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Non-Surgical, Minimally Invasive, Bone-Borne Rapid Palatal Expansion for Orthopaedic Correction of Transverse Maxillary Deficiency in Young Adults: A Review

Review Article

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Abstract

Traditionally, cases with transverse maxillary expansion are treated with Rapid Palatal Expansion (RPE). As conventional RPE appliances transmit forces using teeth as handles, alveolar bone bending and dental tipping is unavoidable. This is more prominently appreciated in older individuals' due to nearly ossified mid palatal suture causing reduction in the amount of skeletal expansion achieved. Miniscrew Assisted Rapid Palatal Expansion (MARPE) appliances have been developed which confine transverse forces of the appliance to the midpalatal suture and minimizes dental side effects; thus, making them suitable for use in older patients. This paper is a review of the appliance design, appropriate location for placement of miniscrews, insertion technique, activation schedule, post-expansion assessment parameters etc.

Keywords: MARPE; Headless screws

Abbreviations

MARPE: Miniscrew Assisted Rapid Palatal Expansion; RPE: Rapid Palatal Expansion; TAD: Temporary Anchorage Devices

Introduction

Traditionally, cases with transverse maxillary expansion are treated with Rapid Palatal Expansion (RPE) that are a combination of orthopaedic and dental expansion which is used to correct skeletal disharmony [1,2].

Though, many types of RPE appliances have been developed, the principal essentially remain the same [3-5]. As conventional RPE appliances transmit forces using teeth as handles, alveolar bone bending and dental tipping is unavoidable. This is more prominently appreciated in older individuals due to nearly ossified mid palatal suture causing reduction in the amount of skeletal expansion achieved [6,7].

RPE also leads to clockwise rotation of mandible and opening of the bite. Not much earlier, Miniscrew Assisted Rapid Palatal Expansion (MARPE) appliances have been developed which confine transverse forces of the appliance to the midpalatal suture and minimizes dental side effects; thus, making them suitable for use in older patients [5,8].

MARPE is a simple modification of the conventional RPE appliance; the main difference is the incorporation of several

miniscrews to maximize expansion of the underlying basal bone and minimize dental side effects. MARPE was first introduced by Lee, et al in 2010 reported successful expansion of the maxilla through opening of the midpalatal suture [9,10].

Stress distribution trajectories are mainly along three buttresses in the maxilla; namely zygomaticomaxillary, nasomaxillary and pterygomaxillary. Major disadvantages of conventional RPE appliances include tipping of anchor teeth [11], limited skeletal movements [12], undesirable tooth movement [13], root resorption [14], bony dehiscences and fenestrations as well as post-expansion relapse [15].

Thus, MARPE appliance is beneficial in adult patients with more sutural resistance to skeletal expansion and even in young patients by minimizing or even preventing dental tipping thus avoiding further increase in the vertical dimension and other aforementioned side effects.

Appliance design

Various MARPE designs by Carlson C, Moon W and MacGinnis have been recommended by many authors [16-18]; without any dental support (exclusively bone borne), with support from teeth (teeth-bone borne) and with use of two/four mini screws (Figure 1). They can be prefabricated (commercially available like MSE, etc.) or can be made in the laboratory [10,19-20].

Location of miniscrews

Factors like convenient access, low risk of damage to the surrounding anatomical structures [21-23], high quality cortical bone and thin mucosa confirming adequate stability makes paramedian area (3 mm lateral to the suture in 1st premolar region) the most appropriate site for placement of miniscrews [24-28](Figure 2).

Insertion technique

Temporary Anchorage Device (TAD) placement with a conventional straight driver or an engine mounted driver is problematic sometimes; for the reasons of directional control and lack of torque to drive the implant in hard palatal bone.

A dedicated palatal driver (L'il One, FavAnchorTMSAS, India) can be used to maintain adequate insertion angulation and torque while placing the mini screws (Figure 3). This unique design of the driver makes it very convenient to place the palatal implants with great ease and precision.

Screw design

Headless screws (Medusa, FavAnchor™SAS, India) are recommended for palatal insertions as they're less bulky and in turn comfortable for the patient (Figure 4). Medusa is a uniquely designed screw which is recommended for palatal and closed (sub-apical) insertions. They're available in two sizes namely; short (2 x 10 mm) and long (2 x 12 mm). The hex head of the screw is small enough to have a smooth feel for the tongue (in MARPE cases) and big enough to fit in the driver for a secured insertion.

Activation protocol/schedule

Activation initially is done for 2 turns/day till development of diastema, followed by 1 turn/day till sufficient expansion has been achieved [16]. Activation schedule was followed as Table 1 [17].

Post-expansion assessment

Post expansion transverse measurements of frontonasal area, zygomatic arch and nasal cavity should be recorded and compared to the pre-treatment values to evaluate and compare the skeletal changes (Figure 5). Maximum expansion is usually seen in the nasal cavity [29], followed by zygomatic arch and frontonasal area.

Discussion

Various types of RPE appliances; tooth & tooth-tissue borne are available [3,4,30]. Due to maturation and adjacent articulations

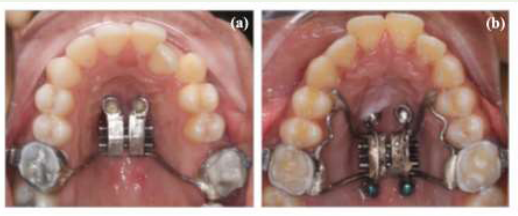

Figure 1: Pre- and Post Expansion.

