EFFECT OF BONE BORNE TRANSPALATAL DISTRACTOR ON BOTH COLLAPSED MAXILLA AND MAXILLARY AIRSINUS

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ABSTRACT

Collapsed maxilla is one of the maxillofacial disorders which results in decreased buccal corridor, bilateral and/or unilateral cross-bite, tapered maxilla, reduced maxillary sinus volume, and crowding of the maxillary teeth. Collapsed maxilla was treated either by non-surgical techniques; as slow orthodontic expansion (SOE) or rapid palatal expansion (RPE) as one part or surgical techniques as either surgically assisted rapid palatal expansion (SA-RPE) or 2 segmented Le Fort I-type osteotomy with expansion (LFI-E) as another part .

The aim of the study was to evaluate the effect of transpalatal distraction through using bone borne device in treatment of collapsed maxilla. Ten patients of both sexes (6 males and 4 females) were included in this study. All patients were evaluated preoperatively through clinical examination both intraorally and extraorally. Intraoral photographs were taken for each patient preoperatively as well as postoperatively for comparison of the final outcomes. Repeated measures ANOVA test showed that time*group interaction had an effect on mean volumetric measurements. Device type, side and time*side had no effect. Repeated measures ANOVA test showed that time only had an effect on mean measurements. Time*group interaction and device type had no effect.

Conclusion: Use of transpalatal distractor was an effective method for treatment of transverse collapse.

INTRODUCTION

Maxillary collapse is one of the maxillofacial disharmonies which results in decreased buccal corridor, bilateral and/or unilateral cross-bite, tapered maxilla, and crowding of the maxillary teeth(1). The etiology of maxillary collapse could be congenital; as cleft palate patient or developmental due to trauma to the maxilla.

Maxillary collapse (constriction), formerly, was treated either by non-surgical techniques; as slow orthodontic expansion (SOE) or rapid palatal expansion (RPE). Or surgical techniques as either surgically assisted rapid palatal expansion (SA-RPE) or 2 segmented Le Fort I-type osteotomy with expansion (LFI-E) (2).
Slow orthodontic expansion (SOE) was used for mild lateral discrepancies and for young patients before age 8 or so where, there is minimal interdigitation at the maxillary suture. This palatal suture needs minimal force and simple appliance for expansion\(^3\).

Rapid palatal expansion (RPE) appliance was used in growing child to open the midpalatal suture. However, long-term stability remains problematic in form of bone resistance and relapse whether the constriction was skeletal, dental, or a combination of both\(^4,5\).

Rapid palatal expansion resulted in alveolar bone bending, periodontal membrane compression, buccal bone fenestration, and lateral tooth displacement\(^6-8\).

In a trial to overcome some of the problems associated with non-surgical procedure that were mentioned before, surgically assisted rapid palatal expansion was developed to release the areas of bony resistance\(^6\). However, because the appliance used was tooth borne, problems related to the orthodontic expansion were noticed\(^9-14\).

Another method of surgical techniques for maxillary expansion is 2 segmented Le Fort I-type osteotomy with expansion (LFI-E), but this technique has drawbacks of bony segment instability and requires waiting for age of growth cessation\(^15,16\).

Distraction osteogenesis is a method of bone lengthening; it is used for treatment of short extremities as well as bone defects. Through this procedure, large amount of bone can be regenerated in the distraction gap. Distraction osteogenesis depends on presence of mechanical stimulation of the callus that is present between the two bony segments to induce regenerate\(^17\).

Cordivilla\(^17\) described lengthening of bone by gradual distraction (distraction osteogenesis), this technique gained wide-spread acceptance in orthopedics. The Russian orthopedist\(^11\) is credited with pioneering technique for long bone distraction.

Snyder et al.\(^18\) were the first to describe use of distraction osteogenesis in the craniofacial skeleton of a canine model. Since that time, a large number of authors have described the application of this technique to the maxillofacial region\(^12,19-21\).

Transpalatal distraction is a technique by which\(^22-26\) the maxillary collapse (constriction) could be treated without any force applied to individual teeth, while the distraction force is applied in the palatal vault\(^22,25,26\).

