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A CASE STUDY

Transverse Maxillary Deficiency Correction Using MARPE

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Abstract

Maxillary transverse insufficiency is one of the most common causes of orthodontic treatment failure. There are a variety of therapeutic options available to address this issue. Rapid maxillary expansion (RME) and miniscrew/surgical assisted rapid palatal expansion (MARPE/SARPE) are the most popular treatment options. Traditional orthodontic appliances can be manufactured with greater precision using 3D printing and computer-aided manufacturing (CAD-CAM). Three pillars support CAD-CAM technology: Digital image acquisition of patients' dental arches, visualisation and manipulation of these images in specific software, and 3D-printing files. In the article we have discussed about a case of transverse maxillary deficiency treated with MARPE using CAD-CAM technology.

Introduction

Transverse maxillary deficit is a moderately common orthodontic condition in adults, with a prevalence of about 10%.[1] According to previous study, roughly 18% of patients having mixed-dentition exhibit a maxillary constrictions transverse.[2] It is generally characterised by a unilateral or bilateral posterior crossbite. The discrepancy between both the maxillary and mandibular arches is linked to crowding, increased vertical alveolar growth, vast buccal corridors, teeth attrition, periodontal disease, as well as facial muscle imbalance. A correct transverse skeletal relationship is essential for achieving a stable occlusion and avoiding these negative consequences.[3]

Rapid palatal expansion (RPE) procedures have both orthopaedic and dental effects to rectify the skeletal discordance[4]. RPE appliances come in a variety of shapes and sizes, with varying expansion rates, but the basics remain the same. The midpalatal suture is ruptured and separated when a quick transverse force is applied to the maxillary teeth, resulting in enhanced cellular activity and bone remodelling.[5] RPE is best performed before the age of 15.With age, the midpalatal suture and neighbouring articulations fuse and become more rigid, resulting in enhanced resistance to expansion [6]

Alveolar bone bending and tooth tipping are unavoidable with traditional RPE appliances because the expansion pressures are transmitted through the teeth by design. Such movements not only use a large amount of the device's overall activation, decreasing total skeletal expansion, but also cause rotation of the jaw clockwise and bite opening.[6]

The application of orthopaedic forces or surgical intervention is required to achieve expansion of the restricted maxillary arch. Patients with little or no residual growth are typically hesitant to have surgery, leading to attempts to address these defects without undergoing surgery, which led to the creation of MARPE. Lee et al. (2010) pioneered miniscrew-assisted RPE (MARPE). Miniscrews were held in place with attachments welded to the expansion screw.[7]

Dr. Won Moon et al developed the MARPE appliance, which is a unique adaptation of the RME appliance that has become a breakthrough in transverse malocclusion correction. It has shown to be a feasible and effective nonsurgical treatment for young people since its inception.[8]

This case study shows an adult's successful orthopaedic correction prior to fixed orthodontic treatment. A unique MARPE design and expansion strategy was used to eliminate the transverse skeletal disparity.

In the world of orthodontics, there is now a lot of discussion regarding what the optimum MARPE design is, how to achieve the best skeletal outcome, if bespoke MARPE is the way to go, or whether prefabricated ones are sufficient in all clinical circumstances. Traditional appliances such as hyrax, lingual, and transpalatal arches are routinely fabricated using conventional laboratory techniques, despite the fact that 3D technology can be utilised to achieve higher precision in their output.

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Digital Streamlines for Customized 3D Digital MARPE Construction.[9]

Figure 1 **Steps in CAD-CAM MARPE**

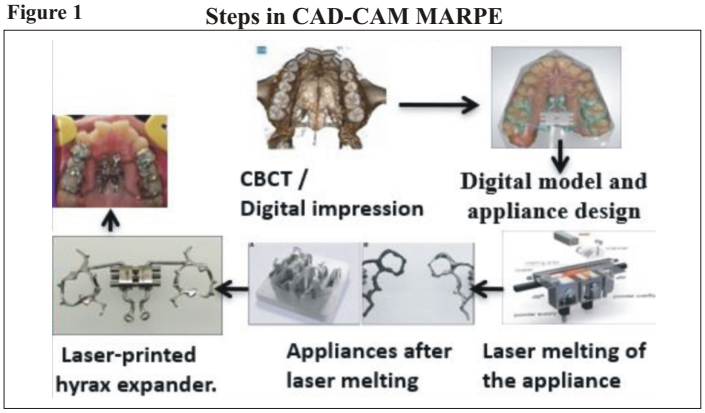

Figure 2

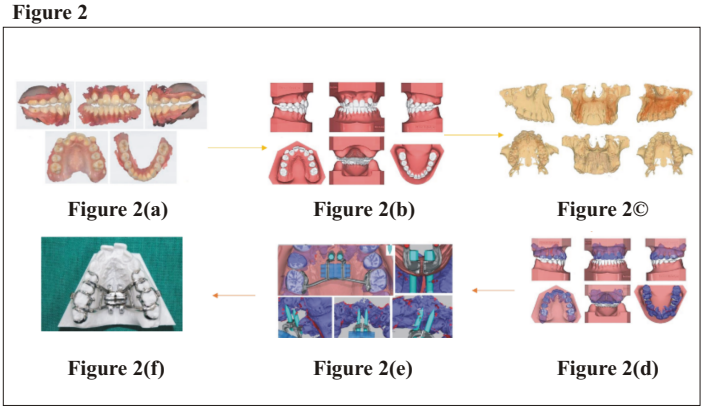

Figure 2(a) Figure 2(b) Figure 2© Figure 2(f) Figure 2(e) Figure 2(d)

