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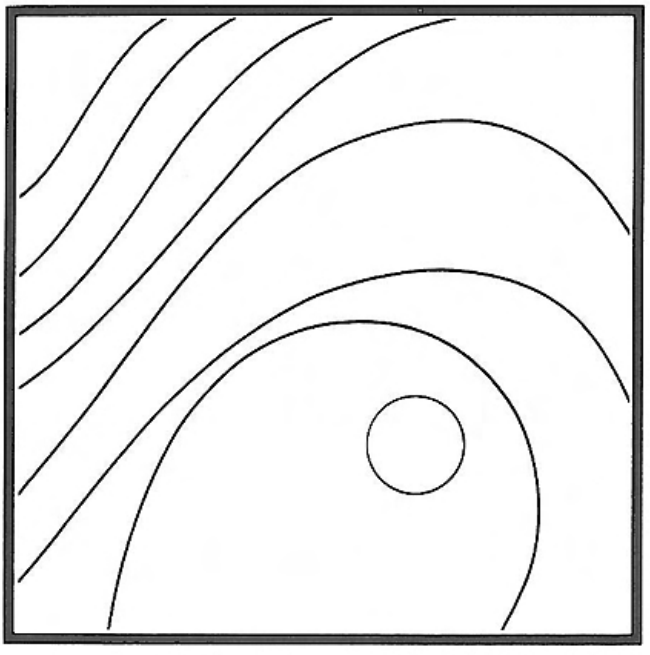

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Osseointegration and Orthodontics: Modern Treatment for Congenitally Missing Teeth

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Abstract

Among the goals of orthodontic therapy is the establishment of optimal facial form, occlusal function, and dental esthetics. Orthodontic treatment of patients with congenitally missing teeth, especially maxillary lateral incisors, can be accomplished best by positioning the remaining natural dentition in the anatomically correct location and closely coordinating therapy with the osseointegration team members. Special divergence of adjacent root tips is essential to provide space for the implant. The Brånemark system of implant therapy is the treatment of choice for the permanent replacement of congenitally missing teeth. (Int J Periodont Rest Dent 1993;13:495–505.)

The goal of orthodontic treatment is to provide patients with biologic preservation, occlusal function, facial form, and optimal esthetics. Current prosthodontic treatment goals include restoration, reconstruction, preservation, function, facial form, and dental facial esthetics. With careful planning and coordination, the specialties of prosthodontics and orthodontics can provide ideal treatment methods for patients with congenitally missing teeth (Figs 1 and 2).

Patients with congenitally missing teeth

The frequency of congenitally missing teeth varies according to sex. The tooth most commonly missing in females is the mandibular second premolar, followed by the maxillary lateral incisor, then the maxillary second premolar. In males, the tooth most frequently missing is the mandibular second premolar, then the maxillary lateral incisor, followed by the mandibular lateral incisors.

Congenitally missing teeth or partial anodontia occurs in about 7% of the population.[1] Aberrant or diminished tooth size frequently is found with these individuals.

Traditional orthodontic treatment for the patient with congenitally missing maxillary lateral incisors often required complete orthodontic movement to position the canines mesially, filling the position of the lateral incisors.[1] Because the canine teeth are anatomically much larger than lateral incisors, this treatment approach requires the removal of enamel and extensive reshaping of the facial, lingual, incisal, and proximal surfaces. Root form of the canines also differs drastically from that of lateral incisors; however, little modification of root surfaces is possible. The color of canines is frequently much darker, with more orange and brown than lateral incisors. Generally, the esthetic results of canine reshaping to mimic lateral incisors, termed "lateralization,"[2] leaves unnatural tell-tale signs of the congenital defect. Functional changes in the occlusion should also be considered, especially the requirements for canine guidance when premolars are moved anteriorly. There is concern for

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Fig 1a Pretreatment smile reveals congenitally missing maxillary lateral incisors.

Fig 1b Post-treatment results following carefully coordinated orthodontic and osseointegration treatment to "permanently" replace the lateral incisors.

Fig 2 Note the pretreatment clinical angulation of the canine eminence.

the added forces imposed on premolars with shorter and thinner roots. Moving a canine into the lateral position will affect the entire occlusal scheme.

