Skeletal Changes Accompanying Surgically Assisted Rapid Maxillary Expansion in Adults A Computed Temography Evaluation

E M Samieh[1], ETDaif[2], HAEG Othman[3]

[1]Assistant Lecturer, [2]Professor, [3]Lecturer, of Oral and Maxillofacial Surgery, Oral Surgery Department, Faculty of Oral and Dental Medicine, Cairo University, Cairo, Egypt

Abstract

Background: Surgically assisted rapid maxillary expansion (SARPE) is a common procedure to correct maxillary transverse deficiency of >5mm in patients with closed midpalatal suture. The aim of this study was to three dimensionally analyze skeletal changes afterSARPE.

Studydesign: Twelve adult patients (mean age 20 years)with a palatal transverse deficiency underwent SARPE. The surgical procedure consisted of a lateral osteotomy combined with an interradicular osteotomy between the roots of the upper central incisors. Measuring points were defined on the hard palate. Cone beam computerized tomography scans were performed preoperatively and 6-months postoperatively.

Results: Skeletal changes accompanying SARPE utilizing Hyrax appliance were analyzed.

Conclusions: Bilateral osteotomy combined with a sagital osteotomy is a safe method of SARPE. The expansion was mostly achieved by maxillary expansion. The amount of dentoalveolar tipping was smaller than reported.

Key words: *Cone beam computed tomography, CBCT, maxillary transverse deficiency, MTD, surgically assisted rapid maxillary expansion, SARME.*

Introduction

Surgically assisted rapid palatal expansion (SARPE) has become a widely used and acceptable means to expand the maxilla in adolescents and adult patients. The method has advantage of bone formation at the maxillary edges of the midline, while they are separated by an external force.(1)

Maxillary transverse deficiency (MTD) is a dento-facial disturbance characterized by the presence of unilateral or bilateral posterior cross-bite, deep or high arched palate, anterior tooth crowding, dental tipping and difficult nasal breathing. The SARPE is a clinical therapeutic procedure used to correct this deficiency in adult patient who have already completed ossification of the mid-palatal suture.(2)

Cone beam computerized tomography (CBCT) is a multi-planar imaging technique that allows visualization of slices as well as 3D reconstructions like medical CT scanning does, with a better resolution and a far lower ionizing radiation dose.(3)

Patients and Methods

Twelve adult patients (8 females and 4 males) having a MTD participated in this study. The patients attended the department of Oral and Maxillofacial Surgery for correcting their maxillary deficiency before undergoing

orthodontic treatment. The patient ages ranged from 16 to 29 years, with an average of 20 years. A pre-operative protocol including orthodontic photos, study models and CBCT was carried out for every patient.

Prior to surgery, a tooth-borne expander *(Hyrax appliance)* with a 13mm screw was prepared on the study model and cemented to the first maxillary premolars and first molars in all patients. The inclusion criteria for patient were: skeletally mature patients with a total bilateral transverse maxillary deficiency of more than 5 mm, without a history of trauma or any cranio-facial syndrome.

Surgical technique

SARME was carried out under general naso-endo-tracheal anaesthesia.The technique encloded bilateral zygomatic buttress and mid-palatal osteotomies . The malar buttress osteotomy did not extend forward to the piriform aperture or posteriorly to the pterygo-maxillary fissure. It was about 2 cm in length and perpendicular to the outer surface of the bone. A fine osteotome was inserted into the midline of the maxillary alveolus and anterior nasal spine regions, through a small vertical incision at the midline, to separate the two maxillae. A finger was placed on the palate to protect the mucosa during separation of the palatal suture by gentle malleting of the osteotome. The surgical sites were irrigated copiously and sutured.

Expansion protocol

No expansion was attempted for 5 days postoperatively to facilitate patient comfort. There-after, all patients were instructed to turn the appliance a one-quarter turn (0.25 mm) twice daily, morning and evening (2 turns /day).

The expansion was finalized when an over-correction of 2 mm was achieved at the maxillary molar level on each side. Then, the appliance wassecured inplace for 3 months as a retainer. After 3 months, the appliance was replaced with a trans-palatal arch for an additional 3 months. Later on, patients underwent conventional orthodontic therapy.

