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RESEARCH ARTICLE

ESTHETIC MANAGEMENT OF CONGENITALLY MISSING LATERAL INCISORS WITH SINGLE TOOTH IMPLANTS: A CASE STUDY

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ABSTRACT

Implantology has become an established part of overall dental treatment strategies and is also increasingly being integrated into orthodontic treatment concepts. Recent publications have reported upon the use of osseointegrated implants for orthodontic anchorage and to replace of missing teeth after creation of sufficient space by orthodontic means. This paper describes the therapeutic use of osseointegrated implants to replace congenitally missing upper lateral incisors. Highlighting the importance of the Orthodontic/Restorative interface.

INTRODUCTION

The term hypodontia is classifiedasisolatedor nonsyndromic hypodontia and syndromic hypodontia associated with syndromes. Hypodontia is defined as missing one tosix teeth (excluding the third molars). A tooth is defined to be congenitally missing if it has not erupted in the oral cavity and is not visible in a radiograph. The use of dental panoramic tomography (DPT) is recommended in detecting dental development. All primary teeth should erupt by the age of 3, all permanent teeth between 12 and 14 (except the third molars). The prevalence of hypodontia in permanent teeth has been reported as between 3.5% and 10% (Shapiro and Kokich,1988; Schweizer *et al.,* 1996). Hypodontia is observed as an isolated trait (an autosomal dominant form) or as part of a syndrome (Bowden and Harrison, 1994). Many environmental factors (trauma in dental region, treatment of malignant diseases) or genetic factors (mutations in transcriptions factors MSX1 gene in chromosome 4 or another transcription factor gene PAX9 in chromosome 14) were important in the etiology of this anomaly (Bowden and Harrison, 1994; Hagnmann and Aguilino, 1996).