Modern orthodontics is undergoing a significant change in treatment philosophy, especially with the improvement of prosthodontic methods available to replace the congenitally missing tooth. The goals of this new approach in orthodontics are the establishment of an ideal occlusal relationship, the best possible masticatory function, and the most esthetic appearance.

Treatment planning

When congenital defects of anodontia require restoration, a variety of prosthodontic approaches are possible. Each should be considered by the treatment team before beginning orthodontic therapy. Young patients with missing teeth and their parents should be presented the variety of prosthodontic treatment possibilities prior to orthodontic treatment.

Current prosthodontic methods for replacing congenitally missing teeth include traditional fixed prosthodontics, resin-bonded fixed partial dentures, removable partial dentures, or osseointegrated implants to support an independent anatomically contoured crown. Proper execution of the first three methods requires varying degrees of tooth preparation.

Prosthodontic options

Traditional fixed prosthodontic treatment generally requires complete preparation of abutment teeth with removal of a majority of tooth structure. Useful service of a fixed partial

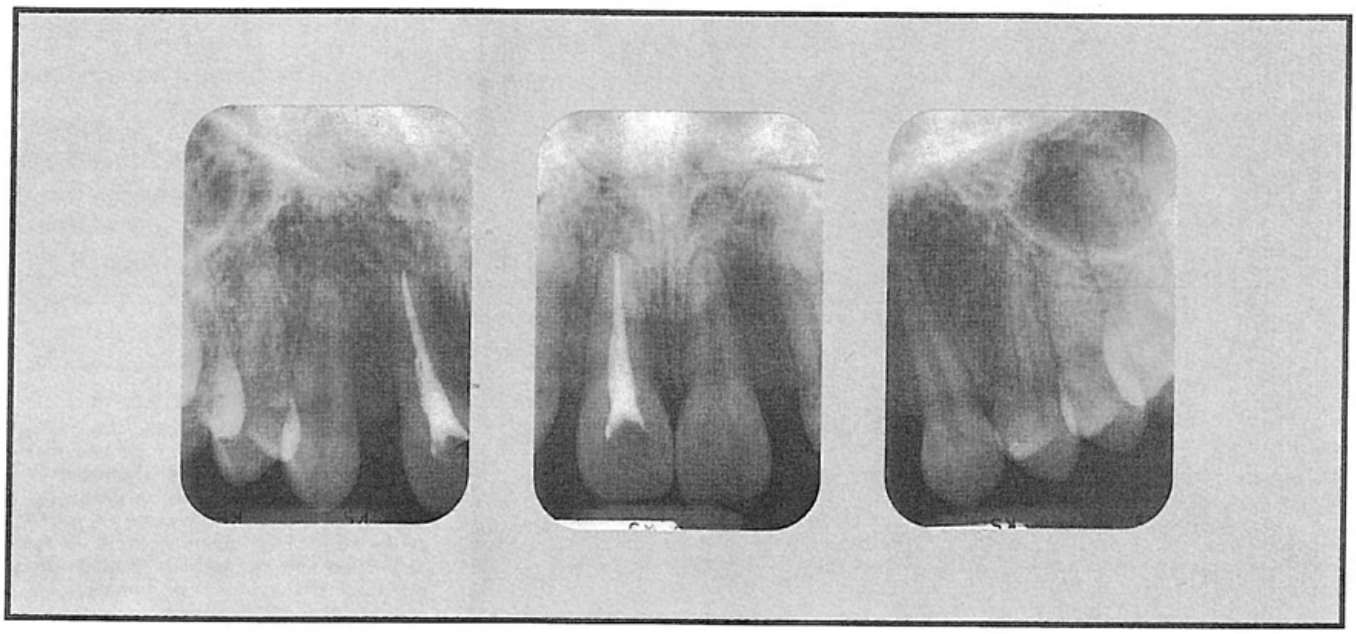
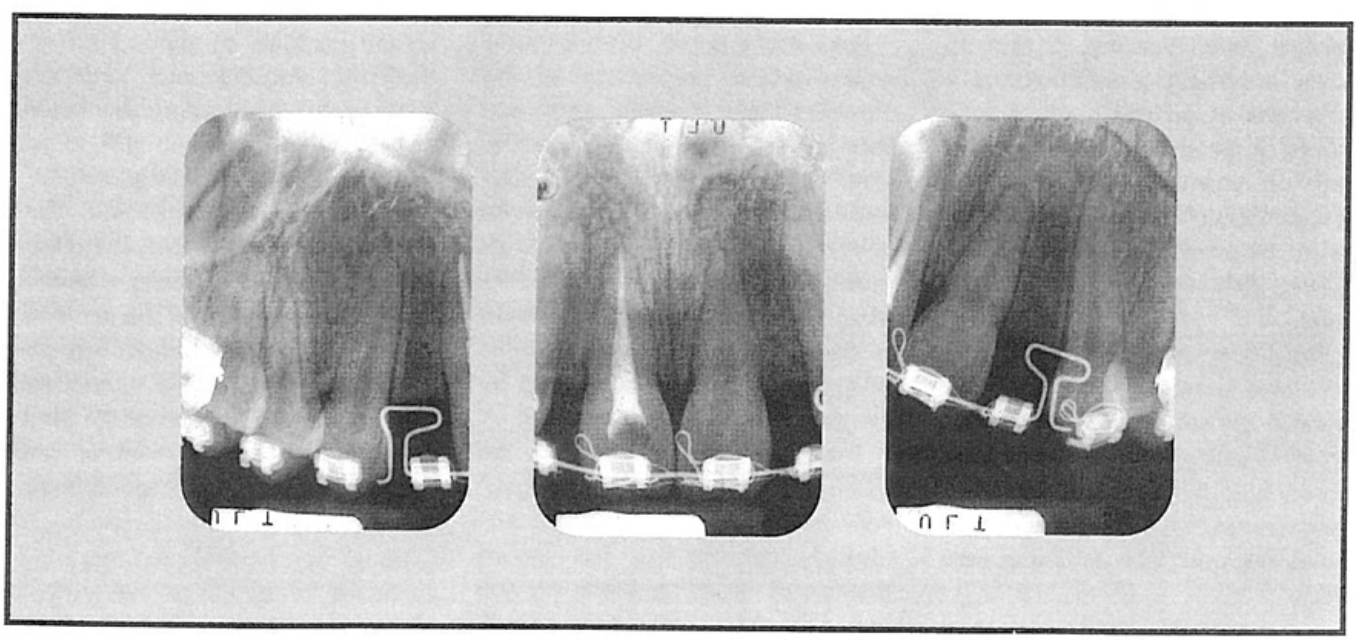
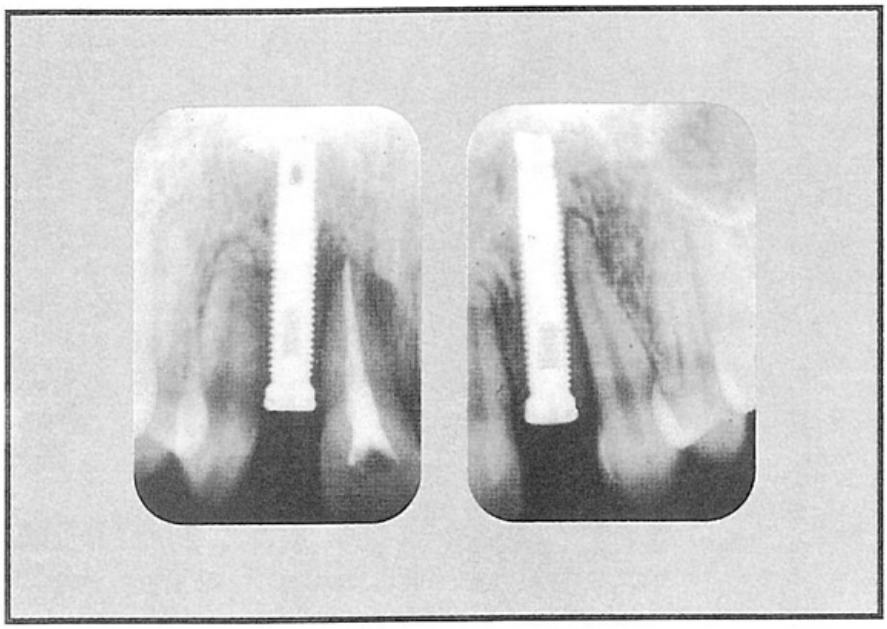


Fig 3 Pretreatment periapical radiographs clearly illustrate the mesial inclination of the maxillary canine roots.