Cone beam computed tomography

Using a cone beam computed tomography (A Scanora 3D, Soredex, Finland) was used to obtain all patient scans. The machine was set to capture axial and coronal images at the manufacturer's recommended settings of 15-mA and 85-kVp.

Every patient was scanned at two time intervals: T0 and T1. The first image (T0) was obtained prior to surgery. The second image (T1) was obtained immediately after removal of the trans-palatal arch at 6 months postoperatively.

I- Coronal measurements.

A- C-angle. It is the angle formed by intersection of two lines touching the inferior palatine margin of the alveolar process of the maxilla (C2) and the palatine process of the maxilla (Fig.1).

B- C1: It is measured at the level of the palatine process of maxilla (Fig.1).

C- C2: It is measured at the inferior palatine margin of the alveolar process of the maxilla.[4]

II- Axial measurements

A- A-angle

It is the angle formed by the intersection of two lines touching the greater palatine foramen and the greatest convexity of the medial wall of the maxillary sinus.

a-A1: It is a linear measurement at the level of the greatest convexity of the medial walls of maxillary sinus.

b-A2: It is the linear measurement at the greater palatine foramina.[4]

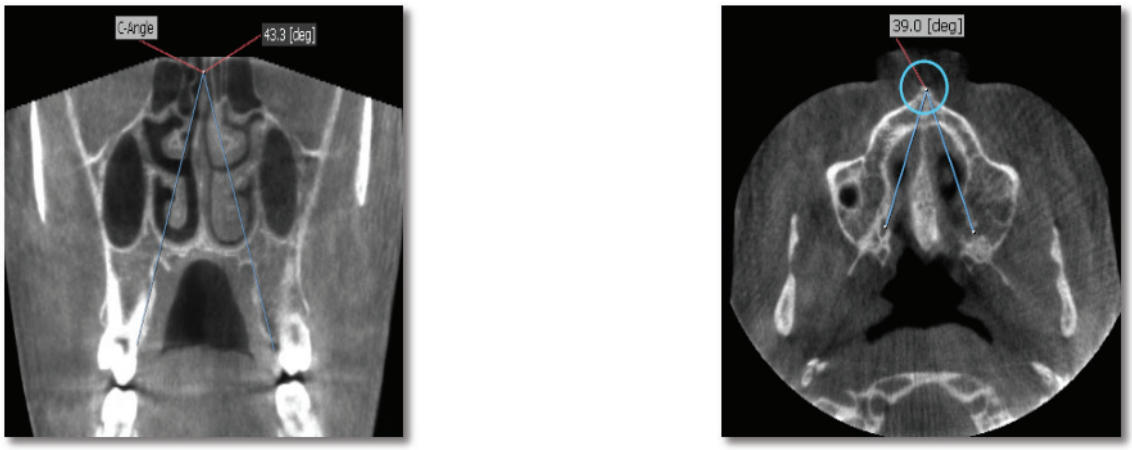

Figure 1: CBCTof axial and coronal cuts representing A&C angles respectively.

Table 1:The mean absolute and relative differences between preoperative and 6-months postoperative axial and coronal measurements.

Measurement (mm)	Preoperative	Postperative	Mean of difference+SD	
			Absolute (mm or degree)	Relative (%)
A1	23 ± 2	27.6 ± 1.9	5 ± 1.8	20+8.6
A2	31 ± 2.1	32.5 ± 1.9	1.5 ± 0.7	4.8+2.5
C1	23 ± 2.1	27.8 ± 1.8	5 ± 1.6	21.8+8.6
C2	32.3 ± 3.1	38.9 ± 4.9	6.6 ± 5.4	23.2+17.1
A angle (degree)	39.7 ± 4.5	37.3 ± 4.3	-2.5 ± 1.1	-6.2+2.7
C angle (degree)	30.9 ± 8.1	37.0 ± 8.7	6.1 ± 2	20.8+7.9

Results

The measurements revealed that the greatest expansion occurred in the most inferior and anterior regions of the maxilla; where it was 6.60 + 5.4mm at C2 and 4.89 + 1.62mm at C1. Table (1) exhibits that, the means of absolute and relativemaxillary expansion were higher at C2 than at C1, where they were 6.6+ 5.4mm(25.2+ 17.1%) and 5+ 1.6 mm (21.8 + 8.6%) respectively. This indicates tilting of the expanded segment outwards at C2 level. Also, the difference in maxillary expansion between C2 and C1 was 3.4 mm.