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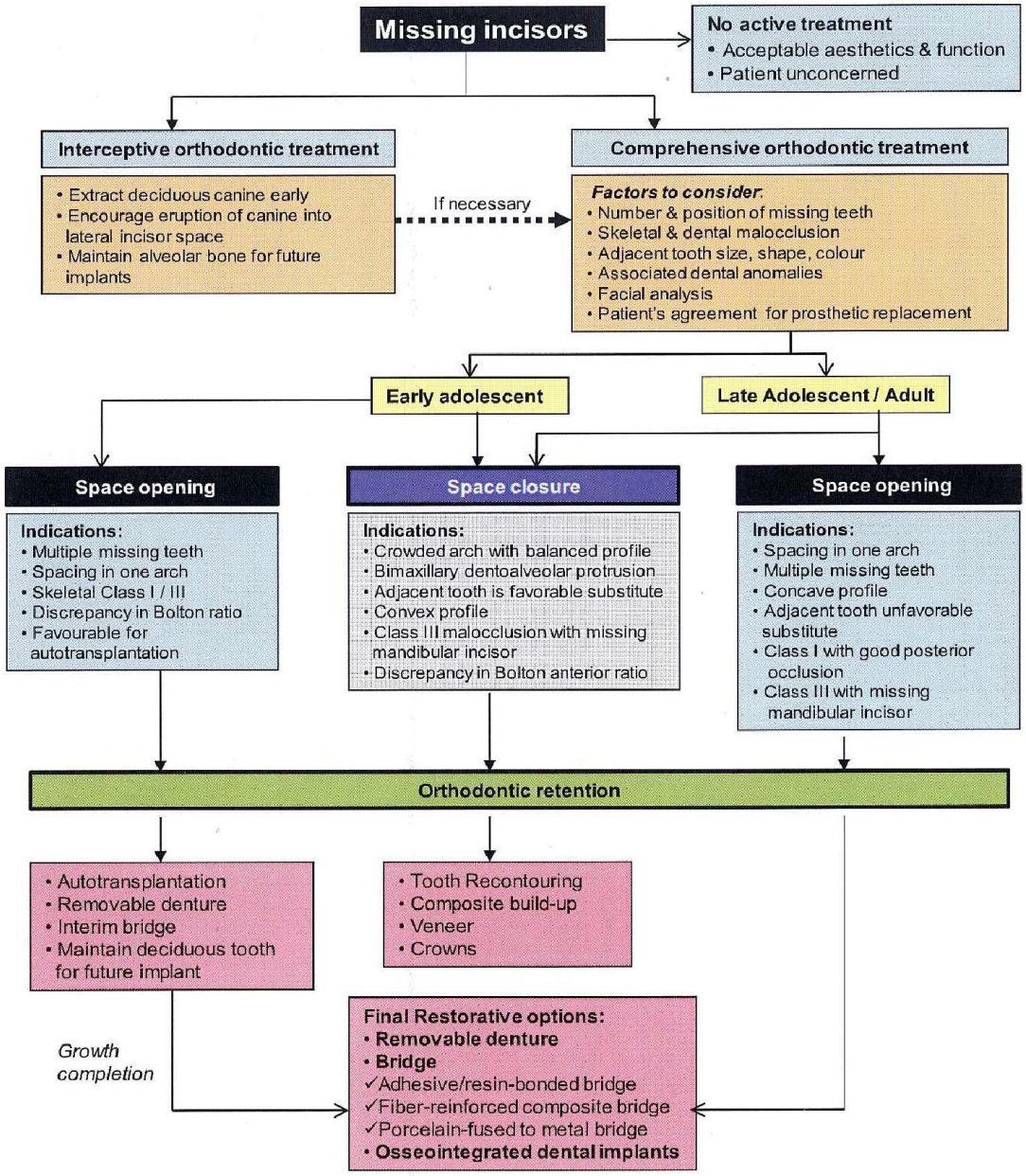
The maxillary lateral incisior or second premolar and mandibular second premolar tooth are the most frequently missing teeth. The absence of maxillary central incisiors, mandibular and maxillary firstmolarandcanines seems to be very rare (Weinstock and Rosenberg, 1995; Schweizer *et al.,* 1996). An interdisciplinary approach is important throughout treatment planning and subsequent treatment can involve dental team members such as an orthodontist, oral and maxillofacial surgeon or periodontist and restorative dentist or prosthodontist (Hagnmann and Aguilino, 1996; Shroff *et al.,*1996; Abu-Hussein *et al.,* 2014; Nik Hussein *et al.,* 1995). The use of a diagnostic set-up is one of the most important aids in clinical decision-making due to the inherent Bolton discrepancy. With the introduction of osseointegrated, new, Long-Lasting space management that is noninvasive for the adjacent teeth can be realized.It is recommended that the implant shoulder and the adjacent root surface should be at least 1mm apart (Abu-Hussein *et al.,* 2014; Nik Hussein *et al.,* 1995;Wu *et al*., 2007; Lewis and Eldridge, 1994). The shoulder should be positioned in the comfort zone to avoid the danger zone,which is located close to the adjacent root surface and is about 1,0-1,5 mm wide. Orthodontic therapy for space opening should not be started before the age of 13 years so as to prevent the replase and progression of bone atrophy (Lewis and Eldridge, 1994; Bergendal *et al.,* 2006; Cahuana *et al.,* 2004; Cho and Lee,

2006). The time of implantation should be close the end of orthodontic treatment. As opposed to starting orthodontic space closure early, orthodontic space opening before implantation should be started late (Abu-Hussein *et al.,* 2014) Table 1
The advantages of single implant are;

- Due to decreased alveolar bone width and increased labial concavity bone grafting may be needed for implant.

Table 1. Algorithm of "Orthodontic management of developmentally missing incisors"



- Long-term implant osseointegration
- No need for buid-ups of neighboring teeth
- Comparatively short and simple
- Satisfactory short-term esthetics
- Optimal posterior occlusion

The disadvantages of single implant are;

- Progressive infraocclusion
- Visibility of metal or porcelain abutment over time
- Interdental recession (particularly distal papilla)
- Difficulry of making natural-looking porcelain crown

This paper describes the therapeutic use of osseointegrated implants to replace congenitally missing upper lateral incisors. Highlighting the importance of the Orthodontic/Restorative interface.

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 maloclussion.

Therefore, a multidisciplinary treatment was suggested to restore both esthetics and function. (Abu-Hussein *et al.,* 2014)

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 Fig.1a-c

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. 1a Immediately post-orthodontic treatment

Fig. 1b Adequate keratinized tissue present. Bone sounding revealed adequate width