Step 1: Intraoral scanning -Figure2(a)
Step 2: After cleaning the image and creating a digital basis, a Digital Kesling setup is used to segment individual teeth.-Figure2(b)
Step 3: For the maxilla, CBCT is performed, and the files are transformed to STL for improved superimposition. -Figure 2(c)
Step 4: These data are then placed on intraoral scans to serve as a reference for temporary anchoring device (TAD) placements, ensuring that no root contact occurs. -Figure 2(d)
Step 5: Digitally put expansion hyrax scans in the palate and the final digital models are examined for clearance from the roots of the anterior teeth, as well as distance and adaption to the palate. After that, they're exported in STL format (without the TADs' digital data) for direct metal laser sintering. -Figure 2(e)
Step 7:-After metal printing, the appliance is electropolished and hyrax is laser-welded in place. -Figure 2(f)
Step 8: Finally, the appliance is cemented. After cementation, TADS are implanted, and expansion can begin according to the patient's needs.

This case study shows an adult's successful orthopaedic correction prior to fixed orthodontic treatment. A unique MARPE design and expansion strategy was used to eliminate the transverse skeletal disparity

Diagnosis & Etiology

A patient with initials P.S reported to the Dept Of Orthodontics & Dentofacial Orthopedics Manav Rachna Dental College Faridabad Haryana, for consultation and screening **(Figure 3a, 3b and 3c).** Patients chief complaint was "I have crowding in the front, and I am not happy with the arrangement of my teeth." Clinical examination revealed 3mm of arch width disparity, as well as a 3 mm shift in mandibular dental midline to the left. Total crowding of 7 mm in the maxillary arch and 11 mm in the mandibular arch. The patient had already undergone a number of orthodontic consultations and was specific on avoiding any type of orthognathic surgery. There has been no family history of skeletal growth pattern Class II.

Intra-oral Photographs

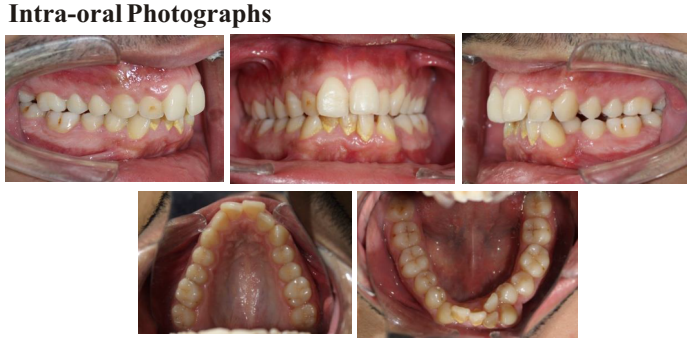

Figure 3 a: Pre MARPE intraoral pictures

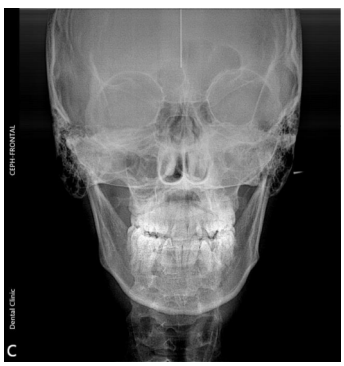

Figure 3 b . PA CEPH

Figure 3 c . Lateral CEPH

Treatment Objectives

A skeletal imbalance induced dental compensation in the patient. The orthopaedic correction of the posterior crossbite was the first goal of orthodontic treatment, followed by fixed orthodontic treatment, because with such a skeletal situation, a harmonious occlusion couldn't have been accomplished. The expansion phase of this treatment should aim for an increase of around 10 mm in the breadth of the basal structures, based on the amount of arch width disparity seen at the first molars.

In this case study, we focus on the effects of the treatment expansion phase in order to emphasise the value of the MARPE procedure.

Treatment Progress

The MARPE expander came with four microimplants (2 * 12 mm) put into the appliance's 2 * 12 mm slots. The insertion slots ensure a precise fit and secure perpendicular position for the

microimplants. The 12-mm length was calculated using a 2-mm insertion slot heightA minimal level of 5 to 6 mm of bone involvement and 1-2 mm of space between both the appliance as well as the palatal surface. This was done to establish a bicortical link between the microimplants as well as the palate. The maximum screw size that'd fit in the palatal vault while also still making sure tight adaptation of a appliance toward the tissue surface between both the maxillary first molars determined the dimensions of the jackscrew. The lateral forces exerted on the pterygomaxillary buttress bone, which is a key obstacle to maxillary growth, were chosen for this position.