The standard transpalatal distractor is primarily fixed to the palatal bone by miniplates. However it cannot adapt the variation in the vault of the palate. Additionally, the device cannot accommodate the narrow maxillary arch either in the child or the adult. Accordingly, a new design of transpalatal distractor is developed and modified to adapt the narrow maxillary arch in a trial to treat the collapsed maxilla. The aim of the study was to evaluate the effect of bone-borne transpalatal distractor in treatment of collapsed maxilla and enlarging the maxillary sinus volume.

**PATIENTS AND METHODS**

Ten patients of both sexes (6 males and 4 females) were included in this study. The age range was from 8 to 32 years. All patients were presented with transverse maxillary collapse. They were chosen from those attending out clinic of the oral and maxillofacial surgery department, Faculty of Dental Medicine, as well as Al-Azhar University Hospitals.

The main complaint of all patients was bad aesthetic of the upper jaw and midface area due to presence of unilateral or bilateral posterior cross-bite, besides, fluid regurge from the nose in cleft palate patients as a result of oro-nasal fistula. The clinical diagnosis showed that, the patients were requiring expansion of the reduced maxillary width by use of the transpalatal distractor to correct the posterior cross bite (collapsed maxilla) and to easily close the oro-nasal fistula.
Preoperative evaluation

All patients were evaluated preoperatively through clinical examination both intraorally and extraorally. Intraoral photographs were taken for each patient preoperatively as well as postoperatively for comparison of the final outcomes (Figs 1,2).

An orthopantomogram was made preoperatively for each patient for giving a full data about both jaws as well as any pathologic lesion that could be present through the jaw bone. Linear and volumetric computed tomography were done for each patient at preoperative period and at 6 months post-distraction for evaluation of the improvement in maxillary sinus volume and transverse maxillary dimension. Specific fixed point of measurement were taken around the affected maxillary sinus for each patient in a trial to measure the change in volume of sinus that could occur after finishing the active period of the distraction process. These fixed points were used before and after CT scan making for each patient to make a volumetric comparison for the affected sinus. The patient head position was maintained the same at both times.

Surgical technique

All patients were operated under general anesthesia with nasotracheal intubation. The surgical design was performed according to the existing deformity (i.e.) in case of unilateral posterior cross-bite, one side of the maxilla was distracted, while, in case of bilateral posterior cross-bite, both sides of the maxilla were operated on.

Soft tissue incision

In case of bilateral maxillary distraction; long vestibular incision from upper right second molar to upper left second molar was done. Subperiosteal dissection was performed to expose the buccal bone of maxilla and pyriform nasal aperture on both sides to level of the infraorbital nerve. The nasal mucosa was dissected away from the lateral nasal wall using freer elevator. Whereas, in case of unilateral maxillary distraction; vestibular incision was done from upper second molar on the deficient side to the distal surface of upper central incisor on the opposite side. The soft tissue flap was dissected away to expose the buccal maxillary bone and anterior nasal aperture on this side. The nasal mucosa was dissected away from lateral nasal bone.

The bone osteotomy

The buccal bone was osteotomized and freed but still had a connection to the pterygoid bone plate (without complete down fracture).
In case of bilateral maxillary distraction; the osteotomy started from pyriform fossa involving maxillary buttress ending at pterygomaxillary junction (left intact) on both sides of the maxilla using the reciprocating saw. The lateral nasal wall was cut by unilateral nasal osteotome. A midline osteotomy between upper central incisors was done by fine reciprocating saw and fine osteotome to divide the maxilla into two pieces(7). While, in case of unilateral maxillary distraction; the osteotomy extended from pterygomaxillary junction to the periform fossa on one side (deficient side). The lateral nasal wall was cut using lateral nasal osteotome. A midline osteotomy was done by fine reciprocating saw and fine osteotome (Fig 3).

After doing the bone osteotomy the distractor that was designed for each case was fixed to the maxillary bone. The distractor activated 4 turns (1 mm) for making initial expansion of the maxilla. Finally, all incisions were closed with 3/0 black silk sutures.

