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Osseointegrated Implants as an Adjunct to Facemask Therapy: A Case Report

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ABSTRACT

Branemark Implants were placed in the zygomatic buttresses of the maxilla in a 12-year and 1-month-old female patient with a Class III malocclusion caused by maxillary growth retardation secondary to repair of a unilateral cleft lip and palate defect. The implants were left to integrate for 6 months followed by placement of customized abutments that projected into the buccal sulcus. Elastic traction (400 g per side) was applied from a facemask to the implants at 30° to the occlusal plane for 14 hours per day for 8 months (ages 12 years and 10 months to 13 years and 6 months). The maxilla moved downward and forward 4 mm rotating anteriorly as it was displaced. The change in the maxillary occlusal plane resulted in a secondary opening of the mandible. There was a 2° increase in the SN-mandibular plane angle and an increase in nasion to menton distance of 9 mm. Clinically, this resulted in an increase in fullness of the infraorbital region and correction of the pretreatment mandibular prognathism. There was an increase in nasal prominence as the maxilla advanced. This contributed to the increase in facial convexity. The secondary dental change frequently seen in standard facemask therapy was avoided. The displacement of the maxilla was stable 1 year beyond cessation of facemask therapy. The patient's midface profile was improved by age of 13 years and 6 months. Details of the clinical procedure and treatment changes are presented.

KEY WORDS: Osseointegrated implants, Facemask therapy, Circummaxillary sutures, Basal bone, Orthopedic movement.

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INTRODUCTION Return to TOC

Facemask therapy is an effective treatment modality for the early correction of a Class III malocclusion where maxillary retrusion or hypoplasia is a component.[1–8] The aim of facemask therapy is to displace the maxillary complex anteriorly by the application of force from an external face frame to the circummaxillary sutures via the dentition. The necessity to use teeth as anchorage results in stimulation of the periodontal membrane and dissipation of the protraction force transmitted to the circummaxillary sutures. Clinical studies in humans have consistently shown that the occlusal changes are a combination of the movement of teeth and orthopedic displacement of the maxilla.[3–9] This results in proclination of the maxillary incisors[3,5,7,9], retroclination of the mandibular incisors,[7,9] and extrusion of the maxillary first permanent molars.[9] The molar extrusion occurs in conjunction with a downward and forward movement of the posterior part of the maxilla resulting in a counter-clockwise rotation of the occlusal plane. This maxillary rotation leads to a secondary downward and

backward rotation of the mandible.[9] The net effect is a limitation of the improvement in mid-facial profile that would have been achieved by a purely orthopedic displacement of the maxilla. It has been suggested that pressure from a facemask chin cup may inhibit mandibular growth.[7]

The application of force to purposefully ankylosed deciduous canines has been suggested as a method of direct transmission of force to the circummaxillary sutures.[10,11] The application of this technique to facemask therapy has been shown to be clinically viable, however, the anchor teeth inevitably resorb as their permanent successors erupt. This limits the time available for treatment and restricts the facemask option to a younger age group.[12,13]

Osseointegrated implants are an alternative method of obtaining attachment of a traction force directly to the maxilla. Implants have been demonstrated to be biologically compatible[14,15] and to provide absolute anchorage when subjected to orthodontic forces in both animal models[16–18] and in human case reports.[19–22] Implants have also been shown to provide absolute anchorage when subjected to orthopedic force in animal models.[23–25]

In this case report we describe the treatment of a female patient with a Cl III malocclusion who had titanium implants placed in basal maxillary bone as a means of applying force from a facemask directly to the circummaxillary sutures. The clinical and radiographic changes are described.

CASE HISTORY Return to TOC

An 11-year and 7-month-old Caucasian female was seen in the Dental Department of Princess Margaret Hospital for assessment of her malocclusion. She had a history of a complete unilateral cleft of the lip and palate on the left side. Primary repair had been carried out in Adelaide, South Australia. Lip repair was carried out at 3 months of age using a Z plasty procedure. The palatal defect was closed in a 2-stage procedure with soft palate closure at 1 year and hard palate closure at 2 years. Revisionary lip surgery was performed at 4 years. The patient subsequently moved to Western Australia and management was continued at Princess Margaret Hospital, Perth. A secondary alveolar bone graft was placed at 11 years 2 months of age.

