The Oscillating Micro-Saw: A Safe and Pliable Instrument for Transverse Osteotomy in Rhinoplasty

Yakup Avşar, MD

Abstract

Background: A low-to-low lateral osteotomy combined with a transverse osteotomy offers a reliable technique to mobilize the lateral walls in patients with broad bony vaults, but variable “brittling” characteristics of the nasal bones near the radix make it difficult to guarantee the result of manual transverse osteotomy.

Objectives: The author describes a split-thickness transverse osteotomy with the aid of an oscillating micro-saw under video/endoscopic control to eliminate the risk of probable pitfall fractures on the structure of the bony nasal vault near the radix during blind manual osteotomy.

Methods: The author reviewed 1550 consecutive rhinoplasty and septorhinoplasty operations performed between April 2005 and October 2010. Among these the transverse osteotomy was used bilaterally in 1374 cases. Split-thickness transverse osteotomy was carried out with a powered micro-saw system from an endonasal approach under video/endoscopic control. CT-based 3D models of 16 patients with different functional indications were used to assess the mean depth of the transverse osteotomy line.

Results: The mean depth of the nasal wall at the thickest point of the transverse osteotomy line near the radix was 2.5 ± 0.66 mm. It decreased toward the medial canthus in all 16 patients. The mean thickness of bone was 1.2 ± 0.21 mm in the medial canthal area.

Conclusions: The oscillating micro-saw is a safe and pliable instrument to aid in transverse osteotomy during rhinoplasty. Video endoscopy provides an excellent view of the osteotomy site, including direction and depth, in addition to providing documentation for and education about the procedure.

Level of Evidence: 4

Keywords
rhinoplasty, transverse osteotomy, endoscopy, split-thickness osteotomy, micro-saw

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Balanced reduction and modification of the bony nasal vault is one of the most important aspects of rhinoplasty. A successful surgery on the bony vault essentially involves stable and controlled mobilization of lateral walls after performing a detailed hump reduction. A low-to-low lateral osteotomy combined with a transverse osteotomy offers a reliable technique to mobilize the lateral walls in patients with broad bony vaults. Internal continuous\textsuperscript{1,2} and external perforation\textsuperscript{3,4} techniques are the 2 most popular osteotomy methods that are used routinely for this purpose; each has specific advantages and disadvantages. The anatomic characteristics of bony vault should always be considered when performing these osteotomies. Variable “brittling” of nasal bones near the radix makes it difficult to ensure a consistent result from manual osteotomies, even for 2 sides of a single patient’s nose. Complications such as the “rocker effect” (lateralization of the most cephalad part of the nasal bone when the caudal end is medialized),\textsuperscript{5} step deformity, or bone fragmentation may be encountered in the area near the radix, which is difficult to access. In the search for a

Dr Avşar is a plastic surgeon in private practice in Istanbul, Turkey.

Corresponding Author:
Dr Yakup Avşar, Güi sokak, No 1, Akatlar, Beşiktaş, Istanbul, 34335, Turkey.
E-mail: yakupavsar@avsarestetik.com

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method to interchange the unwanted fractures with a clear cut, the author found that a specially designed oscillating micro-saw can offer a safe and reliable method for performing osteotomies, even in the case of endonasal approach, under video endoscopy. The author examined models based on computer tomography (CT) of 16 patients (32 lateral walls) to determine the mean depth of the transverse osteotomy line.

METHODOLOGY

The author retrospectively reviewed 1550 consecutive rhinoplasty and septorhinoplasty operations performed between April 2005 and October 2010. Among these, 1374 patients were treated with bilateral transverse osteotomy. Computed tomography (CT)-based, 3-dimensional (3D) models of 16 patients with different functional indications were used to assess the mean depth of the transverse osteotomy line. Endonasal approach was performed in all of these cases.

