Surgical treatment of maxillary transverse deficiency: retrospective study of 14 patients

Received: 19 May 2009 / Accepted: 12 August 2009
© Association of Oral and Maxillofacial Surgeons of India 2009

Abstract

Introduction The diversity of the proposed techniques in the treatment of maxillary transverse deficiency in adults reflects the conflicting opinions about the primary area of resistance to maxillary expansion in the craniofacial skeleton. In order to evaluate the efficiency of the surgical expansion in which no osteotomies of the pterygomaxillary junction were made, we have carried out a retrospective study with 14 patients with maxillary transverse deficiency, who were treated from 2003 to 2006. **Material and methods** In the study, models were made prior to and after surgery, and the intercanine and intermolar distances and the improvement of the interocclusal relationships were analyzed. Breathing function and the complications that occurred during and after the surgeries were also analyzed. **Results** All expansions were carried out according to pre-surgical planning so that expansion completely corrected the crossbite, resulting in the desired final occlusion for all patients. Intraoperative complications were limited to one Hyrax appliance deformation. Two patients had minor postoperative complications that included wound dehiscence and pain. Improvements in nasal breathing were observed in all patients that complained of breathing problems prior to the surgery. **Conclusion** The satisfactory results obtained turns the surgical protocol described in this study recommended for the treatment of maxillary transverse deficiency in adults. Importantly, we found that pterygomaxillary osteotomy is not essential for maxillary expansion. The morbidity of the procedure was low with fairly minor complications, and surgically assisted rapid maxillary expansion was shown to improve nasal breathing.

Keywords Crossbite • Maxilla • Osteotomy

Cintia Mussi Milani Contar¹ ✉ • Paulo Roberto Muller² • Ademir Roberto Brunetto³ • Maria Angela Naval Machado⁴ • Abrao Rappoport⁵

¹ Professor of Oral Radiology, Universidade Tuiuti do Parana, Brazil

² Professor of Oral and Maxillofacial Surgery

³ Professor of Orthodontics

Universidade Federal do Parana, Brazil

⁴ Professor of Stomatology, Universidade Federal do Parana, Curitiba, Brazil

⁵ Technical Director of the Health Dept., Heliopolis Hospital, Brazil

Address for correspondence:

Cintia Mussi Milani Contar
Professor of Oral Radiology
Universidade Tuiuti do Parana
Curitiba, Brazil
E-mail: cintiacontar@hotmail.com

Introduction

Maxillary bone hypodevelopment can occur in the transverse, vertical and anteroposterior direction [1]. The transverse dimension may be more crucial than either the anteroposterior or vertical dimensions in the achievement of a stable occlusion, and the treatment of skeletally mature patients is often complicated due to inadequately treated or undiagnosed transverse skeletal discrepancy [2]. Maxillary transverse deficiency is characterized by the presence of a high arched palate, dental crowding and rotation, unilateral or bilateral posterior crossbite, with a

reduction in arch perimeter and negative space [1,2].

Managing maxillary transverse discrepancy in adults represents a challenge to orthodontists and surgeons [3]. In these patients, attempts at orthopedic rapid maxillary expansion are frequently associated with significant problems due to the increased resistance of maxillary articulations [3,4,5]. It is generally accepted that rapid palatal expansion without surgical assistance is only clinically successful until age 14 to 16. After this age, due to skeletal maturation, surgical intervention is necessary to achieve the desired results in the treatment of transverse discrepancies [3].

Determining the necessity for surgery in a maxillary transverse-deficient patient requires an initial evaluation of the existence and severity of the discrepancy and differentiation between the skeletal and dental components of the deformity [6]. Many cases exist in which teeth are compensated and although the occlusion appears to be normal, there is a transverse deficiency present. Anteroposterior skeletal discrepancies can also exaggerate or mask the maxillary transverse deficiency [7]. An accurate diagnosis should involve clinical, radiographic and casts models evaluations [2].