Fig 4 Periapical radiographs illustrate the orthodontic appliances in place with the arch wire bent to create apical distillation pressure on the maxillary canine roots.





Figs 5a and 5b Right and left lateral incisal areas with Brånemark implants in place following orthodontic repositioning and correction of the long axis angulation of the incisor and canine roots. A 20-mm Brånemark titanium fixture is placed with a minimum of 1 mm of bone between the implant and adjacent roots.

denture varies between 5 and 15 years (according to our 20-year observations of patients), with a wide variety of reasons for ultimate failure such as recurrent caries, discoloration, periodontal disease, endodontic failure, or prosthesis deterioration requiring their removal and re-treatment.

Resin-bonded fixed partial dentures also require modification of the enamel on abutment teeth. Many prosthodontists consider this a temporary form of treatment because of deterioration of the bond and chronic loosening and loss of these dentures.[3]

Removable partial dentures also require proper preparation of the abutment teeth. However, most patients reject this form of tooth replacement because of the extensive material required, especially the palatal coverage and the retentive clasps required to attain even modest stability. Most removable prostheses continue to demonstrate movement, which is often annoying or embarrassing for the patient.

The osseointegrated implant, the fourth method for replacing congenitally missing teeth, is the most biologically conservative. The fundamentals of osseointegration provide sound scientific rationale for using titanium implants as support for esthetically pleasing and functional tooth replacement. Using Brånemark implants (Nobelpharma AB) to replace congenitally missing lateral incisors requires a coordinated team approach to patient care. The orthodontist takes a lead role in establishing the ideal position of the dentition, especially the teeth immediately adjacent to the anticipated implant site. When planning the use of this treatment method, several anatomic and esthetic factors must be considered.

Treatment planning considerations

Root position

Finishing orthodontic movement to prepare for implant placement requires apical root positioning away from the implant site (Figs 2 to 5). The standard Brånemark implant is 3.75 mm in diameter. A minimum of 1 mm of bone should be available between the implant threads and the adjacent root surfaces (Fig 5b). If the teeth are exceptionally small, a 3-mm-diameter Brånemark implant can be used; however, custom prosthetic components will be required to complete the restoration.

Interdental space

The coronal aspect of the Brånemark implant is 4.0 mm wide. A minimum of 7 mm of interdental space is necessary for sufficient osseous support to maintain the interdental papilla (see Figs 5a and 5b). During active tooth movement, establishing adequate interdental space can be assisted by connecting the correct size denture tooth to the orthodontic arch wire. This "ortho-pontic" also provides interim esthetics.

Esthetic aspects

The lip line at rest and smiling will dictate much of the implant rehabilitation procedure. If the gingival and mucosal tissues are visible, careful planning is required to maintain the cervical mucosal position. When defects in the alveolar ridge create unesthetic shadows, augmentation may be required.

The cervical relationship of the mucosa to the implant crown complex can be controlled. Ideally, the crestal

