Nasal Osteotomies
A Cadaveric Study of Fracture Lines

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IMPORTANCE The different nasal osteotomy patterns used to perform rhinoplasty are poorly described in the literature, and there is a continuous debate between surgeons on the ideal sequence and technique to obtain desired results.

OBJECTIVES (1) To evaluate the necessity of a paramedian osteotomy when performing a high-low-high (HLH) osteotomy, (2) to study the fracture pattern of a high-low-low (HLL) osteotomy when combined with a paramedian osteotomy in the presence and in the absence of a transverse osteotomy, and (3) to evaluate the mobility of the central segment (located between the paramedian osteotomies) after digital pressure and the ideal osteotomy to mobilize it if needed.

DESIGN AND SETTING This was a prospective cadaveric study performed in the dissection laboratory in our tertiary referral center.

EXPOSURE Twenty cadavers were divided in 2 groups of 10. Group A had a paramedian osteotomy combined with an HLH osteotomy on 1 side and an HLH osteotomy alone on the other side. Group B had a paramedian combined with a transverse osteotomy followed by HLL osteotomy on 1 side. On the other side, we performed a paramedian combined with an HLL osteotomy. Finally, we evaluated the mobility of the central segment in group B, first with digital manipulation and then with a transverse osteotomy.

MAIN OUTCOME AND MEASURE The 3 authors evaluated individually the different fracture patterns. A result was considered successful when (1) the fracture followed the desired pattern, (2) a continuous line was obtained, and (3) a complete mobilization of the nasal segment was visualized.

RESULTS In group A, the side without a paramedian osteotomy had more unstable and greenstick fractures than the other side (P < .001). In group B, the side with a transverse osteotomy had more reliable and stable fractures than the other side (P < .05). Digital manipulation alone was not enough to mobilize the central segment in 8 of the 10 cadavers studied.

CONCLUSIONS AND RELEVANCE Following this study we make the following suggestions: (1) to perform a paramedian osteotomy when an HLH osteotomy is needed, (2) to perform a transverse osteotomy before an HLL osteotomy when combined with paramedian osteotomy, and (3) to manipulate the central segment with a transverse osteotomy in order to mobilize it in a safe and predictable manner.

LEVEL OF EVIDENCE NA.
Rhinoplasty remains one of the most challenging procedures in facial plastic surgery. The surgeon seeks an aesthetic harmony with the surrounding facial features while preserving nasal functions. The procedural steps of rhinoplasty largely vary and are modified according to each patient.

Performing osteotomies is a critical step to correct deformities of the nasal bony vault. Its indications are well established: (1) open roof closure and (2) nasal pyramid narrowing, widening, and/or straightening.\(^6\)-\(^9\)

Many terms have been used to describe the pattern of nasal osteotomies along the nasal sidewalls (\textit{low-to-low, low-to-high, high-low-high [HLH]}), and numerous techniques have been described to perform lateral osteotomies.\(^3\)-\(^5\) Some studies compare the continuous (internal) lateral osteotomies with the microperforating (percutaneous) technique in terms of edema, postoperative ecchymosis, and their effect on dorsum and base narrowing.\(^6\)-\(^9\) However, the different fracture patterns are less often described in the literature, and there is a continuous debate between surgeons on the ideal sequence and technique of osteotomies.

The main obstacle in performing osteotomies is correcting the deformity while controlling the fracture line and the digital force applied. Undesired aesthetic results may occur when there is inadequate mobilization of the bony vault or unpredictable fracture lines caused by digital pressure.

Since different approaches have been described with no consensus, the purpose of this study was 3-fold: (1) to evaluate the necessity of a paramedian (PM) osteotomy when performing an HLH osteotomy, (2) to study the fracture pattern of a high-low-low (HLL) osteotomy when combined with a PM osteotomy in the presence and in the absence of a transverse (T) osteotomy, and (3) to evaluate the mobility of the central segment (located between the PM osteotomies) after digital pressure and the ideal osteotomy (safe and efficient) to mobilize it if needed as in cases where the upper third is lateral to the midline.

### Methods

Institutional review board approval was given by Maisonneuve-Rosemont Hospital. Twenty cadavers of 60- to 80-year-old white adults were first skeletonized over the nasal and maxillary bones using a T-shaped incision. All the manipulations and analysis were performed by the 2 senior authors (A.R. and C.A.).

We divided the cadavers in 2 groups. Group A consisted of 10 cadavers: 1 female and 9 male. In this group, we performed on 1 side a PM osteotomy followed by a continuous lateral HLH osteotomy and on the other side an HLH osteotomy only (Figure 1). In that group, PM osteotomies were performed using a 4-mm straight osteotome, and HLH osteotomies were performed using a 4-mm curved, guarded osteotome.

Group B also consisted of 10 cadavers: 1 female and 9 male. In this group, we performed on 1 side a PM osteotomy combined with a T percutaneous microperforating osteotomy, followed by a lateral HLL osteotomy. On the other side, we performed a PM osteotomy followed by a lateral HLL osteotomy without any T osteotomy (Figure 2).

In that group, PM osteotomies were also performed using a 4-mm straight osteotome, and HLL osteotomies were performed using a 4-mm curved, guarded osteotome for 1 cadaver and 4-mm straight, unguarded osteotome for the remaining 9 cadavers. The transverse osteotomies were performed using a 2-mm unguarded osteotome percutaneously. Figure 3 illustrates the difference between an HLH osteotomy and an HLL osteotomy.

In each cadaver, after the osteotomies were completed, digital pressure was applied to fracture and mobilize the bony fragments.