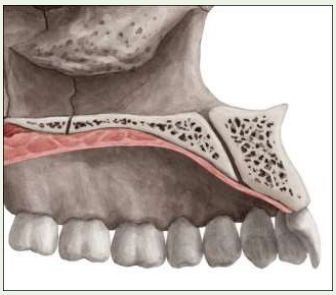

Figure 2: Palatal Anatomy.

Figure 3: L'il One Driver (FavAnchorTMSAS, India).

Figure 4: "Medusa' Screw (FavAnchorTMSAS, India).

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Figure 5: 'Comparison of skeletal parameters.

Table 1: Activation Schedule.

Age of the patient	Initial expansion rate	Expansion rate after opening of the diastema
13-16 years	3 turns/week	3 turns/week
16-19 years	1 turn/day	1 turn/day
19-30 years	2 turns/day	1 turn/day
Older patients (> 30 years)	> 2 turns/day	1 turn/day

in the midpalatal suture region [31,32]; palatal expansion in non-growing individuals has been shown to be less fruitful as compared to RPE in younger individuals [33-35]. This potential risk of tooth-borne appliances has been recognized in the literature and linked to resorption of buccal cortical bone, fenestrations, and gingival retraction [36].

Age is a vital factor in successful accomplishment of skeletal effects, as palatal expansion rapidly becomes inefficient after the early teens [1,37]. Thus, it was then believed that surgery is the only option for orthopaedic transverse correction [5]. Though, there are a few studies which show successful expansion in adults [4,38,39], there are still doubts whether they will represent general clinical situations.

Mouth breathing is a significant problem caused by nasomaxillary deficiency [40]; studies demonstrate that orthopaedic expansion can change the breathing pattern to nasal breathing [41,42]. RPE increases the nasal cavity volume [29,43], nasopharynx volume and cross-sectional areas of the upper airway [44-46].

More recent MARPE cases provide a clear picture using measurements from computed tomography [39,47]. Rigid interdigitation of palate in adults previously compelled clinician to perform limited lateral and midline osteotomies combined with fixed palatal expanders (SARPE) to effectively expand the maxillary skeletal base [48,49].

However, SARPE approach is a more invasive procedure; increases risk and the treatment costs for the patient [50,51]. The skeletal gain with MARPE appliances has been variable and was reported by Clement A as 61% of total expansion and was higher than that reported by Profitt (50%) [5,52], Kartalian, et al. (40%) [53], Lim, et al. (43.2%) and Garrett, et al. (55%) [54,55]. This can be attributed to the better anchorage potential of miniscrews which Lee, et al. in 2017 in their FEM study claim can be enhanced by bicortical engagement of palatal miniscrews [56]. Tausche, et al. has documented that in their sample [57], 85% - 91% of expansion achieved was skeletal in nature which can be ascribed to surgical intervention done along with MARPE. Dental tipping in the buccal direction has been reported in previous studies of conventional RPE as well as MARPE [8,58]. Gurgel, et al. and Garib, et al. also reported some amount of buccal tipping with MARPE [48,59]. Thus, using a MARPE appliance, some amount of buccal tipping is inevitable though much less as compared to RPE, as teeth are still used as anchor units alongside miniscrews. Tendency of buccal tipping is directly proportional to resistance exerted by midpalatal suture. Moon, et al. in 2010 and later Kolge, et al. in 2018 reported greater changes in the degree of molar inclination than that of premolar inclination [20,26]. The higher density of the buccal cortical bone in the maxillary canine and premolar regions might have resulted in the greater buccal inclination of the first molar in comparison with that of the first premolar [58,60,61].

A conventional RPE is advantageous compared to MARPE appliances as they can be placed or removed in the outpatient clinic, does not usually require administration of local anaesthesia and are economical [50]; while placement of a MARPE appliance can be time consuming. Hygiene can be better maintained with MARPE appliances as compared to the conventional RPE appliances; since they were smaller in size, have less food retentive areas and permit better brushing and flossing [62].

Though, some claim MARPE to be more efficacious than conventional RPE [8,15,63], Lagravere MO in 2010 evaluated and compared treatment efficiency between MARPE and conventional RPE devices and affirmed that both have a similar skeletal expansion potential [8]. Thus, he further said; the decision to use a MARPE device should be based on operator preference and specific patient variables like missing/compromised anchor units. MARPE independent of any anchor units also allows a full bonded orthodontic therapy to be done at the same time as expansion. MARPE has been proved to be a viable treatment modality to correct a transverse maxillary deficiency in adults; with a considerably good success rate and stability [8,9,16,50,52,58,59,63-65].

While zygomatic arch expanded to a lesser extent, expansion of nasal cavity was much more evident, and thus can result in improvement of nasal breathing owing to increased air flow. Thus, by effectively increasing the nasal cavity volume, treatment with a MARPE appliance can improve the constricted airway, thus aiding in long-term stability [66,67].

Conclusion

Expansions achieved in the cases treated by MARPE are majorly skeletal expansion, as the appliance is a tooth-and-tissue borne appliance. It can be used in young adults from late teens to mid-twenties and exhibits a high success in this particular age group. Clinical observations suggest that MARPE prevents many of the adverse effects of RPE and should be considered as a preferred and effective alternative for the same.

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