After completion of soft tissue and subperiosteal bony vault dissection, definitive hump reduction was performed with the aid of powered micro-saw osteotomy (PMSO). Subperiosteal dissection was performed in the field of transverse osteotomy, about 4 to 6 mm lateral from the finishing point of paramedian medial osteotomy. As stated, transverse osteotomy combined with low-to-low lateral osteotomy was required in 1374 cases for mobilization of the lateral walls. All transverse osteotomies were performed with the aid of video endoscopy (Figure 1). A surgical micro-motor system (Bien-Air, Bienne, Switzerland) with autoclavable cables and handpieces was used in all of the manipulations. The oscillating micro-saw—blade of this micro-saw—with its 0.1 mm thickness, 3 mm width, and 3 mm cutting length dimensions—is considered to be among the finest micro-saws in the field of maxillofacial surgery (Figure 2). The irrigation complex design of this micro-saw aided in cooling the surgical field from a distance of 3 mm, with a jet flow of sterile isotonic solution. All transverse osteotomies were planned at the diverging point of the radix (Figure 3). Depending on the bony characteristics of the patients’ noses, the approximate depth of this osteotomy was 1.6 to 2.8 mm and the approximate length was 4 to 6 mm, from the radix halfway toward the medial canthus.

A video of the author’s technique is available at www.aestheticsurgeryjournal.com. You may also use any smartphone to scan the code on the first page of this article to be taken directly to the video on www.YouTube.com.

RESULTS

The age range of the patients was 18 to 65 years. There were 1336 women (86%) and 214 men (14%) included in the study. The average age of the women was 26.2 years; for men, the average age was 27.4 years.
CT-based, 3D models of 16 patients (32 lateral walls) produced by Mimics software (Materialise N.V., Leuven, Belgium), with an accuracy of $-0.62 \pm 0.49 \text{mm}$, were used for measuring the mean depth of the transverse osteotomy. The average depth of the nasal wall at the thickest point of the transverse osteotomy line near the radix was $2.5 \pm 0.66 \text{mm}$. In all patients, this measurement decreased toward the medial canthus. The mean thickness of bone was found to be $1.2 \pm 0.21 \text{mm}$ in the medial canthal area (Figure 4).

The mean long-term follow-up period was 2.3 years (range, 1 to 5.6 years). Direct, long-term follow-up was available for 480 (31%) of patients after 1 year; the rest were surveyed for any complaint via telephone or e-mail. Four hundred seventy-six patients had no problem, and 4 patients (< 1%) presented to the author with complaints about the bony dorsum near the radix. The cause of dissatisfaction in all of these patients was minimal bony prominences; 1 patient underwent reoperation with focal rasping. There were no cases of epistaxis, mucosal tearing, or unusual edema resulting from regional dissection (Table 1).

**DISCUSSION**

Successful dorsal reshaping is dependent not only on definitive hump reduction but also on stable mobilization of the lateral walls. Proper mobilization, stability of the lateral walls, and symmetry are the most important goals when modifying the osseous vault. The symmetry of the vault after mobilization is dependent on equality in the nasal wall dimensions, symmetric bilateral osteotomies, and a straight septum as the middle pole. Any deformity at the septal side can affect the success of lateral wall mobilization.

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**Figure 3.** Illustration of the transverse osteotomy with oscillating micro-saw.

**Figure 4.** CT-based anatomic model of a patient. The cut edges of the lateral nasal wall are shown at the lines of the medial (1), transverse (2), and lateral osteotomies (4). Note the thinnest bony parts at the medial canthal area (3). Piriform aperture (5).

