Surgically assisted rapid maxillary expansion: Cone-beam computed tomography evaluation of different surgical techniques and their effects on the maxillary dentoskeletal complex

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Introduction: The aims of this study were to evaluate and compare skeletal, dentoalveolar, dental, and periodontal changes in surgically assisted rapid maxillary expansion (SARME) patients with and without pterygomaxillary disjunction. **Methods:** The records of 20 patients who underwent SARME in the clinics of the dental school at Marmara University in Turkey were collected and divided into 2 groups of 10 patients each, according to the surgical protocol followed. Cone-beam computed tomography images before the operation and 3 to 6 months after the end of active expansion were analyzed by 20 linear and 7 angular measurements. The reliability of the 3-dimensional analysis was investigated. **Results:** All transversal measurements in the dentoalveolar and dental levels increased after expansion in both the SARME with pterygomaxillary disjunction and the SARME without pterygomaxillary disjunction groups with no significant differences between them. In the SARME without pterygomaxillary disjunction group, more pronounced buccal alveolar bending and buccal tipping of the posterior teeth were found, but the difference did not reach statistical significance. SARME reduces buccal alveolar width in the premolar region significantly when pterygoid disjunction is not performed. **Conclusions:** SARME with or without pterygomaxillary disjunction is an effective technique to treat maxillary transverse deficiency in adolescent and adult patients. Pterygomaxillary disjunction is advised in periodontally compromised patients. Cone-beam computed tomography scanning is a reliable method for studying the dentoskeletal effects of SARME. (Am J Orthod Dentofacial Orthop 2014;146:748-57)

Transverse maxillary deficiency is a frequent component of malocclusions. Rapid maxillary expansion (RME) is a well-established method to correct this problem as well as arch length discrepancies.[1-3] Although this is the treatment of choice for growing adolescents, for skeletally mature patients RME has proved to have limited orthopedic effects on the maxillary skeletal structures because of the increased thickness of the bones, with reduced elasticity and obliteration of the maxillary sutures that accompany maturation. Surgically assisted RME (SARME) has been used in recent years to overcome these obstacles and offers a true orthopedic result without unwanted effects such as lateral tipping of the posterior teeth, buccal fenestrations, failure to open the midpalatal suture, alveolar bending, extrusion of posterior teeth, pain, instability, and root resorption.[4,5]

Although SARME was introduced in 1938 and has been well established, there is no current consensus for the surgical technique to be followed.[6] Different osteotomies and combinations of them have been described in the literature, and only general guidelines exist. Ideally, the patient's age, treatment needs, and the stresses generated in each area of the maxilla during the application of orthodontic forces should dictate the osteotomy lines.[4,7,8] Recognized areas of stresses that impede the unrestricted opening of the maxilla are the piriform aperture pillars (anteriorly), the zygomatic buttress (laterally), the pterygoid junction (posteriorly), and the midpalatal suture (medially).[9] More specifically, the

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need for dissecting the pterygoid plates and the effects of such procedures on the treatment outcome still need to be elucidated, especially if we consider the increased risk of an osteotomy in the pterygoid plate area.

The need for releasing the maxilla from the posterior stresses of the pterygoid plates has been advocated,[5] whereas other authors have shared the more conservative approach that removing the resistance from the zygomatic buttress is sufficient for true orthopedic expansion.[10-13] Koudstaal et al[14] stated that SARME without pterygoid separation results in a different pattern of expansion. They believed that the ratio of anterior to posterior expansion is higher in patients with no pterygoid separation than in SARME patients who underwent pterygoid osteotomy, and this might be considered as an individualized treatment to achieve more distraction on either the posterior or the anterior level.

A review of the literature about SARME shows that the authors of most studies evaluated the efficiency and efficacy of the technique using plaster models of the patient's dentition,[14] posteroanterior cephalograms, or computed tomography.[15-18] Only recently, cone-beam computed tomography (CBCT) studies on the subject of SARME have started appearing, and this is the first CBCT study to investigate the effect of pterygoid disjunction on the treatment outcome.[19,20]

The aims of this study were to compare and evaluate the immediate dentoskeletal effects of 2 distinct surgical techniques used for SARME. The difference between these techniques consists of whether the release of the pterygoid junction was performed.

MATERIAL AND METHODS

This was a retrospective study approved by the ethical committee of the Institute of Health Sciences of Marmara University in Istanbul, Turkey. Between June 2011 and July 2012, 26 patients underwent SARME in the Department of Orthodontics. Of the 26 patients, 3 with craniofacial anomalies, including cleft patients, were excluded from this study, as were 3 patients with missing diagnostic records at the desired time points. CBCT records of 20 patients (4 male, 16 female; mean age, 18.8 years) were retrieved from the department's archives. All subjects were white from the same geographic area. CBCT images were obtained immediately before the surgical procedure and 3 to 6 months after completion of the active expansion according to the standardized protocol for all patients undergoing SARME at Marmara University. In all patients, expansion was performed with the same intraoral appliance, a bonded acrylic hyrax-type expander, covering all posterior teeth, without previous orthodontic treatment.

Table I. Skeletal measurements

Measurement	*Definition*
J distance	The distance between jugale points of the left and right sides. Jugale point for a specific side is defined on the coronal slice passing through the molar furcation point of that side, as the intersection between the arch of the zygomatic process and the horizontal line passing through the floor of the nose (Fig 1).
Pir L-R	The diameter of the piriform aperture. Distance between left and right piriform rims (the most latero-inferior points were traced on the 3D reconstructed image).
lpp L-R	The distance between anterior points of the left and right lateral pterygoid plates. Pterygoid plates were traced on the axial slice at the level that the palatal foramens could be best seen; lateral and medial plates were traced by 2 points each, anterior and posterior—posteriorly at the most posterior aspect of the plate and anteriorly at the most concave point on the pterygomaxillary fissure line for the lateral plates and on the pterygomaxillary fissure line for the medial plates (Fig 2, *A*).
lpp angle	The angle between the left and right lateral pterygoid plates (Fig 2, *B*).
mpp angle	The angle between the left and right medial pterygoid plates.

According to the surgical protocol that was undertaken, the patients were divided into 2 groups: SARME with pterygoid disjunction (SARME +PD) and SARME without pterygoid disjunction (SARME −PD).

In the SARME −PD group (10 patients; mean age, 19.2 years), the surgical technique involved the bilateral LeFort I type of osteotomy plus midline osteotomy. In the SARME +PD (10 patients; mean age, 18.4 years), the same protocol was followed with pterygoid disjunction performed additionally. The lateral LeFort I cuts extended from the piriform rims anteriorly through the zygomatic buttress to the tuberosity area posteriorly, 4 to 5 mm above the apices of the maxillary teeth, and were carried out with a reciprocating saw. The midline osteotomy was performed with a spatula type of chisel placed between the anterior nasal spine and the apices of the central incisors. Separation of the pterygoid plates was done with an angulated osteotome. Intraoperatively the hyrax screw was activated 8 times (2 mm) just before the midline osteotomy. After a latency period of 3 days, the patients started activating the expander twice daily (0.5 mm) until adequate expansion was achieved.

All 3-dimensional (3D) scans in DICOM format were reoriented and resliced based on the Frankfort horizontal