Osteotomy of the Nasal Wall Using a Newly Designed Piezo Scalpel—A Cadaver Study

Alireza Ghassemi, MD, DDS, PhD,* Andreas Prescher, MD, PhD, † Mohammad Talebzadeh, DDS, ‡ Frank Hölzle, MD, DDS, PhD, § and Ali Modabber, MD, DDS, PhD‖

Purpose: Achieving the desired outcome in rhinoplasty depends on many factors. Osteotomy and adjustment of the lateral nasal wall are important steps that necessitate careful planning and execution. A cadaver study was performed to evaluate the osteotomy result obtained with a newly designed piezoelectric-based scalpel.

Materials and Methods: Twenty lateral osteotomies of the nasal wall were performed in 10 human cadaver noses. The osteotomies were conducted in 6 female and 4 male cadavers (age range, 65 to 83 yr; mean age, 74.8 yr). A specially designed Piezosurgery-based scalpel was used endonasally to perform the lateral osteotomy. Cutting of the bony nasal wall was performed subperiostally along the planned osteotomy route under tactile control. Digital infracturing was accomplished by applying gentle pressure. After completing the osteotomy, the osteotomy line and nasal mucosa were examined endoscopically. The skin cover was removed to examine the lateral bony nasal wall for the shape and amount of bone fragments, the osteotomy path, and mucosa involvement.

Results: Using the Piezosurgery-based scalpel required a learning curve, but the handling was easy. It allowed an exact performance of the osteotomy and caused no mucosal tearing. If excessive force was used, the piezo tip stopped working. There was no comminuted fracture pattern and the lateral nasal wall remained in 1 piece. The duration of the osteotomy was 5 to 10 minutes on each side.

Conclusion: The piezoelectric-based scalpel is a useful tool, which can be used to perform osteotomy of the nasal wall. In addition, this specifically designed tool tip allows an endonasal approach, is easy to handle, and allows effective irrigation of the osteotomy region.

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A significant yet difficult contributor to operative success in rhinoplasty is shaping the underlying nasal bony structures.1,2 Depending on the deformities presented, different osteotomy techniques—lateral, medial, and transverse—can be indicated to achieve the desired esthetic and functional outcome.3 Two different approaches—endonasal and percutaneous—with corresponding instruments have been developed to make this step predictable, less traumatic, easy to perform, and controllable.2,4,5 Nevertheless, every technique has its advantages and disadvantages, and osteotomy can cause soft tissue injury, irregularity of the bony lateral wall, a comminuted fracture pattern, and, as sequels, prolonged postoperative edema and ecchymosis and functional nasal obstruction with an undesired esthetic and functional outcome.2,5,7 Soft

*Assistant Professor, Department of Oral, Maxillofacial, and Plastic Facial Surgery, University Hospital RWTH-Aachen, Aachen, Germany.
†Assistant Professor, Institute of Anatomy, Medical Faculty of RWTH-Aachen, Aachen, Germany.
‡Resident, Department of Oral, Maxillofacial, and Plastic Facial Surgery, University Hospital RWTH-Aachen, Aachen, Germany.
§Head and Chairman, Department of Oral, Maxillofacial, and Plastic Facial Surgery, University Hospital RWTH-Aachen, Aachen, Germany.
‖Senior Resident, Department of Oral, Maxillofacial, and Plastic Facial Surgery, University Hospital RWTH-Aachen, Aachen, Germany.

Address correspondence and reprint requests to Dr Ghassemi: Pauwelsstr 30, 52074 Aachen, Germany; e-mail: aghassemi@ukaachen.de
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Tissue trauma may contribute to destabilization, hemorrhage, and prolonged postoperative ecchymosis and edema. The nasal skin is very thin and any nasal wall irregularity from a comminuted fracture and irregular-shaped bony fragments will be apparent.8,9

Horton et al10,11 introduced piezo surgery in alveolar bone surgery in 1975, using the piezoelectric ultrasonic vibration for gentle cutting of the bone. They reported better bone healing of the bony fragments when using piezo surgery. Subsequently, additional uses were introduced, such as cutting a bony window in the maxillary sinus wall to perform sinus augmentation or to perform orthognathic surgery.10-16 In 2007, Robiony et al17 suggested this technique for nasal osteotomy. This device cuts the bone micrometrically using ultrasonic piezoelectric vibration, and it can be adjusted by changing the frequency and cutting power. It has proved a useful tool for cutting thin bone with precision, causing minimal damage to soft tissue and avoiding osteonecrosis.18 Since then, the technique has improved rapidly and has extended its indication.12

This anatomic study was undertaken to perform osteotomy of the nasal wall with a newly designed piezo scalpel. The degree of difficulty of performing osteotomy was evaluated using this scalpel through an endonasal approach. In addition, the effectiveness of the cooling capacity, the condition of the osteotomy path, the amount and shape of bony fragments, and mucosal injuries were examined.