There are currently three surgical treatment possibilities for maxillary

Fig. 1 Patient 14 intraoral condition: severely crowded teeth, bilateral posterior crossbite and midline deviation

Fig. 3 Accentuated diastema during the expansion

expansion: Surgically Assisted Rapid Maxillary Expansion (SARME), segmental Le Fort I osteotomy, and, more recently, transpalatal distraction [3,5]. Each procedure has its benefits and disadvantages. When making treatment decisions, patient morbidity and the ability to achieve stable and predictable results with minimal disruption of routine activities should be the deciding factors in developing a treatment plan [3].

SARME has become a widely used and efficient means to expand the maxilla in skeletal mature patients [8]. However, the diverse osteotomies that have been proposed to facilitate the procedure highlight the fact that no consensus has been reached about the minimum osteotomy required to achieve maxillary expansion [8,9].

The aims of this study were to evaluate the efficiency of the osteotomies used in surgically assisted maxillary expansion according to a defined protocol used in our hospital, analyze the complications of this technique and make a subjective evaluation of the potential improvements in nasal breathing.

Material and methods

This study was conducted with Ethics Committee of Pontifícia Universidade Católica do Paraná approval. A retrospective study was conducted of maxillary transverse deficiency cases who were surgically treated in the Oral and Maxillofacial department of fractures XV hospital in Curitiba, Paraná, Brazil, from

Fig. 2 Intraoperative view showing the osteotomies and the interincisive diastema

Fig. 4 Final interocclusal relationship

2003 to 2006. Fourteen patients (five males and nine females) averaging 33.5 years old (ranging from 22 to 54), who opted for surgical intervention were referred by their orthodontists with maxillary transverse deficiency associated or unassociated with other dentofacial malformations.

Preoperative evaluation

In addition to the customary health questionnaire, all patients were questioned about nasal breathing difficulty and all medical information was noted in their medical records.

Twelve of the fourteen analyzed patients complained of breathing difficulties before operation. This difficulty ranged from moderate (obstruction of one of the nostrils) to severe (obstruction of both nostrils), as seen in Table 1.

The diagnosis was established through clinical and dental cast analyses. Lateral cephalograms were used to evaluate any associated postero-anterior deformities and periapical X-rays of the central incisors were also used to evaluate the space between the roots. One patient had a unilateral transverse deficiency and in the others, the deformity was bilateral (Fig. 1).

Surgical technique

All patients were treated with an expansion Hyrax appliance (Dental Morelli, São

Paulo, Brazil) bonded to the first maxillary premolars and first molars, five days before surgery. When first premolars or first molars were absent, the adjacent teeth were used.

The surgery was performed under general anesthesia and nasotracheal intubation. After carrying out intra- and extra-buccal antisepsis with a polyvinyl pyrrolidone iodine topical solution, the local anesthetic solution was infiltrated (Marcaine 0,5% 1:200.000 epinephrine) along all of the maxillary buccal mucosa in order to obtain local vessel constriction, thus reducing the bleeding and facilitating the surgical procedure.

Five minutes after the infiltration, an incision was made bilaterally in the vestibule from the right first molar to the left first molar. Mucoperiosteal flaps were raised and bone readings were performed to avoid damage to the teeth roots during the osteotomies. Then, after locating the points 25 mm above the molars' occlusal plane and 35 mm above the canines' incisal edge, the osteotomies were carried out under continuous sterile distilled water irrigation.

A modified Le Fort I osteotomy was performed, not including the separation of the pterygomaxillary suture and down-fracture. In conjunction, a sagittal palatal osteotomy was carried out, running from the midline of the alveolar bone, between the central incisors, to the posterior nasal spine (Fig. 2). At this time, the osteotomy was finalized with a delicate chisel to avoid injuries to the incisor roots and soft tissues. For the patient with the unilateral transverse deficiency, the osteotomy was carried out on one side of the maxilla in conjunction with the sagittal palatal osteotomy.

After the osteotomies, the Hyrax appliance was activated to obtain maximum aperture and diastema formation in order to analyze the symmetric expansion of the two maxillary halves. This procedure was followed by immediate regression of the appliance and suture of the wounds.