Extraoral examination revealed facial characteristics typical of a cleft patient who had grown unfavorably following primary palatoplasty. She had a divergent facial profile characterized by a maxillary retrusion with hypoplasia of the infraorbital region. A tight upper lip following primary surgery (Figure 1) accentuated the divergent profile. Intraoral examination revealed an anterior crossbite with an overjet of −3 mm (Figure 2). The maxillary and mandibular incisors were retroclined (1 − Mandibular plane = 86°). There was no occlusal centric relation discrepancy upon closure. There was a cusp-to-cusp transverse molar relationship due to maxillary arch collapse secondary to scarring of the palate. There was no occlusal contact between teeth 16 and 46. Temperomandibular joint function was normal. The maxillary midline was to the right and the mandibular midline coincided with the facial midline despite the presence of a mandibular asymmetry on the left.

Radiographic examination revealed that teeth 15, 22, 18, 28, 38, and 48 were absent. Cephalometric analysis indicated a mild skeletal Class III pattern due to a retrusive maxilla (SNA = 79°, SNB = 78°). The position of the maxilla was more retrusive than indicated by the value of SNA because the abnormal cleft alveolar anatomy and anterior location of the apex of the left central incisor was influencing the true location of A point (Figure 3A). The skeletal Class III pattern appeared more severe following decompensation of the lower incisors before initiation of facemask traction (1 − Mandibular plane = 90°) (Figure 3B).

TREATMENT PLAN Return to TOC

The patient presented concerns related to her dental and facial esthetics. She wanted to have her “reverse bite” corrected and indicated that, if possible, she would also like to improve her divergent facial profile.

Following a review of the clinical records, two treatment options were discussed with the patient and her parents. The first option was to delay treatment until growth was complete and then use orthodontic treatment in combination with orthognathic surgery to advance the maxilla. The second option was to use facemask therapy combined with orthodontic treatment to correct the anterior crossbite.

The patient chose to proceed with option 2 because of a desire to improve her dentofacial appearance as early as possible. The patient was advised that, although orthodontic treatment and standard facemask therapy may be able to correct the anterior crossbite, it was not likely to improve the flatness of the infraorbital region or counteract the tight upper lip which were contributing to the imbalance of her facial profile.

Because the patient wanted an improvement in her facial profile as well as a dental correction, the use of implants as anchorage was discussed. Due to the absence of maxillary deciduous canines, the placement of titanium fixtures was proposed. Both the patient and her parents indicated that they were willing to proceed with this option; however, they decided to accept the bilateral crossbite because it was nondisplacing and if corrected would be unstable due to severe scarring of the palate following primary palatoplasty.

TREATMENT PROGRESS Return to TOC

Treatment was initiated with the placement of a single Branemark implant (3.5 × 7 mm) in the inferior portion of both zygomatic processes of the maxilla. Following a 6-month healing period, stage 2 surgery was completed to attach customized abutments to the implants. They projected into the buccal sulcus and extended to the occlusal level of the maxillary first premolars. Abutment length was 25 mm. Following a 2-month period to allow soft tissue adaptation, orthodontic bands were cemented to the terminal portions of each abutment. A ligature was passed through a hole, which had been drilled through the band and abutment and then tied to a maxillary fixed appliance (.022 × .028″ pre-adjusted edgewise) (Figure 4). This was done to resist torsional forces during facemask therapy that may otherwise have resulted in disengagement of the abutment retention screw.

A Petit facemask was subsequently fitted with the application of 400 gm of force to the abutments on each side at 30° to the occlusal plane. The patient was instructed to wear the facemask for 14 hours per day. Traction was continued for 8 months until sufficient clinical movement of the maxilla had been achieved to improve midface esthetics and allow correction of the malocclusion. During this period, the role of the maxillary fixed appliance was to stabilize the implant abutments with no attempt being made to orthodontically align the maxillary teeth. This resulted in an increased retroclination of the maxillary incisors (−7°) due to occlusal interference with the mandibular incisors as the maxilla advanced (Figure 5A). At the cessation of facemask therapy, routine orthodontic mechanics were initiated to complete treatment (Figure 6). Despite the use of vertical elastics it was not possible to achieve occlusal contact between the first molars on the left side. Appliances were removed at 15 years and 7 months of age. A multistrand archwire was bonded on the lingual surfaces of teeth 12, 11, 21, and 23 to maintain space closure in area of the cleft. Maxillary and mandibular removable Hawley retainers were placed to maintain the results of treatment. A labial facing was placed on the upper left canine. Teeth 21 and 12 were built up with composite to improve maxillary incisor esthetics. The abutments were removed 3 months after use of the facemask was terminated. Cover screws were placed and the implants left in situ. The right cover screw subsequently became loose necessitating the removal of both implants. All surgical procedures were carried out under general anesthetic.