**Table 1. Rate and Treatment Results of Complications After Transverse Osteotomy**

<table>
<thead>
<tr>
<th>Complication</th>
<th>Rate</th>
<th>Treatment</th>
<th>Final Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Epistaxis due to bleeding at transverse osteotomy line</td>
<td>0</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Mucosal tear under transverse osteotomy line</td>
<td>0</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Unusual edema due to the regional extra dissection</td>
<td>0</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Bony prominence near the radix</td>
<td>4</td>
<td>1 (Patient request—surgical rasping)</td>
<td>Full recovery</td>
</tr>
<tr>
<td>Bony depression at the region of transverse osteotomy</td>
<td>0</td>
<td>—</td>
<td>—</td>
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An integral lateral wall is established by performing precise medial, transverse, and lateral osteotomies. The challenge of every practiced surgeon is to keep the stability of lateral walls despite prominent mobilization. Low-to-low lateral osteotomy for prominent lateral wall mobilization is indicated for patients with wide bony vault base. Reliable fracturing that mobilizes the nasal wall between the medial and lateral osteotomies near the radix is perhaps the most complicated aspect of the vault surgery. Connecting these 2 osteotomies has been practiced before with forced finger-pressure green-sticking, but the minimal success in achieving a safe result with that method has led surgeons to perform transverse osteotomies with the aid of either angled medial osteotomes through the internal approach or the transverse external perforation technique.\textsuperscript{1-5,25} Although advantageous in many cases, the presence of structural bony pitfalls near the radix makes it difficult to guarantee the result of these blind procedures, especially in the case of hard bony structures. Possible fragmentation, the “rocker effect,” and step deformities are among the most common complications that any rhinoplasty surgeon may encounter. In the search for a simple, safe, and reliable method of performing these osteotomies, the author designed the novel oscillating micro-saw described in the methods section. Similar indications have been cited in other branches of surgical literature,\textsuperscript{8-17} although no descriptions of this micro-saw for transverse osteotomy have been published in the rhinoplasty literature. The dimensions and the irrigation cooling system of this micro-saw were fully specialized to make it pliable for transverse osteotomy, even in the case of an endonasal approach.

Historically, Guyuron reported successful use of the shielded Burr for deepening of the nasofrontal angle.\textsuperscript{18} Use of a powered saw for mobilization of the lateral walls was reported by Giampapa and DiBernardo in 1993; they used saw blades for low-to-high lateral osteotomies.\textsuperscript{19} In the reports of Becker et al,\textsuperscript{20} Krouse,\textsuperscript{21} Davis et al,\textsuperscript{22} and Lopez et al,\textsuperscript{23} powered instrumentation for nasal hump removal resulted in more precise bone reduction and smoother bone contouring.

The aim of transverse osteotomy is mainly to create a reliable cut at the hard radix area, immediately caudal to the divergence of the lateral nasal walls. This surgically produced cleavage can prevent the undesirable fractures that may be encountered at the transition zone, which continues somewhat caudally in an oblique direction. The apical point of the open roof is almost always finished at

Figure 5. CT-based anatomic model of a patient. (A) Lateral view. (B) Inside view. Black and white lines represent the lines of medial (1), transverse (2), and lateral osteotomies (4). Red dots denote a well-known transition zone.
the beginning of transverse osteotomy after reduction of large and very large humps, without need for any medial osteotomy. In patients who require moderate hump reduction or who have a wide dorsum, there may be a need for paramedian medial osteotomy, and in this case the most cephalad point of the medial osteotomy will be the beginning of the transverse osteotomy (just caudal to the diverging point of the lateral wall near the radix) and no more medial osteotomy is needed toward the dense part of the frontal processes.

Cephalometric analysis based on cadaveric studies, CT-based measurements, and 3-D simulating CT models provide clinically applicable information about the bone thickness of the lateral walls near the radix.\textsuperscript{25-27} CT-based models have high sensitivity in terms of accurately mapping the patient’s anatomy. Age, sex, and race are among the important indicators that influence the varying bone thickness of lateral walls.\textsuperscript{26} The presence of transition zones between the dense and loose bony areas along the lateral walls is the most important factor that influences fracture patterns during nasal osteotomies (Figure 5).\textsuperscript{24} There are few studies regarding quantitative bone thickness details on the lateral wall near the radix. Variation in the protocol of each study relating to the individual

