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Short-term skeletal and dental changes following bone-borne versus tooth-borne surgically assisted rapid maxillary expansion: A randomized clinical trial study☆

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ABSTRACT

Aim: To evaluate and compare the short-term (post-retention) skeletal and dental changes following bone-borne and tooth-borne surgically assisted rapid maxillary expansion (SARME) using cone beam computed tomography (CBCT).

Subjects and methods: In this randomized clinical study, 30 patients with transverse maxillary deficiency underwent either tooth-borne ($n = 15$) or bone-borne ($n = 15$) SARME. Before treatment and immediately after the consolidation period, CBCT was obtained and the nasal floor width, interdental root distance, palatal bone width and interdental cusp distance were measured at first premolar and first molar regions of maxilla.

Results: Twenty eight patients completed the study protocol. In both tooth-borne ($n = 13$) and bone-borne ($n = 15$) groups the highest degree of expansion occurred in the dental arch, followed by palatal bone, and nasal floor (V-shaped widening in coronal dimension). The amount and pattern of expansion was comparable between anterior and posterior maxillary regions in each group (parallel posteroanterior expansion) and between the two groups.

Conclusion: Dental and skeletal effects of tooth-borne and bone-borne devices were comparable. The overall complication rate was negligible. Selection of an expansion device should be based on each individual patient's requirements. Future long-term clinical trial studies to evaluate the stability and relapse of these two techniques are recommended.

1. Introduction

Maxillary transverse (horizontal) deficiency may exist as an isolated entity or may be associated with other dentofacial deformities such as cleft palate, mandibular prognathism, mandibular deficiency, and anterior open bite. It is typically characterized by unilateral or bilateral crossbites, crowded teeth, and a constricted and tapered maxillary arch. In children and growing adolescents, conventional orthodontic rapid maxillary expansion can successfully be accomplished to treat maxillary constriction. However, in non-growing adolescents and adult patients, because of fusion of the midpalatal and lateral maxillary sutures and increased skeletal resistance, surgically assisted rapid maxillary expansion (SARME) is the treatment of choice. In these cases, traditionally, a tooth-borne palatal expander (Hass or Hyrax appliance) is used to do the maxillary expansion. Because these appliances are fixed to the teeth, they deliver a large amount of force into the anchor teeth, periodontal tissues, and alveolar bone during expansion, and may cause buccal tipping of the anchor teeth, outward rotation of the palatal bone segments, and complications such as buccal root exposure of anchor teeth, periodontal problems, buccal root resorption, and speech difficulties (Harzer et al., 2006; Aziz and Tanchyk, 2008; Koudstaal et al., 2009; Verstraaten et al., 2010). To avoid these complications, several types of bone-borne devices, which deliver expansion force directly to the palatal bone, have been introduced. It has been reported that bone-supported devices have several advantages over tooth-supported expanders including

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ability to be placed in an extremely narrow maxilla, avoiding dental tipping and periodontal problems, avoiding root resorption and exposure, low palatal profile, and creating true orthopaedic palatal expansion. However, bone-borne devices are expensive, their placement during surgery is time consuming, and their removal needs a second operation (Pinto et al., 2001; Gerlach and Zahl, 2005; Harzer et al., 2006; Aziz and Tanchyk, 2008; Verstraaten et al., 2010).

Dental and skeletal changes after either tooth-borne or bone-borne SARME have been evaluated in several studies (Matteini and Mommaerts, 2001; Pinto et al., 2001; Gerlach and Zahl, 2005; Ramieri et al., 2005; Harzer et al., 2006; Lagravère et al., 2006; Baraldi et al., 2007; Aziz and Tanchyk, 2008; Altug-Atac et al., 2010; Verstraaten et al., 2010; Seeberger et al., 2011). Because bone-borne SARME is a relatively new technique (introduced in 1999), most of the previous research on this treatment modality have been retrospective studies or prospective case report and series (Mommaerts, 1999; Verstraaten et al., 2010). By reviewing the published literature, especially systematic review and meta-analysis researches on SARME, the authors of the present study found few studies directly comparing the dentoskeletal effects of bone-borne and tooth-borne SARME (Suri and Taneja, 2008; Koudstaal et al., 2009; Landes et al., 2009; Laudemann et al., 2010; Verstraaten et al., 2010; Nada et al., 2012; Vilani et al., 2012). These studies had some shortcomings including non-randomized clinical trial design (using various types of expanders and surgical techniques in each study group based on practitioners' preferences) and assessment of dentofacial changes using dental casts and/or plain radiographs instead of advanced imaging techniques. Therefore, a randomized clinical trial to evaluate and compare the dentoskeletal effects of bone-supported versus tooth-supported SARME using an advanced imaging technique was required.

The aim of the present study was to evaluate and compare the short-term (post-retention) skeletal and dental changes following bone-borne and tooth-borne SARME using cone beam computed tomography (CBCT) imaging.

