal limits **Extraoral:** Lip dynamics are affected on the upper left side. **Intraoral:** The patient presented with retained maxillary primary cuspids and permanent maxillary cuspids in the lateral incisor position. Also, these cuspids were slightly underdeveloped on their mesial aspect. The patient had a history of regular dental care and excellent oral hygiene, requiring continual care and preventive dental procedures only . Adult dentition was not fully erupted, the primary cuspids were evident with minimal residual root present, only one third molar was developing, and the maxillary laterals were absent. The occlusion is diagnosed as skeletal Class I with a mild Class II tendency. She presented with a dental Class II molar relation on the right and a Class I molar relation on the left. Maxillary lateral incisors were congenitally missing, and the maxillary primary canines were retained. **Figure 2** The maxillary canines were in the position of the missing lateral incisors. The maxillary left first premolar was in buccal crossbite. The overjet was mildly increased, and the overbite was 60%. The maxillary dental midline was displaced 3 mm to the left, and the mandibular midline was coincident with the facial midline. The prognosis for this dentition was considered good but was highly dependent on the successful achievement of the orthodontic treatment to place the teeth in acceptable occlusion and to provide enough space for the placement of implants in the maxillary lateral spaces. In addition, the prognosis depended on the placement of implants in adequate bone and management of the hard and soft tissues for the patient's esthetic demands.

Treatmentplan

To address her needs, several options were offered to the patient:

- Orthodontic treatment and resin-bonded bridges to replace the lateral incisors.
- Conventional bridgework.
- Orthodontic treatment, followed by dental implants and implant-supported crowns.

The patient and her parents chose option Orthodontic treatment, followed by dental implants and implant-supported crowns.



Figure 1; Initial frontal view

Phase I: Orthodontics

Orthodontic appliances were bonded into place. A Herbst appliance was fabricated and delivered 3 weeks later. Primary canines were extracted after all orthodontic hardware was in place, and composite was bonded onto the mesial of the maxillary first premolars to fill the vacancy of the extracted primary canines (for esthetics). The Herbst appliance was advanced on the left slightly and the right at 4-week intervals to achieve anterior-posterior correction and to distalize maxillary molars during canine retraction. As the canines were retracted, the composite was removed from the premolars. Eventually, prosthetic lateral incisors were placed on the archwire. **Figure 3**

The maxillary canines were fully retracted in 10 months, and the Herbst appliance was removed 1 month later. Then, rubber band wear was used to detail occlusion and finalize midline correction. After most of

the vertical growth had occurred, resin-bonded bridges were cemented and Essex retainers fabricated for retention until the implant phase could be started. **Figure 4**



Figure 2; Initial panoramic radiograph

Phase II: Management of the Hard and Soft Tissues—Dental Implant Placement

The following five diagnostic keys for implant success in the esthetic zone are critical for formulating a treatment plan:

- Relative tooth position (both apical/coronally as well as buccal/lingually)
- Tissue biotype
- Tooth shape
- Osseous crest level
- Scallop form

The significant findings relative to these five diagnostic keys:

- The tissue biotype was relatively thin.
- The teeth were more triangular than square.
- The bone thickness buccal-lingually at the surgical sites was deficient, precluding a conventional implant-placement technique.

Hard- and soft-tissue augmentation was required. The technique of splitting the edentulous maxillary ridge, expanding the bone, along with a simultaneous pediculated connective soft-tissue graft, was chosen to address these concerns. The rationale for expansion of the ridge, with simultaneous soft-tissue augmentation, was not only to provide enough bone volume for implant placement, but also to provide a more pleasing soft-tissue framework for the implant-supported crown. A concave soft-tissue contour creates a slight shadow, whereas a convex soft-tissue profile allows light reflection for the viewer. This increased light reflection/light creates a more pleasing esthetic outcome. **Figure 5**



Figure 3;Retracted frontal view, early orthodontic composite on premolar.

The surgeries were initiated with a 10-mm long supraperiosteal incision lingual to the osteotomy site. With internal mesial-, distal-, and apical-releasing incisions, as well as a full-thickness flap elevation over the crest and toward the buccal, a pediculated connective soft-tissue graft was harvested and access to the osteotomy site gained.



Figure 4; Retracted frontal view postorthodontics.

The center of the ridge was located with a fitted Vassos Implant Position System ring and a precision drill was used to initiate the osteotomy. The surgical kit twist drill was used to a depth of 9 mm and the angulations verified radiographically with a position indicator. The ridge was split with an 1169 bur mesial-distally. Access for a diamond disk was insufficient. **Figure 6**



Figure 5; Panoramic radiograph postorthodontics.

The exposed alveolar ridge was expanded horizontally, using a split-control kit, taking care not to fracture the cortical plates. The site was refined further with an osteotome to condense the bone and shape the osteotomy prior to final preparation with the conical reamer. An implant was placed 1 mm below the bone crest because of the significant platform-switch design of this implant system. There was 1.5 mm of bone mesial and distal to the implant and 2 mm to the facial. These are critical parameters for health and long-term retention of the hard and soft tissues.