The appliance was not activated during the first five postoperative days to allow for capillary healing across the osteotomy area and also for the patient to feel more comfortable. Reestablishment of this blood supply should lead to earlier and more complete ossification of the expanded defect according to Ilizarov's work [10]. After this period, the orthodontist initiated the expansion by effecting a 0.25 expansion ($\frac{1}{4}$ turn). The patient was instructed to perform a $\frac{1}{4}$ turn every 12 hours (Fig. 3). Weekly evaluations were performed until

the planned expansion was achieved. After that, the appliance was kept in place for six months on average (range from 4–7 months), to allow the bone mineralization to occur and thus improve the stability of the procedure. One year after the desired expansion was achieved, the dental casts were repeated for each patient. After the desired orthodontic movement was attained, the fixed appliances were removed (Fig. 4) and a final complete orthodontic documentation was completed.

Technical evaluation method

Using a digital sliding caliper, the maxillary transarch width was measured on the study models between the right and left canines and first molars. The points used for the measurements were on the mesio-palatal surfaces of these teeth.

Four parameters were analyzed:

- Achievement of the desired occlusion through the post-expansion occlusion analysis.
- The amount of expansion, as evaluated by the measurements mentioned above.
- The improvement of the nasal condition by noting in the medical records whether or not the patient showed improvements in nasal breathing.
- Intraoperative and postoperative complications.

Results

Achievement of the desired expansion

All palatal expansions were carried out according to pre-surgical planning so that a level of expansion was achieved that completely corrected the crossbite, and resulted in the desired final occlusion for all patients.

Degree of expansion

In the canine area, the mean expansion was 5.46 mm, ranging from 2.66 mm to 8.89 mm (Table 2).

In the first molars, the mean expansion area was 5.93 mm, ranging from 3.11 mm to 8.44 mm (Table 3).

Nasal breathing

After surgery and at the end of the expansion period, all patients [12] that had

Table 1 Breathing difficulty complaint

Patient	Nasal breathing difficulty
1	Severe
2	No complaint
3	Moderate
4	Severe
5	Severe
6	Moderate
7	Moderate
8	Severe
9	Moderate
10	No complaint
11	Moderate
12	Moderate
13	Severe
14	Moderate

Moderate: obstruction of one of the nostrils

Severe: obstruction of both nostrils

Table 2 Maxillary expansion in the canines area

Patient	Canines pre-surgical	Canines post-surgical	Total expansion
1	26.63 mm	34.50 mm	7.87 mm
2	30.13 mm	33.93 mm	3.80 mm
3	25.23 mm	30.24 mm	5.01 mm
4	21.61 mm	30.50 mm	8.89 mm
5	25.16 mm	27.82 mm	2.66 mm
6	29.36 mm	32.79 mm	3.43 mm
7	23.40 mm	28.44 mm	5.04 mm
8	24.67 mm	32.00 mm	7.33 mm
9	23.94 mm	27.99 mm	4.35 mm
10	22.50 mm	27.38 mm	4.88 mm
11	24.62 mm	27.43 mm	2.81 mm
12	26.60 mm	35.00 mm	8.40 mm
13	22.70 mm	28.90 mm	6.20 mm
14	25.03 mm	30.89 mm	5.86 mm

Table 3 Maxillary expansion in the first molars area

Patient	First molars pre-surgical	First molars post-surgical	Total expansion
1	34.95 mm	39.00 mm	5.95 mm
2	45.40 mm	48.51 mm	3.11 mm
3	41.80 mm	48.70 mm	6.90 mm
4	38.56 mm	47.00 mm	8.44 mm
5	37.80 mm	45.67 mm	7.87 mm
6	46.61 mm	52.47 mm	5.86 mm
7	45.50 mm	50.63 mm	5.13 mm
8	45.78 mm	52.13 mm	6.35 mm
9	47.68 mm	53.45 mm	5.77 mm
10	45.00 mm	51.63 mm	6.63 mm
11	43.17 mm	46.72 mm	3.55 mm
12	37.83 mm	42.50 mm	4.67 mm
13	41.00 mm	47.06 mm	6.06 mm
14	43.60 mm	50.35 mm	6.75 mm

previous complaints about breathing problems experienced improvement in nasal breathing.