Fig. 1c The inadequate mesial to distal width #12

Phase 3: Surgical Fig.2a-b,3a-b

A more recent option for treating congenitally missing lateral incisors, and one that currently is recommended often, is the single-tooth implant. Over the past several years, the predictability and longterm success rates of implants have made them an obvious restorative choice (Shapiro and Kokich, 1988), respecially when teeth adjacent to the space are healthy, of normal size and shape, and unrestored. Furthermore, placement of an implant may provide a functional stimulus to help preserve bone and prevent resorption. However, when choosing the single-tooth implant as a restorative option, several factors must be taken into account such as growth considerations, space requirements, and site development (Millar and Taylor, 1995; Weinstock and Rosenberg, 1995; Cho and Lee, 2006). Because an implant acts essentially like an ankylosed tooth, any vertical alveolar growth and eruption of teeth would cause a discrepancy between the gingival margin of the natural tooth and the implant. Therefore, implant placement should occur only after growth has been completed, and it has been suggested that neither chronological age nor hand-wrist radiographs are reliable enough to make that determination. Instead it would be best to compare superimposed cephalometric radiographs taken at 1-year intervals until no growth changes are detected (Das *et al*., 2002; Fekonja, 2005). Also, the amount of space between the roots is critical to successful implant placement, and orthodontic intervention usually is necessary to achieve not only the amount of interradicular space needed, but also the proper rootarigulation.Because orthodontic treatment usually occurs at an early age, several years of maintenance therapy may be required until the appropriate age for implant placement. It is also important to maintain proper spacing for ideal tooth proportions of the final restoration In addition to the tooth width requirements for mesiodistal spacing, the alveolar width in a buccolingual direction must be adequate for implant placement. Often an additional surgical appointment is necessary to graft or augment the alveolar ridge before an implant can be placed. It has been suggested in the literature

that by allowing or guiding the eruption of the canines into the lateral position and orthodontically moving them to their natural position, the necessary amount of buccolingual alveolar thickness for implant placement can be achieved naturally, without the need to perform any ridge augmentation (Fekonja, 2005; Winkler *et al.,* 2008).

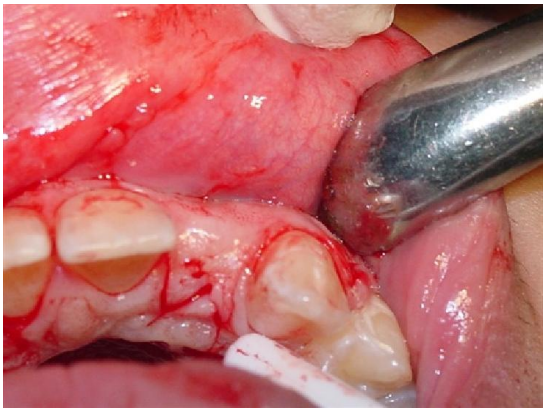


Fig. 2a Instead of a midcrestal incision, a modified incision was used. Midcrestal incisions tend to produce an "envelope effect" when appoximating tissue around an abutment

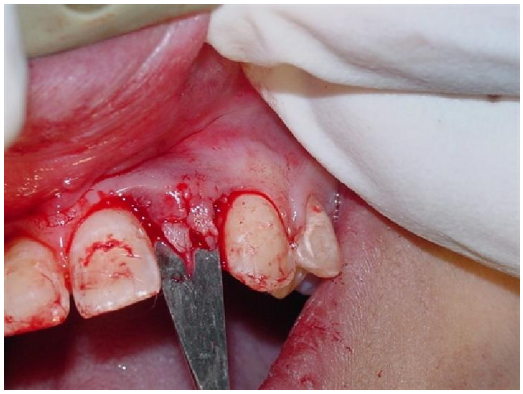


Fig. 2b The fingers are visible

Fig.3a 3I 3.75 x 13 mm placed to level of crest. The platform has a bevel that rests on the cortical bone but is not countersunk. The fixtures were approximately at 50 Ncm as the motor indicated

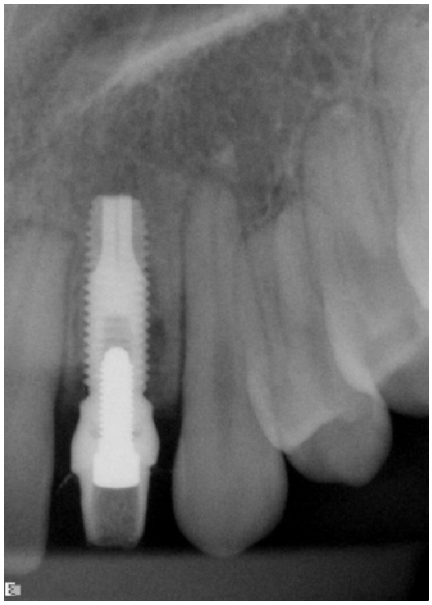


Fig.3b 3I 3.75 x 13 mm placed to level of crest. The platform has a bevel that rests on the cortical bone but is not countersunk. The fixtures were approximately at 50 Ncm as the motor indicated. The abutments were prepared mostly extraoral and torqued to 32Ncm. Acrylic temporaries fabricated and temporarilly cemented