**Description of the distractor**

The bone-borne distractor composed of distractor body (screw), four retention arms arising in two opposing directions, and four screw rings, the retention arms of the distractor were adapted to the palatal surface before distractor application to the palatal bone of the maxilla. Two different sizes of the distractor were available, the first size produces 9 mm maximum expansion (about 40 activations), while, the other size produces 11 mm maximum expansion (about 48 activations). The distractor was fixed to maxillary bone by four (titanium) mini-screws, 2mm diameter central drive screws, (Fig. 4).

**Postoperative follow up**

- I.V injection of unasyn * 1500 mg every 12 hours for 5 days, Decadrone ** 8 mg I.M. every 12 hours for two days, and voltarine *** 75 mg I.M injection every 12 hours for three days were prescribed

**- Latency period**

The distractors were left 5-7 days (latency period) to allow soft callus formation.

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* Sulbactam/Ampicillin, Pfizer, Egypt, S.A.E., Cairo, A.R.E, under authority of Pfizer Inc. U.S.A.
*** Declafenac sodium, 75 mg ampoule, NOVARTIS Pharma S.A.E., Cairo under license from NOVARTIS Pharma A.G., Basle, Switzerland.
Activation period: The distractors were activated 2 turns per day (0.5 mm) one turn at morning and one turn at night, until the adequate and proper relation between the maxillary teeth and the mandibular teeth with slight over correction (expansion) of the maxilla had been achieved.

The appliance was then left in place for 6-8 weeks as a retainer in a passive position for bone consolidation (consolidation period).

All cases were submitted for orthodontic treatment to correct their maloccluded and imprecated teeth at the end of the consolidation period (6-8 weeks) (Fig. 5).

The obtained data were collected and statistically analyzed.

RESULTS

Ten patients with age range 8-32 years with a mean of (18.05 y) were operated for correction of transverse maxillary collapse by transpalatal distraction. Three patients out of the total were excluded from the study, as they did not come for follow up.

Patients of the present study were assessed preoperatively as well as postoperatively through:

(1) Clinical assessment including intraoral, photographs.

(2) CT scan including sinus volumetric measurement and linear measurement on upper 1st premolar level and on upper 1st molar level, (Figs 6,7).

[1] Clinical assessment

Photographs

Intra-oral photographs of the upper jaw were taken for the patients preoperatively and postoperatively to compare the postdistraction outcome of the upper jaw with the predistraction (collapsed) upper jaw for the patients (Figs. 8,9).
Postoperative clinical assessment

Within the first five postoperative days, clinical examination of patients showed good soft tissue healing and no infection was noticed in the healing of bone and overlying soft tissue. No wound bleeding was noticed at the first postoperative day. The pain was felt back in the second day at night, then it was started to decrease until completely disappeared at the fifth postoperative day.

The sutures were removed in the fifth day postoperatively. Moderate to severe soft tissue edema of upper lip and checks was apparent at the day of surgery. Then after, it was gradually resolved. Palatal tissue ulcers were observed around arms of bone-borne device. These ulcers healed spontaneously without medication. Patients of the study exhibited no difficulty on maintaining adequate nutrition throughout duration of the study. The patients reported minimal discomfort associated with activation of the distraction tram. No abnormal tooth mobility was seen during the latency period. In case of cleft palate patient, the patients showed more running fluids from the nose with drinking due to increase in width of the palatonasal fistula or palatal cleft as a result of maxillary expansion (Fig. 10). This problem was treated by closure of the fistula or cleft after removal of the transpalatal distractor.

Radiographic analysis

The radiographic analysis was made using computed tomography (CT) scan in 2 patterns, linear measurements of horizontal maxillary bone dimension and volumetric measurements of maxillary air sinuses (Figs. 6, 7).

Sinus volumetric measurement:

The mean of right maxillary sinus volume as regard to our taken fixed point around the sinuses was 40.3 cm³ preoperatively, and became 45.1 cm³ at 6 months post-distraction that showed increase in the mean of volume of sinus. For the left maxillary sinus, the mean preoperatively was 32.6 cm³ and became 38.81 cm³ at 6 months post-distraction which exhibited increase in sinus volume
mean. From the previous result, the mean percentage of increase in right sinuses was 11.9 %, while the mean percentage of enlargement of left sinuses was 19%.

There was a statistically significant increase in mean measurements on the right and left sides (P < 0.001 and P = 0.002, respectively).