Complications

Intraoperative complications were limited to one Hyrax appliance deformation. Two patients had minor postoperative complications that included wound dehiscence, gingival recession and pain.

Discussion

A review of literature on transverse maxillary deficiency revealed that great controversy exists in the treatment of this deformity, especially concerning the structures that offer the greatest resistance to maxillary expansion and the osteotomies required to achieve the desired expansion.

The previous studies have used varying techniques and they each guarantee their success in obtaining maxillary surgical expansion. Due to the great number of techniques described, the current work was carried out in order to evaluate a less invasive technique that has a low indication of complications, but still guarantees a satisfactory final result in the treatment of maxillary transverse deficiency.

Some authors favor orthopedic expansion in adults, and their studies showed partially satisfactory results in achieving their objectives [11]. However, the great majority of published studies state that this kind of treatment in adults is associated with several problems such as inability to open the midpalatal suture, excessive tipping and buccal root resorption of the anchor teeth, unequal expansion, bending of alveolar bone, periodontal membrane compression, pain and unpredictable relapse [2,4,12–15]. All of the patients of our study were submitted to SARME without a previous attempt of orthopedic expansion.

Some authors [9,12,13,16] favor SARME without pterygomaxillary osteotomies, while others [2,15] believe that pterygomaxillary osteotomies are essential in order to achieve a complete expansion in adults. Due to these clinical inconsistencies, experimental studies like those of Kennedy et al. [4], Shetty et al. [14] and Han et al. [17] have been conducted. However, even in the experimental studies no consensus has been reached. The first study used a variety of osteotomies in monkeys and concluded that

the lateral maxillary osteotomy was the most effective cut. However, in the second study, a photoelastic analog of a skull was used and the authors concluded that all of the bony buttresses of the maxilla generated resistance to the expansion, but the midpalatal suture followed by the pterygomaxillary articulations were the primary anatomic sites of resistance. Han et al. [17] used a three-dimensional finite element model of a maxilla with a Hyrax appliance and applied an expansion force of 6000 grams using the expansion screw, to investigate the displacement and stress distributions during SARME under different surgical conditions. The authors concluded that the combination of a Le Fort I and paramedian osteotomy with pterygomaxillary separation is effective at increasing the expansion of the maxilla with lower side effects caused by excessive stresses around the anchor teeth.

SARME has been an integral part of orthodontic therapy for many years as adequate transverse dimension is crucial in the achievement of a stable and functional occlusion. Currently, there is a consensus in the oral and maxillofacial surgery community that less invasive techniques should be developed. The goal is to have minimal tissue trauma, with few or no complications, resulting in a less painful and much better postoperative period for the patient. The present study indicates that it is possible to achieve the desired expansion without the pterygomaxillary osteotomies. The technique used was found to be favorable compared to the widening and stability achieved in other reports in which less invasive osteotomies were used [9,12,13,16].

Avoiding the pterygomaxillary suture makes this procedure acceptable for outpatient use, because the chance of intraoperative and postoperative bleeding is minimal [6]. Some studies have even proposed the possibility of office-based surgery [6,12,16]. Although the technique is feasible on an outpatient basis under intravenous sedation and local anesthesia, our protocol recommends general anesthesia in order to make the patient more comfortable and to decrease surgery time. However, the financial costs of general anesthesia and hospitalization can sometimes influence the decision of whether or not to undergo SARME, and the possibility of managing SARME in the office setting remains a question that is frequently asked by surgeons [16].

In the study, the expansion average in the canine area was 5.46 mm, with a

minimum of 2.66 mm and a maximum of 8.89 mm. In the molar area, the average expansion was 5.93 mm, with minimal expansion of 3.11 mm and a maximal expansion of 8.44 mm. These results were quite close to those presented in a previous study [6]. However, we believe comparing the amounts of expansion is not relevant, as transverse needs vary from case to case. The most important outcome that should be evaluated is that adequate expansion was achieved to correct the crossbites in all patients and that they all remained stable one year later.