Although not completely understood, it has been shown that very little, if any, resorptive change in alveolar bone width is observed when space is opened orthodontically compared with the decrease in alveolar ridge width after extraction of maxillary anterior teeth. However, a disadvantage of orthodontic canine distalization for implant site development is the potential for loss of arch length when the canines are allowed to eruptmesially (Abu-Hussein *et al.,* 2014; Fekonja, 2005; Winkler *et al.,* 2008; Bukhary *et al.,* 2007). When agenesis of maxillary lateral incisors is diagnosed in a young patient, usually primary maxillary lateral incisors are retained. In such cases, it may be necessary to selectively extract the primary lateral incisors to encourage the permanent canine to erupt mesially, adjacent to the central incisor. The canine will influence the thickness of the edentulous alveolar ridge due to its large buccolingual width; otherwise the osseous ridge will not fully develop due to the absence of the lateral incisor (Millar and Taylor, 1995; Bowden and Harrison, 1994; Winkler *et al.,* 2008). As the canine is moved distally to open space for the lateral incisor implant and crown, the root movement creates an increased and adequate alveolar ridge which allows proper implant placement. However, the time of implant placement should be relative close to the orthodontic treatment. This procedure is called “Implant site development”. If inadequate alveolar ridge is present, ridge augmentation may be necessary using bone grafts (Bukhary and Gill, 2007). Adequate implant space: The amount of space needed for the implant and crown is generally determined by the contralateral lateral incisor. However, if both lateral incisors are missing or the contralateral one is peg-shaped, the amount of space should be determined by one of the methods below:

- The golden proportion or a recurrent esthetic proportion
- The Bolton analysis
- A diagnostic wax-up
- Mean values

The small size of the maxillary lateral from 5,5-8,0 mm requires careful planning for an implant to be placed. Is important that orthodontic movement has distanced not only thecrowns, but the roots of the adjacent teeth too. Generally, the adequate coronal space should be no less than 6,3mm whereas the interradicular space no less than 5.7mm. «At least, 1,5 mm between of the implant and adjacent roots is desirable as it is cited that narrower distances between them are more likely to show a reduction in bone height over time. In addition, fixed retention is suggested rather than removable appliances to prevent relapse. crowns, but the roots of the adjacent teeth too (Millar and Taylor, 1995; Abu-Hussein *et al.,* 2014; Nik Hussein *et al.,* 1995;Wu *et al*., 2007). Generally, the adequate coronal space should be no less than 6,3mm whereas the interradicular space no less than 5.7mm. «At least, 1,5 mm between of the implant and adjacent roots is desirable as it is cited that narrower distances between them are more likely to show a reduction in bone height over time. In addition, fixed retention is suggested rather than removable appliances to prevent relapse. Generally, implants must not be placed until the patients have completed their facial growth and the majority of their tooth eruption(Millar and Taylor, 1995; Schweizer *et al.,* 1996; Shroff *et al,*1996; Wu *et al*., 2007). As the face grows and the mandibular rami lengthen, teeth must erupt to remain in occlusion. However, the implant behaves like an ankylosed tooth and will not follow the changes of the alveolar processes due to the eruption of adjacent teeth. This may result in clinical infra occlusion of the implant supported crown and cause a discrepancy in the occlusalplane and between the gingival margins of the implant and the adjacent natural teeth. Thus, evaluation of the completion of facial growth by cephalometric radiographs must be done and subsequently, the patient should be informed for the optimal time of implant placement. However, even mature adults can exhibit major vertical steps afteranterior restorations with implants to the same extend as adolescents

Phase 4: Restorative Fig.4,5a-b,6a-b

Fig.4. Immediately post op

Six weeks after surgery the patient returned for the restorative phase of treatment. The healing abutment on the implant was then modified to create a better emergence profile (1,2,%).

