Piezoelectric Osteotomies for Outpatient Rapid Palatal Expansion

John P. Schmitz, D.D.S., Ph.D., private practice, San Antonio; and Chris J. Megna, D.D.S., Professor, Department of Orthopaedics, UTHSCSA, San Antonio

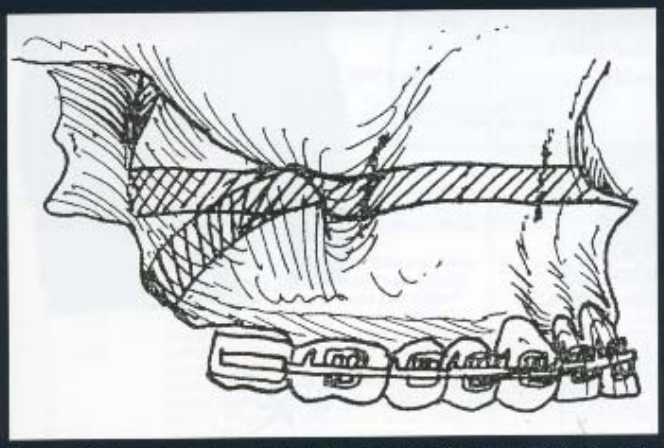

Figure 1. Schematic drawing depicting the direction of the lateral maxillary osteotomies for RPE. The upper horizontal osteotomy is the conventional approach used for LeFort I osteotomy. The lower osteotomy is the osteotomy for RPE.

Introduction

Surgically-assisted rapid palatal expansion (RPE) has been an integral part of surgical orthodontic care for over 30 years (1). RPE is indicated when the maxillary transverse hypoplasia is greater than 5 mm or when maxillary expansion is desired in a patient whose age is greater than 15.5 years (2). This procedure exploits distraction osteogenesis principles to mechanically expand the maxilla using a fixed palatal expander. Osteotomies are typically made in a manner similar to that used for a LeFort I approach and may involve any combination of the anterior and lateral maxilla, the midline of the palate between the central incisors, and at the pterygomaxillary buttress (Figure 1). After a short latency period, lateral maxillary distraction forces are applied via the palatal expander at a rate of 0.5 – 1.0 mm per day with a rhythm of twice a day until the desired expansion is achieved.

Completing the bone cuts in conventional maxillary orthognathic surgery is technique sensitive, and rotary and reciprocating saws are used to complete bone cuts above the roots of teeth, between teeth, and through dense structures such as the pterygomaxillary fissure and lateral wall of the nose.

Because the principal blood supply to areas where maxillary osteotomies are done is from the palatal vessels, damage to the palatal gingiva should be avoided. Conventional instrumentation such as malletting with chisels and rotary and reciprocating saw instrumentation can be disadvantageous in several ways. First, they can produce excessive heat during the osteotomy, causing osteonecrosis and delaying healing. Second, they can damage soft tissues by lacerating gingiva and potentially impeding blood supply to the segments or causing excessive bleeding. Third, they can deliver vibrations to the adjacent bone causing fracture of the thin bone adjacent to the osteotomy. Finally, the use of noisy reciprocating saws and the forces required during malletting with chisels lead to performing the procedure for a patient under general anesthesia in a hospital or surgical center.

Piezoelectric bone surgery is a new technology for osseous bone surgery. It was introduced by Vercellotti to overcome issues associated with rotary and saw bone surgery [3]. Piezosurgery uses piezoelectric ultrasonic vibrations to cut osseous tissues using a variety of tip inserts (saws and diamonds). Although originally initiated for periodontal and implant applications, its use is expanding into orthognathic and maxillofacial indications [4–6]. A case is presented here using an ultrasonic bone surgery system to perform RPE surgery for an outpatient using IV anesthesia.

Methods

A 41-year-old patient presented for surgical-orthodontic evaluation with a significant maxillary transverse hypoplasia (Figure 2). Complete crossbite of the maxillary posterior teeth and openbite were present. Because of the adult status as well as the significant transverse hypoplasia, an RPE was planned using the piezosurgery device to complete a midline and lateral release of the maxilla and then a fixed palatal expander to distract the maxilla laterally. The mandible was bowed transversely in the molar region and mandibular orthodontic narrowing was to be attempted after expansion in this region.

This procedure was carried out in the office using IV anesthesia (midazolam, fentanyl, and a propofol-ketamine infusion via syringe pump).

Figure 2. Preoperative clinical photograph depicting the severity of maxillary transverse hypoplasia.

Piezoelectric Osteotomies, continued

Figure 3. Lateral nasal wall osteotomy was performed using the Piezosurgery saw insert.

Figure 4. A round diamond insert is used to r educe the anterior nasal spine.

Figure 5. View of the lateral maxillary wall osteotomy. Note the release at the posterior 1.5 cm to insure the absence of interferences during expansion.