2. Material and methods

Thirty consecutive patients with transverse maxillary deficiency who were referred by orthodontists for SARME to the Department of Oral and Maxillofacial Surgery were included in this prospective randomized clinical study. Patients were randomly assigned to bone-borne ($n = 15$) and tooth-borne ($n = 15$) groups using a computer generated random sequence. The patients were aged between 15 and 27 years, and consisted of 11 males and 19 females. The inclusion criteria included skeletal maturity and the presence of one or more of the clinical signs of transverse maxillary deficiency such as dental crossbite, crowded teeth, and constricted maxillary arch. The exclusion criteria were congenital maxillofacial deformities, prior orthodontic and surgical treatment on maxilla, prior maxillary trauma, and transverse maxillary deficiency that could be corrected by orthodontic treatment alone.

This study was approved by the Research Ethics Committee of the University, and the written informed consent of all patients was obtained.

The surgical procedure, which was the same for all patients and performed by the same surgeon, consisted of osteotomy of the lateral maxillary wall from the piriform rim to the pterygomaxillary junction, midline osteotomy between the central incisors, and pterygomaxillary disjunction, not including the releasing of the nasal septum. In the tooth-borne group, a Hyrax appliance (Dentaurum, Ispringen, Germany) was passively bonded to the maxillary first premolars and the first molars before surgery. In the bone-borne group, a transpalatal distractor (TPD, Surgi-Tec, Bruges, Belgium) was placed at the end of the surgery at the level of the second premolars, high on the palate. After a latency period of 7 days, the distractors were activated at an approximate rate of 0.5–0.6 mm/day until an overexpansion of 2–3 mm was observed on either side. Then, the distractors were locked and kept in place for a consolidation period of approximately 4 months. At the end of consolidation period, the distractors were removed and a transpalatal retainer was placed. In both groups, cone beam computed tomography (CBCT) scans were performed before operation and immediately after completion of the consolidation period by using a Newtom 3G scanner (AFP Imaging, Elmsford, NY, USA). The scanning parameters were 120 kV, 2 mA, with a field of view of 12″ and a 0.4-mm voxel size.

To assess the skeletal and dental changes after SARME, the following distances (Fig. 1) were measured on the coronal CBCT images before treatment (BT) and immediately after the end of the consolidation period (AT):

NFW4: Nasal floor width measured at the area of the first premolars, 5 mm above the most inferior part of the nasal floor.
NFW6: Nasal floor width measured at the area of the first molars, 5 mm above the most inferior part of the nasal floor.
PBW4: Palatal bone width measured at the level of a line connecting the palatal root apex of the first premolars.
PBW6: Palatal bone width measured at the level of a line connecting the palatal root apex of the first molars.
IRD4 (Interdental Root Distance 4): The distance between the palatal root apex of the right and left first premolars.
IRD6 (Interdental Root Distance 6): The distance between the palatal root apex of the right and left first molars.
ICD4 (Interdental Cusp Distance 4): The distance between the mesiopalatal cusp tip of the right and left first premolars.

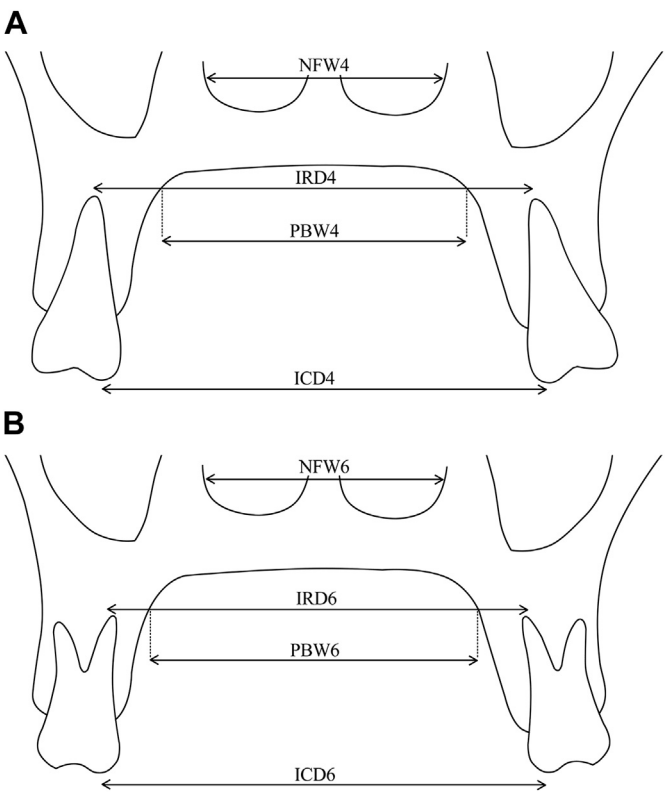

Fig. 1. The distances measured at the first premolar (A) and first molar (B) regions: NFW, Nasal floor width; IRD, Interdental root distance; PBW, Palatal bone width; ICD, Interdental cusp distance, 4: first premolar area, 6: first molar area.

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