The pediculated graft was rolled under the facial flap to augment the soft-tissue volume. This augmented soft tissue was then sutured to the palatal gingiva. The resin-bonded bridge provisionals were re-cemented with a self-adhesive resin cement.

Phase III: Restorative

The restorative phase was initiated 10 weeks after implant placement. After the resin-bonded bridges were removed, an incision was made lingual to the implants and the tissue released to the facial. The implant cover screws were removed, and standard analog abutments were tried in using an Essex retainer to evaluate space. A 1.5-mm to 4-mm straight standard abutment was chosen for each implant. Bis-acryl provisionals were made and cemented with a temporary crown-and-bridge cement. The tissue was approximated around the provisional and sutured.

After 2 weeks of healing, the provisionals were removed and a closed-tray polyvinyl siloxane impression was taken. Two weeks later, porcelain-fused-to-metal crowns were tried in and cemented with Premier Implant Cement. **Figure 7**



Figure 6; Ridge expansion with Meisinger kit.

The height of the interproximal gingival tissues around an implant-supported restoration is dependent on the bone level of the adjacent natural teeth. The bone on the facial of the implant determines the height of facial tissue. Conservative flap management development of thicker tissue biotype, surgical and prosthetic selection of the implant and abutment design to minimize the micro-movement via a Morse taper internal connection and a platform switch to promote increased soft-tissue volume, and minimizing inflammation by medializing and decreasing the biologic width are all major factors that influence the final position of the tissues around the implant-supported restoration. Other factors include minimizing the number of disconnections and reconnections of the abutment/implant assembly. Complete maturation of the gingival tissue takes several months **Figure 8**.



Figure 7;Bis-acryl provisionals at uncovering of implants, tissues sutured.

At 1-year postsurgery, the peri-implant and interproximal tissues were maturing and a more normal gingival architecture was realized. Select contouring of the anterior teeth was accomplished to improve the overall esthetic . **Figure 9**

Phase IV: Maintenance

The patient achieved her goals of replacement of her missing lateral incisors, improved occlusion, and pleasing esthetic results. More importantly, the results afforded the patient a sense of completeness and improved confidence. This interdisciplinary approach necessitated a treatment-planning process that started with the final outcome in mind. The incisal edge position, occlusal plane, orthopedic position, and esthetic factors were anticipated and planned from the start.

Respecting the five keys to esthetic success for implants in the esthetic zone and anticipating potential hard- and soft-tissue variables and how to address them during the surgical and prosthetic phases, assured the greatest likelihood for success, both in the short and long term. The detailed orthodontic placement of the teeth in the arch and face and with adequate interroot space for implant placement was equally important. Ideal esthetics requires ideal tooth position. **Figure 10**



Figure 8; Initial porcelain fused to metal crown try-in.

Although there can be only one correct diagnosis, various treatment options are possible, each with a different long-term prognosis. Surgically, other treatment modalities for splitting and expanding the ridge could have been the use of Piezosurgery or a scalpel blade, with the use of D spreaders. Prosthetically, lab selected customized-machined and contoured abutments also could have been selected.

The approach used for this patient, with missing and improperly aligned teeth, illustrates the rationale and execution of an interdisciplinary treatment plan. This treatment facilitated the management of the patient's functional, esthetic, and psychological needs in a relatively noninvasive and long-term predictable manner. The results were very acceptable to the patient and exceeded her expectations.

III. Discussion

For patients with congenitally missing lateral incisors, in addition to over-retained primary teeth, permanent canines may erupt or drift mesially into the edentulous space. If the space is to be opened orthodontically for ideal prosthesis, the canines will need to be moved distally, which may result in development of the alveolar ridge in the canine region [2,7,20]. In cases where the occlusion and esthetics of the canine in the lateral position are acceptable, closure of the lateral space by the mesially positioned canine may be the simplest alternative treatment option. However, in all the above congenital missing cases we considered space opening followed by fixed prosthesis would be more acceptable on aesthetic point of view.[5]



Figure9; Retracted frontal view 1-year postimplant.

The optimal time for placement of fixed prosthesis is after the growth of the maxilla, mandible and alveolus is complete. If fixed prosthesis/implant are placed before growth is complete, the surrounding alveolar bone may continue to develop vertically and adjacent teeth may continue to erupt. Thus a discrepancy between the gingival margins of the prosthesis and the natural teeth is created and the prosthesis appears to become submerged. This creates a functional as well as an esthetic problem.[1,3,5] In this case, alveolar bone was available in maxillary lateral incisor areas in the mesiodistal and coronapical dimension; however, there was deficiency in orofacial dimension. The patient was refused to have bone augmentation procedures using either autogenic or synthetic bone grafts because of financial and patient related factors [2,4].

Therefore, implants with 3 mm diameter were used to compensate for horizontal alveolar bone deficiency. However, to avoid labial fenestration, the implants had to be placed off axis in labial direction. The relationship of the position between the implant and the proposed restoration should be based on the position of the implant shoulder, since it will influence the final hard and soft tissue response [2,5]. The malposition of the implant shoulder in the coronapical direction causes soft tissue recession. In this case, location of the implant shoulders was in coronapical and mesiodistal dimension in comfort zone. However, in the orofacial dimension the implant shoulders were in danger zone [2,5].

