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Comparison of tooth-borne and hybrid devices in surgically assisted rapid maxillary expansion: A randomized clinical cone-beam computed tomography study

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ABSTRACT

Purpose: The objective of this 2-arm, parallel, single-center trial was to compare the skeletal, dental, and periodontal effects of tooth-borne (TB) and hybrid devices in surgically assisted rapid maxillary expansion (SARME).

Materials and methods: Twenty consecutive patients (9 male and 11 female) with skeletal transverse maxillary deficiency seeking treatment at the Department of Orthodontics at Istanbul University in Istanbul, Turkey, were randomly assigned to 2 groups (10 patients each). Hybrid devices were inserted in the first group and TB (Hyrax) devices in the second. All of the patients had undergone SARME operations, which were carried out by the same surgeons using the same procedure (a Le Fort I osteotomy with pterygomaxillary dysjunction). All of the patients had similar transverse deficits, and 7 mm of expansion was achieved in all of them over 14 days. CBCT was carried out preoperatively (T0), at the end of the active expansion phase (T1), and after 6 months of retention (T2). Measurements were made using Mimics 16.0.

Results: Anterior skeletal maxillary widening parameters increased significantly in the T0–T1 and T0–T2 periods in the 2 groups ($P = 0.001$). There was significantly less dental expansion anteriorly with the hybrid devices (T0–T2: 4.03 mm vs. 6.29 mm). The first molars tipped buccally more in the group with TB devices during the T0–T1 phase ($P = 0.029$) and moved upright more than those in the group with hybrid devices during the retention phase ($P = 0.035$). Dental tipping, buccal alveolar bone resorption, and root resorption were observed significantly more often with the TB devices.

Conclusion: Hybrid RME devices, with similar skeletal effects, different dental movement patterns, and fewer dental and periodontal side effects, thus appear to be a beneficial alternative to TB devices for SARME procedures.

1. Introduction

Rapid maxillary expansion (RME) is a commonly used orthopedic procedure for correcting transverse maxillary discrepancies in growing children. Strong orthopedic forces are used to separate the maxilla into 2 halves at the midpalatal suture (Bell, 1982). Transverse maxillary hypoplasia is frequently seen in nonsyndromic patients (Proffit and Moray, 1998). Nonsurgical, conventional expansion is usually carried out in patients younger than 13 years. Skeletally mature patients, however, cannot be treated using conventional maxillary expansion, as the palatal suture has already ossified. As described by Glassman et al. (1984), ossified palatal sutures can be treated with surgically assisted rapid maxillary expansion (SARME), with local bone osteotomy and either tooth-borne or bone-borne expanders (Mommaerts, 1999).

Tooth-borne expanders are the commonly used treatment choice after SARME in adult patients, and have been shown to be

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satisfactory. However, they often cause dental tipping, root resorption, periodontal damage, and alveolar deformation, which may even extend to fractures of the alveolar process (Timms and Moss, 1971). Mommaerts (1999) introduced the bone-borne SARME technique to prevent these side effects. The major advantage of bone-borne expanders is that forces are directly transmitted to the palatal bone, thus causing more skeletal expansion closer to the center of resistance, less periodontal bone loss, and less root resorption (Neyt et al., 2002). However, some studies have reported that bone-borne devices may increase the risk of root lesions or infections, asymmetric maxillary expansion, and periodontal damage. In addition, there is a risk of losing the distractor modules, and insertion and removal of the bone-borne devices are invasive, as they require flap preparation (Neyt et al., 2002; Seitz et al., 2008; Koudstaal et al., 2009; Verlinden et al., 2011).

Mini-implants have attracted considerable attention in recent years, as they are versatile, minimally invasive, low in cost, and easy to use clinically (Wilmes, 2008). More recently, expansion appliances have been developed that use palatal mini-implants to secure the expansion screw directly to the palate, reducing the forces that are placed directly on the teeth. Mini-implant–assisted RME has been developed in an effort to maximize skeletal expansion and to minimize dental tipping. The basis of bone-anchored rapid maxillary expansion is the idea of avoiding direct forces on the teeth in order to maximize the orthopedic effect. Bone-anchored rapid maxillary expander designs can vary widely. Harzer et al. (2004) introduced the Dresden Distractor, which is attached solely to an implant and a mini-implant. Cortese et al. (2010) developed an appliance consisting of four 8-mm mini-screw implants that secure 2 titanium mini-plates and a titanium jackscrew to the palate. Lagravere et al. (2010) also used a bone-anchored maxillary expander consisting of an expansion screw and 2 stainless steel onplants secured to the palate with 2 mini-screw implants.