TREATMENT RESULTS AND DISCUSSION Return to TOC

The application of an anteriorly directed force from a facemask to osseointegrated implants placed in maxillary basal bone resulted in a significant improvement in midface esthetics (Figure 7). This was characterized by an increase in fullness of the infraorbital region and the correction of the relative mandibular prognathism.

Pre- and post-treatment cephalometric radiographs were superimposed on anterior cranial base structures at Sella as described by Björk to demonstrate skeletal change. The implants were used as an internal reference point to measure spatial movement of the maxilla that was found to have been displaced 4 mm horizontally and vertically during the period of facemask therapy. This movement is more than reported in clinical studies when the dentition is used as anchorage for facemask therapy alone or in combination with maxillary expansion techniques.[4–9,26–29] The vertical pull from the facemask would have contributed to the downward displacement of the implants. S-N length increased 3 mm (71 to 74 mm). This change is greater growth than would be expected over an 8-month period and may explain the decrease in the value of SNA (77) post-treatment despite obvious clinical facial change.[30] The lack of change in A point may also have been caused by local alveolar remodeling as the maxillary incisors moved. The horizontal displacement of Nasion and the implants suggests orthopedic displacement of the entire maxillary complex. The improvement in facial profile and the increase in nasal tip prominence observed during treatment supported this. The improvement in facial profile was evident despite retroclination of the maxillary incisors. These observations suggest that the application of 800 mg of force from a facemask to osseointegrated implants placed in maxillary basal bone can facilitate the orthopedic displacement of the maxillary complex and avoid the dental changes seen in standard facemask therapy.[24] The maxillary occlusal plane rotated in a counterclockwise direction despite the 30° downward and forward pull of the facemask which was directed toward reducing such a rotational effect.[9] There was an inferior movement of posterior nasal spine of 3 mm. Anterior nasal spine moved horizontally (Figure 8). Extrusion of the maxillary dentition was not observed. This differs from standard facemask therapy where any change in occlusal plane is a combination of downward movement of posterior nasal spine and dental extrusion.[9] There was a 2° increase in the SN-mandibular plane angle and an increase in nasion to menton distance of 9 mm. This was caused by a downward and backward rotation of the mandible secondary to the counterclockwise rotation of the maxilla as it was displaced downwards and forwards (SNB 73). This change is a feature of all variations of facemask therapy[4–9,26–29] and would also have contributed to the change in profile. The tendency to cause a downward and backward rotation of the mandible makes this protraction technique unsuitable for an individual with an open bite tendency. The combined change in the maxillary and mandibular skeletal relationship allowed for the subsequent orthodontic correction of the malocclusion. The maxillary incisors further retroclined as the maxilla advanced (−7°) and would have contributed to the upper incisors being upright at the cessation of treatment. This could have been avoided by initiating incisor alignment at the start of treatment or by the placement of a lower bite plane during facemask protraction.

The increase in nasal tip prominence observed due to the advancement of nasion contributed to making the mandible appear retrognathic and resulted in an increase in facial convexity. Such a potential change must be considered when assessing a patient for this procedure as it could have a detrimental effect on facial esthetics.

Longterm stability of early Class III correction is dependent on the ability of the treatment changes to compensate for subsequent growth

which tends to be unfavorable.[26,27] This is particularly troublesome in a patient with a repaired cleft palate because the abnormal soft tissue environment in which the maxilla develops leads to a progressive worsening of the skeletal discrepancy.[31] The possibility of effecting true orthopedic change in a growing individual offers a more effective improvement in retrusive midface esthetics (and also the prospect of greater stability by eliminating the dental component of correction seen with standard facemask therapy). Long-term stability was good with no alteration in position of the maxillary implants as observed on lateral cephalometric radiographs 1-year post-facemask therapy. This supports animal studies which have shown that treatment changes produced by facemask therapy are more stable when osseointegrated implants rather than teeth are used for anchorage.[24,32]

An implant that is to be used as an anchor for facemask therapy can be placed in either maxillary alveolar or basal bone.[33] The most accessible site is alveolar bone; however, biologically this is not regarded as suitable in an actively growing individual due to the tendency for the implant to submerge as vertical alveolar development occurs.[34–37] In addition, an edentulous area is required for implant placement.