Then, we all evaluated individually each cadaver. Three criteria had to be fulfilled in order to consider the result successful: there had to be (1) a fracture that followed the desired pattern; (2) a continuous, uninterrupted line; and (3) a complete mobilization of the nasal fragment.

Finally, the mobility of the central segment was evaluated in group B only. If the central segment remained immobile after digital manipulation, we mobilized it using a T osteotomy with a 2-mm osteotome (Figure 2). Results were analyzed using Fisher exact test, and \(P < .05\) was considered statistically significant.

### Results

In group A, 1 cadaver was excluded from the study because the lateral osteotomy was started too low on 1 side. In 8 of the 9 remaining cadavers (89\%), the bony fragments of the nasal sidewalls had predictable fracture lines and were completely mobilized after mild to moderate digital pressure on the side of PM and HLH osteotomies. The remaining cadaver (1 of 9 [11\%]) had an inferior oblique fracture between the HLH and PM osteotomies, and the result was considered undesirable. On the side of the lateral HLH osteotomy alone (without a PM

Figure 1. A High-Low-High (HLH) Osteotomy in the Presence and in the Absence of a Paramedian (PM) Osteotomy

The purple line indicates the HLH osteotomy, and the blue line indicates the PM osteotomy.
osteotomy), 9 of the 9 cadavers (100%) had incomplete fractures and the nasal fragments were never fully mobilized. Thus, on that side, cadavers had less desirable fracture lines with a statistically significant difference (P < .001).

In group B, we performed the lateral HLL osteotomy on 1 cadaver using a curved, guarded osteotome. With this osteotome, the fractures were not controlled and tended to curve higher as we proceeded toward the medial canthus. It was thus excluded from this analysis. In the rest of the cadavers, we then used a straight osteotome. In these cadavers, 8 of 9 (89%) had stable, controlled osteotomies that resulted in a complete fracture after moderate digital pressure on the side where a T osteotomy was coupled with a lateral HLL osteotomy.

In only 1 cadaver (11%), the fracture line deviated in a low to high pattern, although we had used a straight osteotome. On the side where no T osteotomy was performed, only 3 of 9 cadavers (33%) had a stable and controlled HLL osteotomy, whereas the remaining 6 (67%) had lateral HLL osteotomies that tended to deviate higher as we approached the medial canthus. There was a statistically significant difference between these 2 groups (P < .05).

Concerning the central segment, excessive digital pressure had to be applied to fracture the central segment in 2 of the 10 cadavers in group B. In the remaining 8, it was impossible to fracture the central segment with digital pressure. It was therefore separated from the frontal bone by a T osteotomy. In all these cases, no loss of support of the nasal pyramid was noted, which confirms the safety of this T osteotomy.

Discussion

Osteotomies are an essential part of straightening a crooked nose. However, since it is less artistically demanding than other procedures in rhinoplasty (eg, nasal tip plasty), it is less often described in the literature.1 A poorly performed osteotomy is an important cause of revision rhinoplasties, and surgeons have a constant debate about the ideal technique. The goal of a surgeon is to obtain reliable osteotomy patterns with a moderate digital pressure required to complete fracturing.

The first issue we addressed in this study was the necessity of a paramedian osteotomy when performing an HLH osteotomy in a case in which no hump needs to be removed. Our results demonstrated that an HLH osteotomy performed without a previous PM osteotomy results in a greenstick fracture superiorly and incomplete mobilization of the bony nasal sidewalls. However, when combined with a PM osteotomy, the HLH osteotomy was reliable, and a complete mobilization of the nasal sidewalls was obtained with mild to moderate digital pressure in 89% of the cadavers.

The second issue we addressed is the importance of a T osteotomy when performing a PM and a lateral HLL osteotomy. Lateral HLL osteotomies are used to manipulate a wide nasal base at the level of the nasal canthus and in the correction of a crooked nose. Our results demonstrated that in the absence of a T osteotomy, the lateral HLL osteotomy tends to deviate into a higher pattern as the osteotomy approaches the medial canthus, even if a straight osteotome is used. This was observed in 67% of the cadavers. However, in the presence of a T osteotomy, the HLL tends to follow a more predictable pattern. This can be explained by the fact that a lateral HLL osteotomy tends to follow the natural cleavage of the nasal bone and a T osteotomy disrupts this pattern by creating a new weakness point. Therefore, performing a T osteotomy before an HLL results in more controllable fracture lines.

The third issue we evaluated in this study was the central segment mobility after digital pressure and the need to fracture it with an osteotome. Our results suggest that digital manipulation is not a predictable means to fracture this strong nasal segment. The force needed is excessive and can easily cause an undesired result. A T osteotomy of the central segment is a more reliable technique to separate this bony fragment from the frontal bone, to which it is attached, in order to replace it in the midline. Furthermore, the osteotomy of the central segment did not result in any collapse of the nasal pyramid in any cadaver. It is then considered safe.
Conclusions

Every rhinoplasty surgeon usually has his or her own techniques based on personal experience. Based on this study, in which we compared common osteotomy techniques, we suggest the following:

1. In the absence of a bony hump removal, an HLH lateral osteotomy could be combined with a PM osteotomy to mobilize the lateral bony sidewalls in a predictable manner.

2. When performing a PM osteotomy combined with a lateral HLL osteotomy, the T osteotomy, performed before the lateral HLL, is necessary to achieve predictable lines and adequate mobilization of the nasal sidewalls.

3. In the absence of a bony hump removal, the central segment of bone located between the PM osteotomy cannot be adequately mobilized using digital pressure only. A T osteotomy of that segment is needed to mobilize it in a predictable and safe manner.

REFERENCES