Materials and Methods

Ten human cadaver heads were used for performing lateral osteotomy (age range, 65 to 83 yr; mean age, 74.8 yr; gender distribution, 4 male and 6 female). One experienced rhinoplasty surgeon, who was familiar in applying the Piezosurgery device (Mectron Medical Technology, Carasco, Italy), performed the osteotomies through an endonasal approach. A specially designed piezo scalpel was used to dissect a tunnel and to perform the osteotomy (Figs 1, 2). In addition, irrigation with internal cooling and a flow of 40 mL/min was used to avoid heating the bone. The coolant was transferred to the osteotomy area through a hole at the end of the tool tip (Fig 2).

The mucosa was incised along the lower edge of the pyriform aperture for about 3 mm to access the bony lateral wall. A special tool tip was used as a periosteal elevator to create a subperiosteal tunnel around the pyriform aperture along the planned osteotomy path, as marked on the skin (Fig 3). The piezo scalpel was inserted into this tunnel and the osteotomy was performed along the osteotomy path under digital control. After accomplishing the endonasal cutting of the bony lateral nasal wall, 3 independent examiners (excluding the surgeons) who were blinded to the technique inspected the intranasal cavities of all cadavers on each side with a 4-mm 30° rigid endoscope (Karl Storz GmbH & Co KG, Tuttingen; Germany). They looked for lacerations of the nasal mucosa. Then, the nasal pyramid was infractured digitally on each cadaver. The soft tissue envelope was removed after infracturing to evaluate the condition of the osteotomy line and the size, shape, and amount of the bony fragments. Special inspection was performed for contour irregularities, bony spur or spicules generated, and greenstick infracture characteristics. This step was followed by an intranasal examination to explore the nasal mucosa.

Results

Altogether, 20 lateral osteotomies were performed in human cadaver specimens. The osteotomy path was marked on the skin (Fig 3). It was easy to cut through the bony wall all the way along the osteotomy line by digitally controlling the piezo inset (Figs 1, 2). Because of the learning curve, 10 minutes was required for the first nose and 7 minutes was required for the second nose. For the next 8 noses, approximately 5 minutes was required. For continuous cutting, the scalpel should be moved along the bone...
surface by applying gentle pressure. This is sufficient to cut partly or completely through the bone, as indicated. As soon as any extensive force was exerted, the piezo stopped working. Near the nasal root, cutting the bone required more time. At the end of piezo surgery, digital infracturing could be performed by applying gentle pressure and no forceful manipulation was necessary.

All examiners independently recorded identical findings from their separate endoscopic examinations.
and from the condition of the lateral nasal wall. None of the cadavers exhibited perforation of the nasal mucosa (Fig 4). The examiners recorded 1 complete nasal wall on each side, with small irregularities resembling the tooth of the piezo scalpel. There was minimal loss of bone material along the osteotomy line (Fig 5).

Discussion

Successful rhinoplasty is the result of controlled changes in the nasal framework and its soft tissue cover. Alterations and shaping of the nasal bony structure present an ongoing challenge in esthetic and reconstructive surgery. Numerous lateral osteotomy techniques evolved in the previous century, incorporating the use of different instruments from the saw to the chisel to the diamond. Various modifications of available techniques have been introduced to rhinoplasty surgery to increase ease of performance, precision, controllability, and reliability, on the one hand, and reproducibility with low morbidity, on the other.

Despite the many previously described methods, it remains difficult to perform osteotomies in such a way as to provide esthetically pleasing and reliable results. Lateral osteotomy is associated with an increase in hemorrhage, edema, and ecchymosis. This has been substantiated by other studies and can contribute significantly to postoperative morbidity after rhinoplasty. Perforated lateral osteotomy preserves the support of the periosteum and is supposed to decrease lateral nasal wall collapse and minimize hemorrhages and edema. However, this method is suspected of causing comminuted fractures with irregular bony fragments, which can cause postoperative esthetic deformity. The perforating technique is reliable only in the hands of an experienced surgeon, because it is difficult to direct and may need repeated passes. Murakami and Larrabee found more irregular osteotomies and more soft tissue trauma when using the percutaneous approach, and they preferred building a subperiosteal tunnel and using an adequate technique to ensure proper stability. In a cadaver study, Kuran et al evaluated fracture line and mucosal injuries. They found that a wide osteotome causes significantly more mucosal injuries.