Basal bone is a more suitable site for implant placement in a growing individual because growth occurs by sutural displacement and localized remodeling rather than by appositional growth which occurs in the alveolus.[38] An implant would therefore tend to be displaced secondarily to bone deposition at the sutures and would maintain its relative position during growth. In this case, the zygomatic process of the maxilla was chosen because of the absence of adjacent tooth structure, its ease of surgical access and the subsequent ability to place customized abutments (which would be accessible for the patient to apply elastic traction). Another possible location for implant placement could have been the anterior region of the hard palate;[39] however, there was a potential risk of damage to the roots of adjacent teeth because of the length of the implant fixtures available and a possibility of creating an oronasal fistula in a previously repaired cleft of the palate.

The main complication experienced was the soft tissue irritation that developed following placement of the abutments. This irritation subsided over a 2-month period. Other possible problems that could have arisen include the failure of integration and loosening of the long abutments due to torsional forces. To reduce this risk the fixtures were ligated to the upper fixed appliance. This treatment method is inappropriate for a patient with poor oral hygiene or with a reduced immune response (such as a diabetic) due to the potential for a soft tissue infection via the breach in the oral mucosa at the abutment site. The subsequent loosening of a cover screw following removal of the abutments suggests that the implants should be removed by trephination following facemask therapy rather than left in situ.

It is important to consider the patient's age at the treatment planning stage. The lag time between implant insertion and completion of treatment (17 months) would make this technique unsuitable for a patient approaching cessation of growth. It would be more appropriate to offer such individuals conventional orthodontic treatment in combination with orthognathic surgery, as a similar result would be produced with reduced clinical time and general anesthetics.

This technique may offer an early treatment alternative to standard facemask therapy for patients with mild to moderate Class III malocclusions who are concerned about their facial esthetics several years prior to the cessation of growth. Several professional specialists need to be involved to make this course of treatment successful. It should only be considered for a properly motivated individual because success is dependent on excellent patient and parent cooperation. This case presentation illustrates the importance of interdisciplinary management when implementing the correction of a Class III malocclusion characterized by additional complications.

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FIGURES Return to TOC

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FIGURE 1. (A,B) Pretreatment extraoral photographs. Note flat infraorbital region

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FIGURE 2. Pretreatment intraoral photograph

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FIGURE 3. (A) Pretreatment lateral cephalometric radiograph. (B) Lateral cephalometric radiograph was taken when facemask therapy was initiated. The reverse overjet has increased following decompensation of the lower incisors. Note implants with customized abutments attached

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FIGURE 4. View of the abutments projecting into the buccal sulcus. A band has been cemented to the terminal portion of the abutment and ligated to a bonded bracket on the upper left first premolar

Click on thumbnail for full-sized image.

FIGURE 5. (A) An intraoral frontal view of progress 6 months into treatment. (B) Lateral cephalometric radiographs 6 months into treatment. Note retroclination of upper central incisors as maxilla has advanced, indicating orthopaedic change

Click on thumbnail for full-sized image.

FIGURE 6. Post-treatment intraoral photographs

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FIGURE 7. (A,B) Post-treatment extraoral photographs. Note increased fullness in the infraorbital region. Nasal tip prominence has also increased

Click on thumbnail for full-sized image.

FIGURE 8. (A) Pretreatment (solid line) and immediately after use of the facemask showing superimposition of the maxillary complex on anterior cranial based structures at Sella. Note the maxilla has moved downward and forward 4 mm. Nasion has moved anteriorly 3 mm over an 8-month period. (B) Pretreatment (solid line) and 1-year post-treatment protraction (dotted line) tracing of skeletal structures superimposed on anterior cranial base at Sella. (C) Post-treatment lateral cephalometric radiograph

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