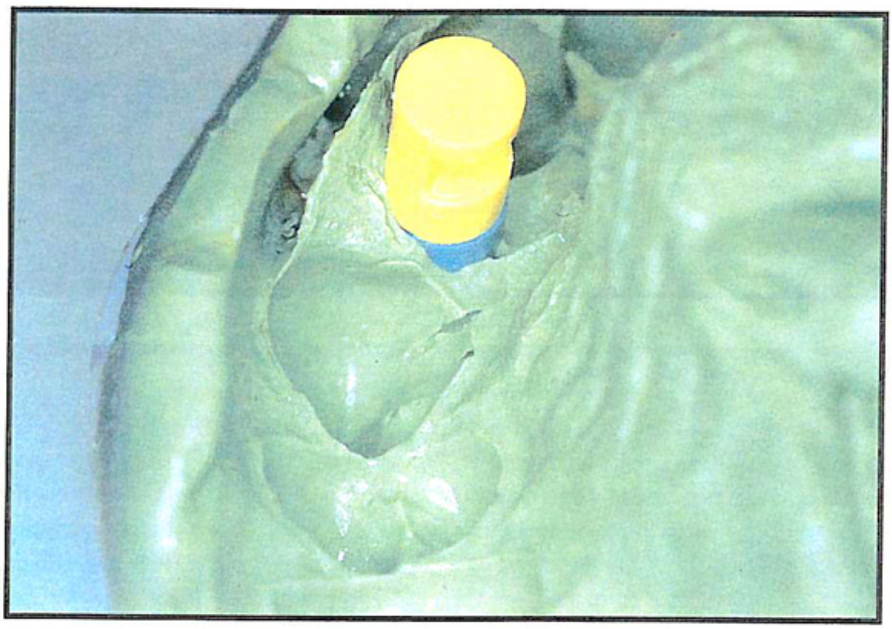
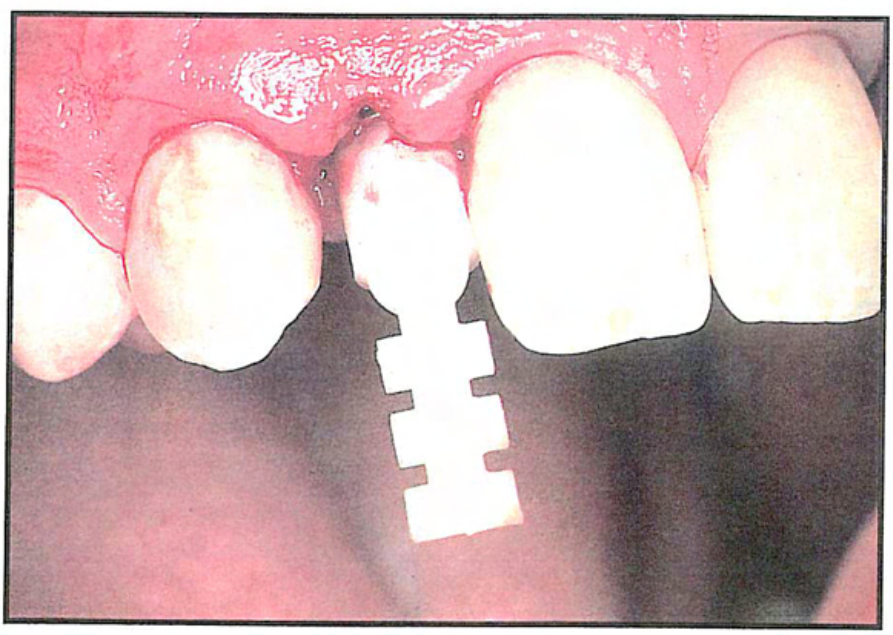


Fig 6a Open flap impression technique assures optimal seating of the coping.

Fig 6b Prefabricated plastic coping for CeraOne (Nobelpharma AB) abutment.



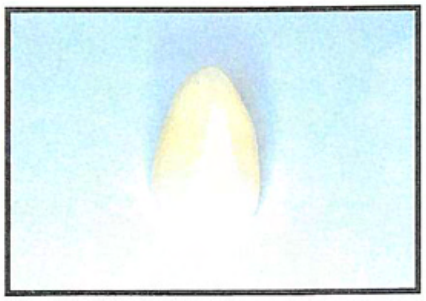
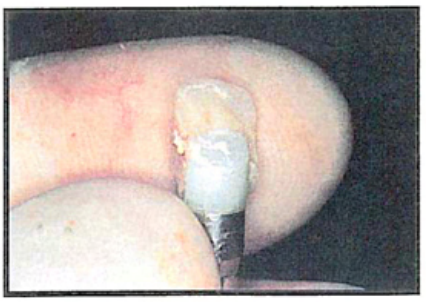
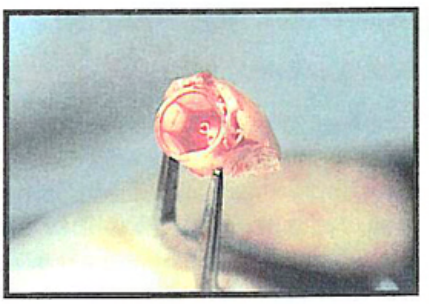


Fig 6c Denture tooth removed from provisional removable partial denture.