In 2008, Wilmes et al. introduced a hybrid RME device (hybrid Hyrax), an expander that is both tooth-borne and bone-borne (Wilmes and Drescher, 2008; Wilmes et al., 2010). The hybrid RME device is attached to 2 orthodontic mini-implants in the anterior palate and to the first molars. The anterior palate is the preferred location for mini-implant insertion, due to the excellent bone quality and thin attached mucosa in the area, resulting in a relatively low failure rate (Karagkiolidou et al., 2013). In addition, there is virtually no risk of tooth damage (Wilmes et al., 2014). Ludwig et al. (2011) have described suitable sites for palatal mini-screw insertion. They suggest that the anterior palate is the optimal site for supporting various treatment mechanisms, including rapid maxillary expansion.

The literature includes only a few published studies on hybrid RME: Wilmes et al. (2010) investigated the dental and skeletal effects of hybrid Hyrax combined with a face mask in 13 patients (mean age 11.2 years) and reported that the side effects of RME can be minimized using a hybrid Hyrax in growing children. Similarly, Ludwig et al. (2010) reported a case series on mini-implant–supported class III treatment with a hybrid rapid palatal expansion advancer. Wilmes et al. (2011) used a hybrid Hyrax in combination with a Mentoplate for early class III treatment. Using cephalograms, Nienkemper et al. (2013) investigated maxillary protraction using a hybrid Hyrax–face mask combination in 16 children (mean age 9.5 ± 1.3 years). These studies focus mostly on the hybrid Hyrax–face mask combination for orthopedic treatment in growing class III patients and use 2-dimensional radiographs or dental casts. However, there have been no studies to date examining whether hybrid SARME can have a positive effect in comparison to conventional dentally anchored SARME.

The objective of the present study was therefore to compare the dental and skeletal effects of tooth-borne and tooth-borne/bone-borne (hybrid) appliances in SARME.

2. Material and methods

2.1. Trial design

This was a single-center, 2-arm, parallel, randomized, clinical trial with a 1:1 allocation ratio.

2.2. Participants, eligibility criteria, and settings

Consecutive patients with skeletal transverse maxillary deficiency seeking treatment at the Department of Orthodontics at Istanbul University in Istanbul, Turkey, between December 2012 to January 2014 were invited to participate (Table 1). Data were collected from December 2012 until the end of January 2014. The inclusion criteria were skeletal maturity, skeletal transverse maxillary deficiency, and no developmental deformity. Exclusion criteria included age younger than 18 years, absence of maxillary first molars, previous periodontal disease, previous orthodontic treatment, and genetic disease. All patients provided informed consent. The study protocol was approved by the Clinical Research Ethics Committee of Istanbul University Medical Faculty (reference number 2012/641-1044).

2.3. Interventions

All orthodontic clinical manipulations were performed by same orthodontist (E.K.). In 10 randomly assigned patients, a tooth-borne (TB) expansion device (Hyrax; Forestadent, Pforzheim, Germany) was cemented onto dental bands fitted onto the first premolars and first molars a few days before the operation. In the remaining 10 patients, a hybrid RME device was inserted in accordance with the procedures described in previous studies by Wilmes et al. and Ludwig et al. (Fig. 1) (Ludwig et al., 2010; Wilmes et al., 2010). After the application of local anesthetic, 2 miniscrews (Ortho Easy, 10.0 × 1.7 mm; Forestadent) were inserted into the anterior palate, perpendicular to the palatal bone surface, at 2 mm paramedian to the suture and between the canine and first premolar contact points and first and second premolar contact points (Ludwig et al., 2011). Bands fitted to the upper first molars and laboratory abutments were attached to the mini-screw heads. A silicone impression of the maxillary arch was taken. The Hyrax expansion unit was fabricated from a Snap Lock expansion screw (Forestadent) by

Table 1
Demographic and skeleto-dental characteristics of sample.

	Hybrid group		Hyrax group		P value
	Mean	SD	Mean	SD	
Age	19.2	3.64	19.3	5.01	0.96
Gender					
Male	3		6		
Female	7		4		0.37
EMW4	37.92	3.49	35.93	1.82	0.13
EMW6	62.11	2.09	62.92	8.14	0.76
ICW4	36.75	1.89	34.71	1.81	0.02*
ICW6	45.49	2.68	45.78	3.18	0.83
IAW4	29.32	1.99	27.28	3.14	0.10
IAW6	31.08	2.25	31.06	1.71	0.98
Angle4	9.23	3.25	8.92	4.08	0.85
Angle6	6.01	5.58	6.93	2.82	0.86

P > 0.05 not significant (no statistically significant change).
*Statistically significant change.