Table (1) exhibits that the means of the absolute and relative maxillary expansion at A1 (5+ 1.8mm, 20 + 8.6 %) were higher than at A2(1.5+ 0.7 mm, 4.8+ 2.5 %).This indicates tilting of the expanded segment outward at the A2 level. The difference in maxillary expansion between A1 and A2 was 3.5 mm (15.2%).

In addition, table (1) shows, also, that the means of the absolute and relative differences between preoperative and postoperative measurements of the C and A angles were 6.1+2°(20.8 +7.9%) and -2.5+ 1.1^0 (-6.2+ 2.7 %) respectively

The postoperative increase in the A angle and the decrease in the C angle indicate tilting of the expanded segment outward inferiorly and anteriorly in the coronal and axial images, respectively.

Discussion

SARME expansion provides a correction of maxillary transverse deficiency. Theexpansion device should separate the maxillary segments by a transverse distraction. SARME is advocated to overcome the fusion and resistance of the adult sutures to expansion.[5]

In skeletally mature individuals, the mid-palatal suture has fused and there is marked resistance to transverse expansion.[6]The SARME is unavoidable where expansion of the maxilla is not possible orthopedically because of the patient's skeletal maturity.[7]

SARPE has been advocated in order to overcome the fusion of mid-palatal suture and resistance arising from the other maxillary articulations to expansion in the adult. The relative lack of complications, high effectiveness and the excellent stability are important reasons for considering this procedure.[4]

The bilateral zygomatic buttress and mid-palatal osteotomies are sufficient to achieve maxillary expansion in adults[1,4], which is in agreement with Pogrel et al.[8]

The sagittal and skeletal displacement was greater posteriorly than anteriorly and this finding in accordance with similar studies on a tooth borne expansion device (Antilla et al 2004, Byloff and Mossaz 2004, Koudstall et al 2009 and Nada et al 2012).[1],[9],[10],[11]

More skeletal displacements were found inferiorly than superiorly and more posteriorly than anteriorly. The superior landmarks in the maxilla were located at the zygomatic process and at the most lateral and inferior point of the nasal aperture and the anterior nasal spine. All these landmarks are validated and reliable for measurements in the maxilla (Moore-Jansen 1994 and Swennen et al 2006).[12],[13]

Maxillary expansion at the midline was greater than that at the canines. Moreover, that greatestexpansion had been occurred in the most inferior region of maxilla. This triangular pattern of maxillary expansion (the base of this triangular at the dental level and the apex toward the nasal floor) might be due to anterior mid-palatal vertical osteotomy of maxilla during surgical operation.

The lateral outward tilting of the posterior bony segment of maxiila was significant. Byloff and Mossaz(2004)[9] considered the "molar tipping"to be anundesirable dental side effects. In this study, the marked posterior tipping at the molars might be related mainly to the tipping of the whole posterior bony segment and to a lesser extent to tipping of teeth. Skeletal over-expansion would reduce the molar tipping which in agreement with Chung and Goldman (2003).[14]

As the greater palatine foramina are stable structures and unaffected by the surgical procedure, they are used for measuring the width changes in the posterior maxilla, being reproducible anatomical landmarks.

Conclusions

The study concluded that;

1. SARME is an extremely valuable operation that should be considered whenever maxillary expansion is needed with adults.

2. The relative lack of major complications and the excellent stability of the expanded two maxillary halves are significant reasons for considering this procedure.

3. During the activation phase for maxillary expansion, a mild diastema was observed that is decreased gradually till closure about two months.

4. A retention period of 6 months is recommended in SARME to allow consolidation of the expanded maxillary two halves by the new bone formation.

Conflict of Interest: Nil.

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Ethical Clearance: Department of Oral and Maxillofacial Surgery (by department's management board) followed by a second approval of board committee of the Faculty of Oral and Dental Medicine, Cairo University, Cairo, Egypt.

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