The improvement in nasal breathing of the twelve patients that complained of breathing problems prior to the surgery is in agreement with the data obtained in other studies [9,18,19]. Subjective evaluation of nasal breathing was also performed by Ribeiro Júnior et al. [20] who revealed that 60% of his patients that underwent SARME reported improved nasal breathing.

Ramires et al. [21] concluded in their non-systematic literary review about nasal cavity changes and the respiratory standard after maxillary expansion that pre- and postmaxillary expansion anteroposterior radiographs provide concrete data that make it possible to visualize the skeletal changes in the nasal cavity inherent to maxillary expansion. Nasal cavity width was found to increase and nasal resistance decreased after maxillary expansion, which results in improved nasal breathing. However, maxillary expansion for the sole purpose of increasing nasal permeability cannot be justified [18]. There is wide variation in individual responses to SARME and this procedure does not necessarily predict a reduction in nasal airflow resistance [21].

When analyzing the risks associated with SARME, most of the complications routinely encountered are fairly minor, reflecting the low morbidity of the procedure. However, the surgery is not free of risks and complications that have been reported in the literature include infection, hemorrhage, periodontal problems, devitalization of teeth, pain and neurological sequelae [3,22,23]. Complications may also arise due to the expansion appliance, including breakage or loosening of the appliance, stripping or locking of the screw and impingement of the palatal soft tissue causing tissue necrosis [24].

When pterygomaxillary and/or lateral nasal osteotomy and nasal mucoperiosteal dissection are not performed, the risk of an intra- or postoperative hemorrhage is very

low [3,6,9]. In our study, none of the patients experienced hemorrhaging. Cases of major bleeding in maxillary surgery, like the one presented by Mehra et al. [22], frequently involve pterygomaxillary separation, being the terminal branches of the maxillary artery, especially the descending palatine or sphenopalatine arteries, the posterior superior alveolar artery and the pterygoid venous plexus the most common sources of hemorrhage.

Wound dehiscence and gingival recession occurred in one patient whose periodontal condition was already significantly compromised before surgery. Another wound dehiscence occurred in a diabetic patient. All of the patients had adequate space between the roots of the central incisors before surgery and had symmetric separation of the midpalatal suture. Preserving bone support along the entire length of each root prevents periodontal complications in this area [3]. When this space is inadequate, diverging the roots of the central incisors before surgery is recommended.

One patient, the same with compromised periodontal condition, complained about severe pain during the expansion and, in this case, the expansion was conducted with only ¼ turn daily. This solution was enough to relieve his pain.

One patient had his appliance deformed during the surgery. According to Betts et al. [2], appliance deformation occurs due to solder overheating during fabrication. In this case, a new appliance was cemented after hospital discharge.

Rare symptoms that have been reported following SARME, such as temporary partial paralysis of the oculomotor nerve [23] and bilateral lingual anesthesia [24], were not observed in our study.

Conclusion

Based on the casuistics of this study, the surgical protocol used is adequate for the treatment of maxillary transverse deficiency, and the final desired interocclusal relationships were achieved in all patients. Pterygomaxillary osteotomy is not essential to allow maxillary expansion. The morbidity is low with fairly minor complications, and SARME does improve nasal breathing.