After satisfactory attainment of maxillary local anesthesia, a full-thickness mucoperiosteal incision using a #15 blade was made from one maxillary first molar to the opposite maxillary first molar. A full-thickness flap was developed to expose the piriform aperture and carried to 1 cm above the roots of the maxillary teeth. The zygomatic buttress and posterior maxillary region was exposed to the pterygomaxillary fissure. A periosteal elevator was used to dissect the nasal mucosa from the lateral nasal walls, posteriorly along the nasal floor, and interdentally between the central incisors to the crest of the alveolus. A septal chisel was used to release the nasal septum from the floor of the nose. The Mectron Piezosurgery System (Mectron, Matawan, NJ) device using an saw insert (OT6 tip) at a bone quality 1 setting with the pump irrigation on 2 was then used to make a horizontal osteotomy from the piriform aperature to the zygomatic buttress (Figure 3). The osteotomies were made bilaterally.

The round diamond blade insert (OP4 tip) was then used to complete the osteotomies posteriorly and inferiorly to the pterygoid plates. No attempt was made to separate the pterygoid plates with a chisel. The OP4 tip was also used: 1) to relieve posterior and septal interferences; 2) to widen the lateral osteotomies for 1–1.5 cm at the zygomatic buttresses; 3) to recontour the nasal spine; and 4) to section the lateral nasal walls for 1.5 cm (Figures 4, 5). An angulated saw insert (OT 6L

Figure 6. The midline osteotomy completed from the floor of the nose to the alveolar crest between #8 and 9.

Figure 7. A chisel is used to mobilize the left and right hemimaxillas. Note the small midline diastema between #8 and 9.

tip) was used to create an interdental osteotomy between the central incisors completely through to the palatal gingiva and then carried superiorly through the anterior nasal spine and anterior floor of the nose (Figure 6). An Obwegeser chisel was used to mobilize the maxilla at the zygomatic buttresses and to insure that the left and right sides of the maxillary were independently mobile (Figures 7, 8). The palatal expansion device was then turned until a 1 mm diastema appeared between the central incisors. After a 5 day latency period, the expander was turned 0.5 mm twice a day until the desired expansion was achieved (Figure 9).

Discussion

The Mectron Piezosurgery System device is capable of doing multiple things including: osteotomy, osteoplasty, lateral sinus wall osteotomy, bone harvesting, and root planning. It uses an internally-irrigated handpiece to deliver an ultrasonic frequency of 25–29 kHz with digital modulation up to 30 kHz to the tip. A variety of insert tips is available depending on the indication. These tips function primarily in a linear vibration pattern with a spatial range between 60 and 210 micrometers (7). Overall the device is three times more powerful than conventional ultrasonic instruments, and it is capable of cutting bone. Because of these features, the Piezosurgery device recognizes the hardness of mineralized tissues and will not cut soft tissue (gingiva, mucosa, or nerve) making it

Figure 8. Completion of all maxillary osteotomies from the lateral nasal walls through the zygomatic buttresses.

Figure 9. Occlusal view of the expanded maxilla. The anterior diastema between #8 and 9 is 9 mm.

highly desirable for delicate maxillofacial procedures involving neurosensory structures.

Bays and Greco were among the first advocates of outpatient RPE using IV sedation (8). They performed osteotomies of the lateral maxilla, lateral nasal wall, and midpalatal suture using reciprocating saws and chisels. No pterygomaxillary separation was achieved and all cases expanded without complications. The absence of the need to seperate the lateral pterygoid plates in RPE surgery was again substantiated by Vasconcelos. Robiony first used piezoelectric bone surgery for multisegment maxillary osteotomies. They validated the precision of micrometric bone cuts and the safety of this technology for orthognathic surgery (7, 9).

Conventional surgical techniques for RPE rely on surgery under outpatient general anesthesia (usually in a hospital or outpatient surgical center) to perform a modified LeFort I, two-piece osteotomy. The osteotomies are performed using a reciprocating saw and malletting with chisels to release the anterior and lateral maxilla, the midline of the palate between the central incisors, and the pterygomaxillary buttresses. The maxilla is not downfractured. Releasing the pterygoid plates can produce significant bleeding and has the potential to cause fracturing of the lateral maxillary wall due to vibrations transmitted to the thin bone by reciprocating saws and chisels.

Piezosurgery has many advantages compared to the conventional technique. First, ultrasonic cutting performs all the osteotomies; there is no need for reciprocating power instrumentation or chisels. Chisels are only used to confirm the depth of the cuts and to mobilize segments without malletting. Because there is less vibration, the tactile feel when cutting with the piezosurgery saws is much greater. Additionally, since there is no reciprocation chatter from a an electric reciprocating saw, fracturing of the anterior maxillary wall does not occur. Second, the piezosurgery device will not cut soft tissue. Third, the cuts between the central incisors are easily made and more precise. This is because the piezosurgery blade is only 0.55 mm thick (as opposed to a reciprocating saw of 1 mm). Fourth, there is reduced bleeding secondary to the cavitational effects of the piezosurgery device. Finally, the ease with which the cuts can be made (no reciprocating saw or malletting) makes this more conducive to RPE surgery's being an office procedure using IV anesthesia.

Conclusion

The Mectron Piezosurgery instrument is new surgical technology with several advantages compared to conventional rotary and reciprocating saw cutting power. Its introduction makes RPE surgery easily performed in the office using IV sedation. Modification of the surgical technique to exclude separation of the pterygomaxillary buttress reduces the intra-operative and postoperative bleeding and allows patient discharge without the concern for serious bleeding.

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