The pace of expansion was chosen based on the procedure that had been devised, through clinical experience of Dr. Won Moon The MARPE appliance was adopted by the orthodontic community. The activation began with two turns daily till a diastema occurred; after that, the activation was increased to four turns per day. The maxillary first molars got 11 mm of expansion after 10 mm of MARPE growth as well as molar uprighting., and the maxillary canines got 10 mm of expansion **(Figure 4a and b)**. On the day when the expansion was completed, a progress conebeam computed tomography(CBCT) image was taken

Figure 4a- 10 mm of expansion -Figure 4b

Treatment Results

The top craniofacial components, including the maxillary basal bone, were considerably expanded after the expansion, resulting in the total eradication of the crossbite. Preoperative as well as postoperative 2d radiographs revealed the documented expansion changes as well as 3-dimensional CBCT images. The measurements reveal a reasonably consistent increase in the width of the upper maxillofacial components such as the zygoma and nasal bone, as well as the alveolar area. Buccolingual angulation increased little in the first molars and premolars.

Discussion

RPE appliances of several varieties, including hyrax and Haas Expanders which are the most commonly available.[10] Despite the fact that the evidence frequently supports the use of RPE in children and adolescents, patient palatal expansion in patients who are not growing Because of maturing, has been demonstrated to be less successful. The midpalatal suture as well as its surrounding articulations are more mechanically resistant. This is related to the previous point. Traditional tooth anchoring does have a number of well-documented disadvantages, which would include post-expansion appliance tipping, root resorption, as well as post-expansion relapse.[10]

Skeletal & Dental Effects

Total expansion refers to skeletal (orthopaedic) but also dentoalveolar (orthodontic) expansion, that also includes alveolar bone bending but also dental tipping. The centre of rotation of the maxilla in traditional hybrid bone-borne RPE appliances is substantially higher than the miniscrew implantation point, resulting in torque creation in two maxillae and alveolar bone bending.[10]

Dental tipping was seen due to alveolar bone bending, even if the relative position of attached teeth did not alter. With less dental tilting, a more lateral translation of the complex could be obtained by exerting expansion forces closer to the maxilla's centre of resistance. Because the pterygomaxillary complex provides the most resistance to sutural opening, the MARPE body should be positioned towards the hard-soft palate intersection[10]. When forces are applied to the maxilla's centre of resistance through appropriate microimplant positioning with customised MARPE appliances, inclined forces are effectively eliminated due to homogeneous force dissipation on the posterior teeth, allowing for more parallel midpalatalsutural opening coronally. Pterygoid plate separation with MARPE results in a parallel growth, whereas SARPE results in a "V" expansion due to the lack of pterygoid plate separation at the mid-palatal suture..[11]

Because their pterygomaxillary and zygomaticomaxillary sutures are not fully formed, children and adolescents have reduced bony barrier to maxillary expansion. Adult patients will face a significant amount of orthopaedic force on the anchor teeth as a result of the increased bony resistance, leading in dental tilting and alveolar bone bending.

The zygomatic bone has shifted forward and to the side. The forward displacement is minor overall, whereas the lateral displacement begins near the zygomatico maxillary suture and gradually diminishes towards the temporal process of the zygomatic bone (zygomatic arch) and finally to the frontozygomatic suture.

Overall, the zygoma rotates with both the zygomatico maxillary complex, with the frontozygomatic suture serving as the fulcrum.. According to Cantarella et al[12], there may be almost no displacement visible above the frontozygomatic suture, as well as the possibility of asymmetric expansion due to differences in densities and morphology of bones, particularly the zygomatic buttress and pyramidal process, which are not always identical on both sides.[13]

Advantages of MARPE

In comparison to conventional expansion, that also takes 2-6 months, the treatment period is rather short, varying from one to four weeks of active expansion. Because of the MARPE independence of any anchor tooth units, fixed orthodontic therapy and removable orthodontic appliances can be employed together.

You'll also be able to expand your business as a bonus. It is feasible to achieve maximum bone displacement while minimising the consequences of dental tilting. In contrast to standard expansion procedures, the back teeth are not as pointed buccally following therapy because the maxillary is more stable .

Limitations of MARPE

When force is exerted from a greater distance towards the bone as well as implant interface, MI deformation is more likely.[11]

When MSE is placed on a narrow high arched palate, the chances of treatment success are reduced.

MARPE failure is caused by unpredictable variability in the pattern of MPS calcification and craniofacial morphology (increased resistance).

The use of missing or compromised anchor units in traditional MARPE deployment is an impediment.

MARPE causing dizziness and tension across the bridge of the nose, eyes, and generally throughout the face by distributing stress around the anchor teeth and zygomaticomaxillary process extending along the external wall of the orbit. Patients with the severe sutural interdigitation and little bone density must therefore turn to medically aided expansion.

Conclusion

This case report shows how a unique MARPE design and expansion technique was used to successfully treat an adult patient with a restricted maxilla. The MARPE treatment resulted in growth of maxilla and adjacent craniofacial components with splitting the midpalatal suture even without surgery. For repair of transverse maxillary deficit, MARPE has proven to be a successful and viable surgery with a high success rate and stability. It is stated that MARPE is more effective than traditional RPE.

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