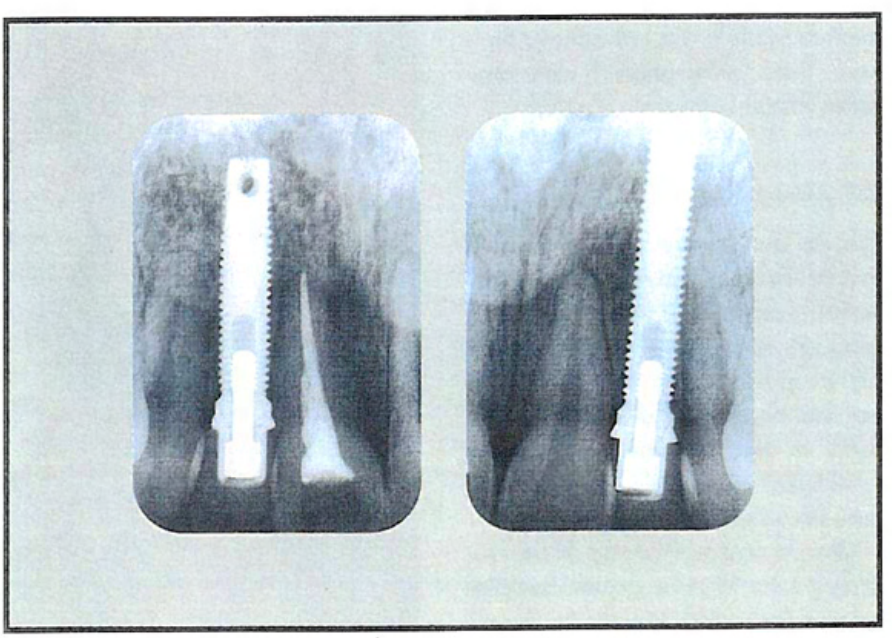
Figs 6d and 6e Denture tooth joined to plastic coping.

Fig 6f Provisional crown cemented to CeraOne abutment provides ideal root form and emergence profile prior to flap closure. The flap heals to the ideal anatomic form created by the provisional crown.

Figs 6g and 6h Post-treatment periapical radiograph shows the completed CeraOne restorations.

Fig 6g CeraOne restoration replacing tooth 7.

Fig 6h CeraOne restoration replacing tooth 10.



aspect of labial bone and the top of the implant should be 2 to 3 mm apical to the cementoenamel junction of the adjacent teeth. This permits the establishment of a root form and appropriate emergence profile in the ceramic crown (Figs 6a to 6h). The CeraOne (Nobelpharma AB) abutment system is ideal for the single-tooth restoration and provides a variety of titanium collar lengths to accomodate various anatomic conditions (Figs 6g and 6h).

Alveolar ridge

When teeth are congenitally missing, complete development of the alveolar ridge is inhibited because of the absence of the dental component. The lack of osseous development often results in a labial and sometimes lingual depression that narrows the alveolus at the implant placement site. A minimum of 6 mm of faciolingual bone is required for placement of the standard 3.75-mm-diameter Brånemark implant.

If the alveolus is narrower than the diameter of the implant body, several methods of guided osseous generation are available to build a wider ridge.[4-6] Use of autogenous bone, alone or mixed with freeze-dried demineralized allograft, covered with a barrier material such as GTAM, Vicryl mesh, or freeze-dried laminar bone has proven to be a predictable method of ridge augmentation.[7] This procedure can be accomplished during the final stages of orthodontic treatment, or in conjunction with implant placement if the osseous defect is minimal. If deeper defects require augmentation, the addition of bone should be accomplished during the orthodontic treatment, which would allow the grafted site to mature prior to fixture placement. Overbuilding the defect with graft material results in better anatomic repair following the slight resorption that may occur while the graft heals. "Plumping" the ridge with an osseous graft not only provides an ideal implant site, but results in a highly esthetic rehabilitation.

When considering an autogenous osseous graft, ideal donor sites are often found intraorally. Because usually only small amounts of bone are required, the anterior mandible offers a convenient donor location with optimal bone quality. This site can also provide sufficient bone for onlay and saddle grafts for the treatment of the congenital edentulous alveolar ridge defect.[8]

The use of hydroxyapatite augmentation methods has been advocated by some clinicians[9] for building or repairing osseous defects around root-form implants. Reentry into these sites as much as 3 years later, however, reveals predominately fibrous encapsulation of the hydroxyapatite granules. This condition does not have the biologic stability of a healed bone graft osseointegrated to the titanium implant, and soft tissue changes at the site of implant emergence have been observed by the author. This can be a detrimental process for esthetically important areas. Therefore, the use of hydroxyapatite for ridge augmentation is not recommended.