Fig.5a Immediately post insertion

Fig.5b Lingual view

Fig.6a One year follow up

Fig.6b One year follow up. Tissue matured well#12

Fig.6c One year follow up. Tissue matured well#22

This was achieved with air abrasion of the healing abutment, application of metal primer, bonding agent and flowable composite. The desired effect was achieved in that the soft tissue moved in a bucco-apical direction creating a more labial emergence profile. A harmonious gingival contour with the adjacent teeth was established. It was suggested from the outset that a crown lengthening procedure on the peg shaped lateral would create a longer crown length and a more symmetrical gingival contour in relation to the contra-lateral incisor [Bowden and Harrison, 1994; Hagnmann and Aguilino, 1996; Shroff *et al*., 1996; Wu *et al*., 2007). The patient decided to keep treatment simple and avoid further surgery and cost (Millar and Taylor, 1995). An open tray NC impression coping was connected to the implant and verified radiographically. The 12,22 was minimally prepared for a full coverage veneer. A polyether impression compound was used to take the final impression, taking great care to record the soft tissue emergence profile. A customised final abutment was cast accordingly and torqued to 35 Ncm. The porcelain fused to metal crown was cemented with Tempbond. The Emax full coverage veneer was luted with transparent Rely-X veneer cement, and the upper Hawley retainer adjusted to fit.

DISCUSSION

Patients with congenitally missing maxillary lateral incisors may seek orthodontic therapy as part of a restorative plan.
Maxillary lateral incisors are the most common congenitally missing teeth (11%) other than third molars. (Schweizer *et al.,* 1996; Hagnmann and Aguilino, 1996; Abu-Hussein *et al.,* 2014). Clinically, the absence of maxillary lateral incisors is reflected by the presence of anterior spacing, including a diastema between the central incisors and a mesial drifting of the cuspids. The correction of this aesthetic problem can be a diagnostic and clinical challenge in dental practice. (Shroff *et al.,* 1996; Abu-Hussein *et al.,* 2014; Small,1996)

Treatment Options Include:(Millar and Taylor, 1995)

a- No treatment/simple improvement with composite resin: Patient's with minimal spacing may feel that the appearance of their teeth is satisfactory. For others, composite resin can be used to improve tooth appearance by closing a small diastema.

b- Space Closure: The space corresponding to missing lateral incisors may be closed by protraction of the cuspids and the buccal segments with the final objective being a class II buccal occlusion. The cuspids and first bicuspids can be masked to simulate the lateral incisor and cuspid, respectively using composite resin.

c- Space Opening: The alternative to space closure is to maintain or create the necessary space, for a prosthetic replacement of the missing tooth. Replacement options have been a removable partial denture, conventional bridges, resin bonded bridges and single tooth implants.

Each one has its own indications, advantages and disadvantages. Osseointegrated implants may be used to restore single unit spaces including the congenitally missing maxillary lateral incisor. However, implants are not indicated in patients for whom a potential for further growth exists since an implant, which does not have periodontal ligament, cannot erupt and keep pace with dentoalveolar development (Abu-Hussein *et al.,* 2014; Chan *et al.,*1994). Single tooth implants are likely to be of most use in the adult patients. Patient selection should be considered carefully keeping in mind oral hygiene socio-economic background and ability of patient to follow maintenance instructions. The importance of early diagnosis of missing teeth should not be forgotten, so that a multidisciplinary approach can be established at an early stage. Preparatory orthodontic treatment may be needed to align teeth, create adequate space in addition to establish an optimal axial inclination of the teeth adjacent to the proposed implant site. With proper patient selection and diagnosis, understanding of occlusion, effective communication among operators and attention to detail, the single tooth restoration can be a predictable esthetic and long-lasting restorations (Abu-Hussein *et al.,* 2014; Nik Hussein *et al.,* 1995;Wu *et al*., 2007).In this case, alveolar bone was available in maxillary lateral incisor areas in the mesiodistal and coronoapical dimen-sion; however, there was deficiency in orofacial dimension (Small,1996).

The patient was refused to have bone augmentation procedures using either autogenic or synthetic bone grafts because of financial and patient related factors (Bukhary *et al*., 2007). 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, (Chan *et al.,*1994). 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 (Gumus *et al.,* 2008). The malposition of the implant shoulder in the coronoapical direction causes soft tissue recession. In this case, location of the implant shoulders was in coronoapical and mesiodistal dimension in comfort zone. However, in the orofacial dimension the implant shoulders were in danger zone (Gumus *et al.,* 2008). 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 (Abu-Hussein *et al.,* 2014;Gumus *et al.,* 2008).

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.

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