The angulation of implants in labial direction was compensated using angled abutments that were prepared for better emergence profile of the ceramic crowns. Many authors have also concluded that angled abutments may be considered a suitable restorative option when implants are not placed in ideal axial positions. Nevertheless, forces applied off axis may be expected to overload the bone surrounding single-tooth implants, as shown by Papavasiliou et al using finite element analysis. Hence, the segmental osteotomy may provide an alternative treatment to reposition the severely malposed implants. [22] Implant placement must be avoided before the growth of the maxilla, mandible, and alveolus ends. [1,3,4] If placed earlier, discrepancies between the gingival contours of the implant and natural teeth, as well as occlusal and restorative complications, may occur. While the surrounding bone presents vertical growth and adjacent teeth keep on erupting, the implant reacting as an ankylosed tooth will seem to have been submerged.

The most suitable method to ascertain the cessation of facial growth is the superimposition of sequential cephalometric radiographs taken 6 months to 1 year apart. Absence of changes in facial height, represented by nasion to menton distance, indicates that facial growth has been completed.[1,3,5]

Rochette¹⁷ in 1972 so, at that time, the only options for a bridge involved tooth preparation. It is reasonable to assume that the orthodontists of 30 years or more ago would have preferred a non-destructive approach for young patients to preserve longterm dental health.[23]



Figure 10; Panoramic radiograph 1-year postimplant.

In orthodontic practice assessed the space for implants by the traditional method of measurement between the crowns of adjacent teeth was not surprising. As long as there is sufficient space to place an implant, the actual width of the finished crown can be adjusted to fit the available space.[24] The finding that orthodontists with access to restorative dentistry advice assessed the space by intraoral radiographs or measurements at the gingival margin probably reflects the emphasis on the implant surgery, ie providing sufficient space for the implant, abutment, bone, adjacent periodontal ligament and gingival cuff rather than the emphasis on providing sufficient space for the crown. [25]

Williams et al. showed a relatively high risk of debonding. Finally, treatment with the single implants – a frequently described method of one-tooth replacement should be mentioned [26]. Many investigations showed that more than 90% of the patients are satisfied with the effects of implant supported single tooth restoration in the aesthetic zone [27,28]. Nonetheless, the longterm observations proved many negative alterations. The periodontal problems such as marginal bone loss around the adjacent teeth, connected with a larger loss and reduction of the distance between the implant and the tooth were mentioned in contemporary literature [28].

A Swedish article regarding implant insertion in the aesthetic zone showed other unfavorable aspects: atrophy of the distal papillas, increased frequency of bleeding or mucositis when compared to the contralateral natural teeth [20].

Iseri and Solow examined radiograms of the patients aged 9–25 years and proved continuous eruption of the natural teeth, which allowed the conclusion that dental implants should not be used in childhood, adolescence or young adulthood. This observation showed the need for temporary reconstruction of the spaces opened for the prosthodontic restorations in the young patients. Some of the disadvantages of single-tooth replacements with the dental implants may be reduced by proper orthodontic treatment with the gaining of adequate space for the screws. Also, the correct timing of implant insertion after completed dental and skeletal development may lead to an improvement of the results [29]

Czochrowska et al. highlighted that canine substitution is a valid therapeutic option, giving satisfying aesthetics. Morphology, width and color of the upper canines serving as the “new lateral incisors”, are the major factors influencing good treatment effects. Brighter than normal and rather small canines are favorable in achieving an attractive smile after closure of the spaces [30]. The substituted canines of ten need recontouring. Thordarson et al. showed that this procedure is safe and painless to the patient.[31]

The term “team approach” has been used throughout the health care industry, and as technologies continue to advance, this term has evolved from simply referring a patient back and forth to detailed treatment planning and case selection.[32,33,34,35] In this case report, the restorative dentist presence and participation at stage I surgery was a valuable asset to achieving the ideal esthetic and functional result for this patient. Patients with congenitally missing maxillary lateral incisors may seek orthodontic therapy as part of a restorative plan.[36,37]

Communication between the disciplines of orthodontics and restorative dentistry is recommended to improve treatment planning in the management of hypodontic patients.[38,39,40] This study has further highlighted the value of multidisciplinary evaluation and management of hypodontia before embarking on treatment and throughout treatment,[1,2,3,39,40]

IV. Conclusions

Orthodontic space closure and implant substitution of missing maxillary incisors produced similar satisfactory esthetic results. Neither of the treatments impaired temporomandibular joint function. However,

orthodontic space closure patients had better periodontal health in comparison with implant substitution patients. Furthermore, infraocclusion more than 1 mm was noticed in all the implant patients. It is important that the orthodontist together with the other specialists frame a treatment objectives which are realistic and meet the needs of the patient. Constant interaction and communication among the team members and the patient at all level of treatment are the keys to the success of the interdisciplinary treatment.

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