**Linear measurement at first premolar**

The mean of distance measured from fixed points for each patient on CT at buccal bone of upper first premolar to the corresponding point on opposite side was 37.3mm preoperatively and became 49.5 mm at 6 months post distraction. The mean percentage of increase in dimension was 32.7 %.

There was a statistically significant increase in mean measurements (P < 0.001).

**Linear measurement at first molar**

The mean of distance measured from fixed points for each patient on CT at buccal bone of upper first molar to the corresponding point on opposite side was 52.9 mm preoperatively, and became 63.8 mm at 6 months post distraction. The mean percentage of increase in dimension was 20.6 %.

There was a statistically significant increase in mean measurements (P < 0.001).

**DISCUSSION**

Transverse maxillary deficiency represents a major problem in maxillofacial region. This may result in unilateral, or bilateral cross bite, tapered maxilla, teeth crowding, and/or dental malocclusion. Different methods of treatment could be used for correction of transverse maxillary deficiency, these include slow orthodontic expansion (SOE), rapid palatal expansion (RPE), surgically assisted rapid palatal expansion (SA-RPE), 2-segmented Le Fort I-type osteotomy with expansion or recently distraction osteogenesis in transverse transpalatal direction.

Expansion of collapsed maxilla by distraction osteogenesis has eliminated most of the complications resulted from the aforementioned techniques. The transpalatal distraction is a recent technique in which distraction osteogenesis is used for expansion of transverse maxillary deficiency.

The distraction osteogenesis allows new bone and soft tissue formation as well as stretching the scar tissue which is an important cause of relapse in cleft palate patients making the distraction superior to all other techniques used for treatment of these cases. Furthermore, in cleft patients, because the appliance is rigidly fixed to the osteotomized bone in bone-borne device, undesired movement of the bony segments is eliminated. Another important point is the ossification of the bone osteotomies which begins during the distraction period and continues during the retention time, where, the transpalatal distraction offers a high retention stability without or with a minimal relapses.

Bone-borne type was directly fixed to the palatal bone the device allowed simultaneous orthodontic multiband therapy to form good dental arch during the retention period after the desired width with newly gained space between the incisors has achieved. Reduction of the overall treatment time is another advantage of the bone-borne distractor.

The bone-borne distractor allows physical movement of the two maxillary halves without undesired side effects caused by the forces acting on the teeth. Furthermore, the application of this distractor is not dependent upon the presence of a complete dentition.

Additionally, the device is a bone-supported palatal distractor, so, the complications as tooth devitalization, extrusion, buccal tipping of teeth, and fracture of alveolar process that have been reported with a forementioned treatment methods were not accompanied with bone-borne distractor. The technique of the transpalatal distraction is more or less well established.
However, the use of any of the two forms of bone osteotomy either with or without pterygoid disjunction was still debatable.

In the first one (with pterygoid dysjunction), the distractor is placed at level of first molar allowing more posterior distraction for correction of posterior cross bite.

In our cases, the second technique (without pterygoid dysjunction) was applied because the cases in this study had anterior maxillary collapse with crowding of the anterior teeth which required more anterior displacement of the lateral maxillary segment. Patients of this study were assessed radiographically by computed tomography (CT scan) preoperatively and at six months post-distraction to assess the amount of maxillary expansion and to decrease the amount of patient’s exposure to the radiation hazards. The mean percentage of right sinuses volume by CT scan exhibited 11.9 % increase while for left sinuses volume showed 19 % increase. The mean distance at first premolar by CT scan linear measurement showed increased mean percentage 32.7 %. The linear measurement at first molar by CT scan showed that, the increased mean percentage was 20.6 %. The comparison between the linear measurement’s of both first premolar and molar imparted that the percentage of distraction was higher in premolar area which goes back to two reasons,(1) the pterygomaxillary junction was lift intact intraoperatively, as well as, the distractor position was placed at premolar which resulted in more anterior opening than posterior . this was agreed with matteini and mommaerts (14).

**CONCLUSION**

- The transverse maxillary distraction using a bone-borne device is an effective method for treatment of transverse maxillary collapse with low rate of complications and low degree of relapse.
- Bone-borne transpalatal distractor was not destroying the teeth and periodontium.

**REFERENCES**