References

- Berretin-Felix G, Yamashita RP, Filho HN, et al. (2006) Short- and long-term effect of surgically assisted maxillary expansion on nasal airway size. *J Craniofac Surg* 17(6): 1045–1049
- Betts NJ, Vanarsdall RL, Barber HD et al. (1995) Diagnosis and treatment of transverse maxillary deficiency. *Int J Adult Orthodon Orthognath Surg* 10(2): 75–96
- Vandersea BA, Ruvo AT, Frost DE (2007) Maxillary transverse deficiency – surgical alternatives to management. *Oral Maxillofac Surg Clin North Am* 19(3): 351–368
- Kennedy JW 3rd, Bell WH, Kimbrough OL, James WB (1976) Osteotomy as an adjunct to rapid maxillary expansion. *Am J Orthod* 70(2): 123–137
- Pinto PX, Mommaerts MY, Wreakes G, Jacobs WV (2001) Immediate postexpansion changes following the use of the transpalatal distractor. *J Oral Maxillofac Surg* 59(9): 994–1000
- Bays RA, Greco JM (1992) Surgically assisted rapid palatal expansion: an outpatient technique with long-term stability. *J Oral Maxillofac Surg* 50(2): 110–113
- Will LA (1995) Transverse maxillary deformities: diagnosis and treatment. *Selected Readings in Oral and Maxillofacial Surgery* 5: 1–28
- Anttila A, Finne K, Nisula KK et al. (2004) Feasibility and long-term stability of surgically assisted rapid maxillary expansion with lateral osteotomy. *Eur J Orthod* 26(4): 391–395
- Goldenberg DC, Alonso N, Goldenberg FC et al. (2007) Using computed tomography to evaluate maxillary changes after surgically assisted rapid palatal expansion. *J Craniofac Surg* 18(2): 302–311
- Ilizarov GA (1990) Clinical application of the tension-stress effect for limb lengthening. *Clin Orthop Relat Res* 250: 8–26
- Handelman CS, Wang L, BeGole EA et al. (2000) Nonsurgical rapid maxillary expansion in adults: report on 47 cases using the Haas expander. *Angle Orthod* 70(2): 129–144
- Glassman AS, Nahigian SJ, Medway JM et al. (1984) Conservative surgical orthodontic adult palatal expansion: sixteen cases. *Am J Orthod* 86(3): 207–213
- Lehman JA Jr, Haas AJ, Haas DG (1984) Surgical orthodontic correction of transverse maxillary deficiency: a simplified approach. *Plast Reconstr Surg* 73(1): 62–68
- Shetty V, Caridad JM, Caputo AA et al. (1994) Biomechanical rationale for surgical-orthodontic expansion of the adult maxilla. *J Oral Maxillofac Surg* 52(7): 742–749
- Byloff FK, Mossaz CF (2004) Skeletal and dental changes following surgically assisted rapid palatal expansion. *Eur J Orthod* 26(4): 403–409
- Marin C, Gil JN, Lima SM Jr (2009) Surgically assisted palatine expansion in adult patients: evaluation of a conservative technique. *J Oral Maxillofac Surg* 67(6): 1274–1279
- Han UA, Kim Y, Park JU (2009) Three-dimensional finite element analysis of stress distribution and displacement of the maxilla following surgically assisted rapid maxillary expansion. *J Craniomaxillofac Surg* 37(3): 145–154
- Wertz RA (1968) Changes in nasal airflow incident to rapid maxillary expansion. *Angle Orthod* 38(1): 1–11
- Wriedt S, Kunkel M, Zentner A et al. (2001) Surgically assisted rapid palatal expansion: an acoustic rhinometric, morphometric and sonographic investigation. *J Orofac Orthop* 62(2): 107–115
- Ramires T, Maia RA, Barone JR (2008) Nasal cavity changes and the respiratory standard after maxillary expansion. *Braz J Otorhinolaryngol* 74(5): 763–769
- Ribeiro Júnior PD, Gonçalves ES, Souza PCU, Nary Filho H, Luz JGC (2006) Clinical evaluation of surgically assisted maxillary expansion (SAME). *Rev Dent Press Ortod Ortop Facial* 11: 44–59
- Mehra P, Cottrell DA, Caiazzo A, Lincoln R (1999) Life-threatening, delayed epistaxis after surgically assisted rapid palatal expansion: a case report. *J Oral Maxillofac Surg* 57(2): 201–204
- Lanigan DT, Mintz SM (2002) Complications of surgically assisted rapid palatal expansion: review of the literature and report of a case. *J Oral Maxillofac Surg* 60(1): 104–110
- Chuah C, Mehra P (2005) Bilateral lingual anesthesia following surgically assisted rapid palatal expansion: report of a case. *J Oral Maxillofac Surg* 63(3): 416–418