The piezo scalpel allows the cutting of a bony window into the maxilla without any laceration of the delicate mucosa of the maxillary sinus. Robiony et al introduced the piezo technique in rhinoplasty and emphasized the advantages of this method. They used an external approach to insert the piezo scalpel. Although soft tissue probably will not be lacerated by slight touches, continuous irrigation would be difficult using this approach. Robiony et al reported decreased bleeding during surgery, minor edema, and periorbital ecchymosis immediately after surgery. The Piezosurgery device offers effortless handling and requires very little manual pressure. Moreover, it is an optimal technique for selectively cutting mineralized tissue. It allows the exact placement and control of the tool tip to cut along the desired path using micrometric movement, and the piezo scalpel is armed with a peristaltic pump for irrigation. Although this instrument was originally developed for augmentation surgery in the dentoalveolar field, there are different working tips for currently available indications.

The main purpose of this cadaver study was to evaluate the quality of osteotomy when using the Piezosurgery device. The newly designed piezo scalpel allowed the osteotomy from an endonasal approach and irrigation of the bone through a hole close to the tip of the scalpel (Fig 2). Lateral osteotomy was performed in 10 human cadaver noses (20 lateral walls) according to the technique described earlier. A 3-mm incision in the mobile mucosa of the pyriform aperture and narrow exposure of the osteotomy site were sufficient to easily access the lateral nasal wall. A short learning curve was necessary to become familiar with the procedure. The exposure of bone
surface at the osteotomy site was less extensive than with other methods. The line of osteotomy, which had been marked on the skin along the nasofacial crease, could be palpated and followed exactly through the skin (Fig 3). The hand piece stopped moving if any excessive force was used.22 It should just be guided over the bone gently, as in piezo surgery generally. It does not involve the risk of accidental dislocation of the osteotome and the course of osteotomy can always be followed exactly as planned.22 The sound of the cutting also can help as acoustic feedback to guide the applied force. The infracturing of the bony lateral wall can be accomplished with gentle pressure. The endoscopic examination along the osteotomy line showed a bone ridge with spikes, similar to the tip of the scalpel, but no major irregularity or comminuted fracture (Fig 5). No tear of nasal mucosa was apparent (Fig 4). The average time for incision and preparation was 5 minutes after a learning curve in the first 2 osteotomies. No residual deformity, such as a bony spur, was observed. The lateral nasal wall was observed as a whole bone fragment, with some irregularities of the bone edge caused by the tooth of the piezo tool tip. The osteotomy part of the bone showed signs of adequate irrigation and no sign of heat development. The irrigation flowed through the shaft of the scalpel to the tip. This had an additional cooling effect on the surrounding soft tissue coverage (Fig 2). In some noses, the osteotomy path was osteotomized incompletely. Nevertheless, the infracturing could be performed easily. The resulting osteotomy gap was approximately 0.5 mm.22

Because the use of piezo surgery does not cause any soft tissue injury, minimal hemorrhage and ecchymosis are expected postoperatively, as was shown clinically by Robiony et al.11 The dissection of a narrow subperiosteal tunnel, combined with healthy and unlacerated nasal mucosa, will hinder the collapse of the osteotomized lateral nasal wall and thus decrease postoperative edema and swelling.9 A precise and reproducible lateral osteotomy can be performed, which is the requirement for successful rhinoplasty. It can be controlled transcannicularly to perform the osteotomy in an exact planned course. It makes this step easier to perform and more controllable, with a predictable and consistent result. This promotes faster healing and shortens postoperative hospital stay.9 Because the bone thickness does not exceed 3 mm at any point on the osteotomy lines, piezo surgery is optimal for this procedure.19,25 In addition, there is no need to cut through the entire thickness of the nasal bone to infracture the nasal wall. All kinds of osteotomies, such as transverse, median, paramedian, and hump removal, also can be performed as required. Although there is limited scarring from the percutaneous approach, the concept of an external incision conjures debate when an internal option exists.2 This specially designed piezo scalpel allows an endonasal approach and thus avoids any risk of possible scar formation.

The optimal technique for osteotomy should be safe, precise, and reproducible, with minimal postoperative ecchymosis and edema, and deliver a predictable result. The piezo scalpel is easy to handle and does not cause any mucosa laceration; the osteotomy can be performed exactly in the planned osteotomy track and does not result in any comminuted fractures. It is a nontraumatic and controllable alternative to known osteotomy techniques. A learning curve may be necessary, but it is a straightforward method to learn.

References