The use of various soft tissue grafts also has been attempted with less variable results. The osseointegrated titanium fixture will help maintain vital bone in the surrounding area but little positive stimulation in making a soft tissue graft.

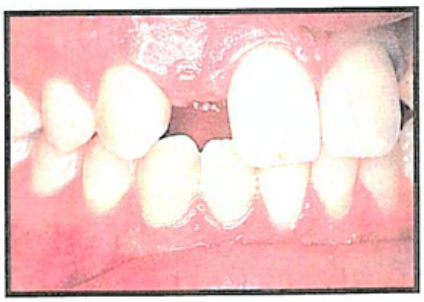
Loading the implant

Loading of the single implant and the crown appear to be well-tolerated in spite of the load not being applied directly to the long axis.[10,11] When a deep overbite condition exists, a custom ceramometal crown may be required to provide adequate support for the incisal porcelain.

If the patient is known to brux or clench, occlusal adjustment of a single osseointegrated implant supported crown must take into account compression of the adjacent odontal ligament. This results in supra-occlusion on the implant-supported crown in light centric contact and moderate contact on the crown when maximum clenching forces are exerted.

Implant length and angulation

Maximum implant length provides the best initial stability and establishes an ideal condition for future implant survival. When Brånemark titanium screw implants are used to replace congenitally missing lateral incisors, every effort should be made to engage several threads in the apical cortical plate. Bicortical stabilization increases initial stability and improves long-term osseointegration.



Figs 7a and 7b Orthodontically repositioned roots with Brånemark titanium fixture in place, ready for prosthetic treatment.

Figs 7c and 7d Clinical view of the CeraOne crown replacing the congenitally missing maxillary lateral incisors 5 months after crown placement.

The long axis of the implant should mimic the long axis of the root if a CeraOne crown is planned as the final restoration (Figs 6g and 6h). This position allows optimal maintenance of the alveolus and frequently eliminates the need for apical augmentation or guided bone generation required when a cingulum screw access dictates a labially oriented implant apex.

Post-orthodontic retention

The use of osseointegrated Brånemark implants to replace congenitally missing teeth provides ideal intra-arch stabilization points following active orthodontics. Because the osseointegrated implant is rigidly anchored in the alveolar bone, no movement of the coronal restoration occurs. This provides a static reference for monitoring changes in adjacent tooth position following orthodontic therapy.

Long-term maintenance

Maintenance of healthy supporting tissues for osseointegrated implants requires the same patient compliance necessary to maintain periodontal health in the natural dentition. Plaque-control procedures similar to those recommended for the natural teeth are suitable for healthy maintenance of the surrounding mucosa. Appropriate periodic professional care should be part of the treatment plan.[12]

Inflammation of the gingival tissue, fistulation, or hyperplastic tissue around the single-tooth implant generally indicates a loose abutment screw. The condition resolves rapidly when abutment screws are retight-

ened. Those conditions were generally noted during the first year following crown delivery to the implant when the original Brånemark titanium single-tooth abutments were fastened to the implants with titanium single-tooth–abutment screws.[13] With the use of the CeraOne system, the titanium abutment is fastened to the implant with 32 Ncm torque. No soft tissue complications because of screw loosening have been noted in our patient population treated with the CeraOne System (Figs 7a to 7d).

Esthetic changes may be required as the younger implant patient ages. When the adjacent dentition "matures," changes in color and incisal edge length occur. With a stable implant, esthetic replacement of the coronal restoration is a simple procedure.

Discussion

The predictable nature of osseointegration and the current level of mechanical components provide an ideal solution to the replacement of congenitally missing teeth. Some clinicians have questioned the appropriate age to commence this treatment process in the growing adolescent. Even when the entire adult dentition has undergone the necessary orthodontic therapy, changes can occur in the cervical relationship of the crown to the mucosa. Further eruption of these teeth is a possibility, which may affect the appearance of the single-tooth implant crown. Therefore, each patient should be evaluated individually with regard to growth patterns and predictable tooth position.

However, adolescent children and young adults benefit immensely from single-tooth implant treatment. This philosophy of treatment is founded in the scientific basis of long-term osseointegration.[14,15] It is biologically the most conservative prosthodontic treatment because no alteration to the adjacent natural dentition is required,[16] other than appropriate orthodontic positioning.