\begin{figure}[h]
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\caption{Endoscopic view of the transverse osteotomy line. (A) Micro-saw on the right nasal bone (R.NB). (B) Transverse osteotomy line (OL). (C) Micro-saw on the left nasal bone (L.NB).}
\end{figure}
indicators and, most important, the lack of a standard point for measuring the transverse osteotomy thickness may be among the factors that influence the emergence of different results. In the cadaveric study of Harshbarger et al, bone thickness was defined as 2.2 to 2.5 mm at the transverse osteotomy line. The mean bone thickness at the site of transverse osteotomy was measured 1.18 ± 0.30 mm in a study by Citardi et al, and 1.75 ± 0.37 mm in a study by Lee et al on CT scans. In our study on 32 lateral walls of 16 patients, the simulated CT models showed the mean thickness at the transverse osteotomy line to be 2.5 ± 0.66 mm. It decreased in all samples toward the medial canthus. The mean thickness was found to be 1.2 ± 0.21 mm at the medial canthus area. These data correlate well with our clinical strategy of restricting the bone cuts to the thickest part of the lateral wall at the radix area—that is, between 4 and 6 mm, beginning from the radix halfway to the medial canthus.

It is necessary to cut only the bone medially between the radix and medial canthus; it is not necessary to dissect the covering soft tissue laterally toward the medial canthus. Despite the amount of dissection that is needed to place the motorized osteotome, the author has noted little postoperative edema, perhaps as a result of intraoperative cooling required for the micro-saw system.

The oscillating blade of the micro-saw is self-guarded and it cuts only at about one-third of the circle on the bony radix; the other two-thirds of the outer side remains at the safe skin-envelope aspect. From the other side, the plate of the dorsal retractor protects the dorsal skin and subcutaneous soft tissue from the micro-saw blade, and it illuminates and scopes the field of osteotomy. The thickness of the micro-osteotomy blade is 0.1 mm; this produces an approximately 0.15-mm gap in the bone that can be healed easily with fast callous formation.

The pliable irrigation complex of the micro-motor system cools the surgical field with a jet flow of sterile isotonic solution just near the osteotomy line. This provides a “cold surgery” that minimizes injury to the bone tissue and has a role in decreasing the intraoperative swelling that interferes with the assessment of the surgical result.

Again, the nasal mucosa is not damaged with PMSO, as the osteotomy is performed such that it cuts 80% to 90% of the thickness, leaving 10% to 20% of the bone near the mucosa. Only the resistant bone structure is cut with the micro-saw, so there is no tearing on the soft tissues. In this study, no evidence of bleeding or tearing on the mucosa was found at the osteotomy region with endoscopic examination (Figure 7). Performing the procedure under video endoscopy has a major effect in preventing complications.

There are hundreds of steps leading to a successful rhinoplasty, and it may not seem practical (or necessary) to purchase all of this equipment for a single substep, when it takes only a moment to accomplish a transverse osteotomy. However, if a surgeon is already using or has access to a video endoscope and the power tool system, the proposal would seem more practical. Also, the other substeps of bony vault remodeling—such as hump resection, open-roof rasping, and medial and lateral osteotomies—can be performed using the technology described in this article, making it more cost-effective to some degree (Figures 8 and 9).

CONCLUSIONS

The oscillating micro-saw is a safe and pliable instrument for use during transverse osteotomy. It provides a precise approach for mobilization of lateral walls at the radix area, which may decrease the various unpredictable fractures related to bony pitfalls during aesthetic and functional rhinoplasty.
Figure 8. (A, C, E) This 23-year-old woman presented with thin skin and a wide bony vault. (B, D, F) Two years after rhinoplasty with the author’s micro-saw technique.
Figure 9. (A, C, E) This 29-year-old woman presented with a large hump and a wide bony vault base. (B, D, F) Twenty-eight months after rhinoplasty with the author’s micro-saw technique.
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REFERENCES