Additional benefits include aid in stabilizing the adjacent dentition after active orthodontic treatment, maintenance or augmentation and maintenance of the alveolar bone, improved occlusal function, a highly esthetic single-tooth replacement, optional phonetic component, and the enormous psychological advantage of a bone-anchored stable replacement over the movement of a removable partial denture or the risk of having a resin-bonded denture debond and "fall out" at the most inappropriate time.

Long-term maintenance of the single-tooth implant prosthesis appears equivalent to maintaining the natural dentition. Hygiene procedures such as the use of dental floss are simplified over the required use of threading devices necessary to maintain periodontal health in patients with traditional or resin-bonded fixed partial dentures.

Another distinct advantage of using the Brånemark implant for congenitally missing tooth replacement is the avoidance of orthodontically positioning adjacent teeth into the missing tooth position, thereby significantly deviating from an ideal occlusal relationship. It also eliminates the need to drastically recontour canine teeth moved into the position of lateral incisors in an effort to improve esthetics. This condition is often met with frustration and disappointment by the patient when reshaped canines do not provide lateral incisor esthetics.

The disadvantages are minor and few. The two-stage surgical procedure and required healing time for osseointegration can frequently occur during the final phase of orthodontics. Implant placement at that time would require removal of the orthodontic arch wire to permit access during the first-stage surgery. It can be replaced immediately following surgical closure.

Although initial costs of the single-tooth implant may be slightly higher than traditional fixed prosthodontic treatment (crown and bridge), the biologic economy of a bone-anchored implant appear to weigh heavily in favor of using the Brånemark system of osseointegrated implants to replace congenitally missing teeth (Fig 8).

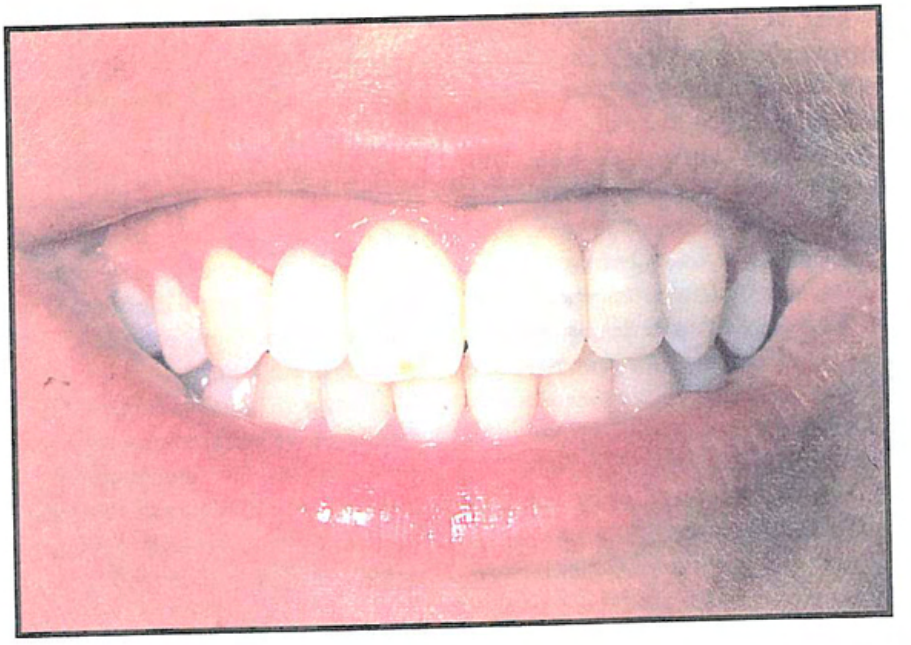


Fig 8 Clinical view 5 months following Stage II surgery with the delivery of all ceramic CeraOne crowns replacing teeth 7 and 10, supported by Brånemark titanium implants.

Summary

Orthodontic treatment of patients with congenitally missing teeth, especially maxillary lateral incisors, can best be accomplished by positioning the remaining natural dentition in the anatomically correct location and closely coordinating therapy with the osseointegration team members. Using the Brånemark system of implant therapy is the treatment of choice for the permanent replacement of congenitally missing teeth.

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