Comparison of L-strut preservation in endonasal and endoscopic septoplasty: a cadaveric study
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Background: Preservation of an adequate cartilaginous L-strut to prevent complications of septoplasty has been long recognized as critical. However, no previous study has examined the dimensions of the L-strut that remain after septoplasty. We hypothesized that differences in exposure and visualization between endoscopic and endonasal techniques would result in differences in preserved L-strut dimensions. We designed this study to determine L-strut dimensions after performance of septoplasty with endonasal and endoscopic technique.

Methods: We performed a cadaveric study with 24 heads randomly assigned to undergo endonasal vs endoscopic septoplasty by senior resident surgeons (postgraduate year 4 [PGY-4] and PGY-5). Removal of the skin–soft tissue envelope and mucoperichondrium was performed after septoplasty to permit direct measurement of the L-strut. Minimum and maximum widths were recorded for the caudal and dorsal segments; a single measurement was recorded for the width at the anterior septal angle. Statistical analysis was carried out using the 2-tailed distribution Student t test.

Results: There was no significant difference in caudal or anterior septal width between endonasal and endoscopic techniques. There was a statistically significant difference in dorsal segment width for both minimum and maximum values, with endoscopic technique resulting in a narrower dorsal segment than endonasal technique (mean minimum value of 10.8 mm vs 13.2 mm, respectively, p = 0.03; and mean maximum value of 12.6 mm vs 16 mm, respectively, p = 0.01). There was significant variation in resident surgeon performance, with the performance of 1 resident surgeon accounting for the difference in minimum dorsal width.

Conclusion: Differences in exposure and visualization between endoscopic and endonasal septoplasty techniques may result in differences in preserved L-strut dimensions. Care should be taken with endoscopic technique to prevent overly aggressive resection of septal cartilage, particularly with learners of this technique.

Key Words: septoplasty; L-strut; cadaver; technique; measurement

How to Cite this Article:

The importance of cartilaginous L-strut preservation has been recognized as a key factor in septoplasty outcomes since the time of Gustav Killian in 1905.1 The quadrangular cartilage and its osseous attachments serve as the structural foundation of the nose, stabilizing the upper and lower lateral cartilages and defining the stability of the nasal dorsum and tip. An insufficiently preserved cartilaginous strut risks postoperative functional or aesthetic complications, including nasal valve collapse, saddle nose deformity, reduced tip projection and abnormal rotation, and columellar shortening.2–4

The commonly accepted width for a preserved L-strut is 10 to 15 mm (Mowlavi et al.5). When septoplasty is performed by endoscopic or endonasal technique, direct measurement of the L-strut, particularly the dorsal limb, is not feasible. The purpose of this study was to determine the dimensions of the L-strut preserved during endonasal and endoscopic septoplasty. We hypothesized that differences in exposure and visualization between the endoscopic and endonasal techniques would result in differences in preserved L-strut dimensions.

For this study, we chose a cadaver model to permit direct measurement of septal cartilage by opening of the soft...
tissue–skin envelope after septoplasty. We also designed the study to mirror conditions in an academic teaching hospital, in which direct supervision of resident-performed endonasal septoplasty is difficult because of limited visibility. For purposes of standardization, all procedures in the study were performed by resident physicians without supervision by an attending physician.

### Materials and methods

Twenty-four fresh-frozen and thawed nonfixed human cadaver heads were used for this study. As these heads were designated for use in an anatomic dissection course, Institutional Review Board approval was waived. Heads were randomly assigned to undergo endoscopic or endonasal septoplasty. Four senior-level resident physicians (postgraduate year 4 [PGY-4] and PGY-5) from our institution participated in performing the procedures. Resident surgeons were chosen in order to best approximate the surgical environment at an academic teaching institution. The participants were blinded to the objectives of the study. Each participant performed 3 endoscopic and 3 endonasal septoplasty procedures. Participants were instructed to utilize a standard Killian incision followed by bilateral submucous resection of the quadrangular cartilage with preservation of an L-strut.

The goal with both endoscopic and endonasal approaches was to perform the standard procedure accomplished at our institution, namely septectomy with preservation of an L-strut. Minimal septal resection, including segmental septal resection and cartilage scoring, was not performed. Headlights and nasal specula were used for exposure during the endonasal portion of the experiment. For the endoscopic portion, participants were furnished with Stryker (Kalamazoo, MI) 0-degree rigid endoscopes connected to a video monitor. Standard operative instrumentation was available for the dissection, and operators were allowed to personalize their choice of specific instrumentation to use for the procedure.

After septoplasty was performed, the skin–soft tissue envelope was opened with a midline incision by the lead author (MDR attending surgeon) and the remaining septal cartilage was dissected free from the upper lateral cartilages and mucoperichondrial flaps to allow full exposure of the preserved L-strut. The width of the L-strut was measured with a ruler at 3 separate points: the caudal strut, the anterior septal angle, and the dorsal strut (see Fig. 1).

Given the heterogeneity of the width along each of the caudal and dorsal segments, maximum and minimum values were recorded. A single width measurement was taken at the anterior septal angle, delineated as the width between the external and internal angles of the L-strut. The measurements were taken independently by 2 separate investigators (the resident surgeon who performed the case and lead author, who performed the nasal decortication) and were averaged. In cases where interobserver measurements were discordant by ≥2 mm, the investigators mutually agreed to a consensus measurement by agreeing upon the appropriate location for obtaining the measurement. Statistical analysis comparing the 2 techniques was carried out using the 2-tailed distribution Student t test. One-way analysis of variance (ANOVA) statistical testing was performed to assess for interoperator variation in performance.

### Results

One cadaveric head randomized to undergo endoscopic septoplasty was excluded from the study due to a preexisting septal perforation located along the caudal septum. Therefore, 12 endonasal and 11 endoscopic procedures were performed, with results included in the analysis. Mean and standard deviation values for L-strut measurements are shown in Table 1.

There was no significant difference in caudal or anterior septal width between endonasal and endoscopic techniques. However, there was a statistically significant difference in dorsal segment width for both minimum and maximum values, with endoscopic technique resulting in a narrower dorsal segment than endonasal technique (mean minimum value of 10.8 mm vs 13.2 mm, respectively, \( p = 0.03 \); and mean maximum value of 12.6 mm vs 16 mm, respectively, \( p = 0.01 \)).

The analysis of variance results by technique and cartilage segment are listed in Table 2. No statistically significant difference in operator performance was seen for the caudal...
and anterior septal angle segments. However, a statistically significant difference was seen in the minimum width of the dorsal strut with the endoscopic technique. Notably, this difference is attributable to the performance of 1 resident surgeon. A post hoc analysis excluding this result to determine its influence on the overall data set demonstrates no statistically significant difference in mean width for any of the cartilage segments (Table 3).

**Discussion**

The importance of adequate cartilaginous L-strut preservation during septoplasty and septorhinoplasty is well recognized. Poor dorsal strut support may result in a saddle-nose deformity or nasal valve collapse, whereas loss of support of the caudal strut can lead to decreased tip projection and columellar retraction.\(^2\)\(^-\)\(^4\) The commonly accepted width of the L-strut is 10 to 15 mm (Mowlavi et al.\(^5\)), though this is not well-established in the literature. Indeed, there is great variation in recommended width, with some authors suggesting that 6 mm offers sufficient strength\(^6\) and others advocating that at least 15 mm be preserved in some segments.\(^3\) Despite this lack of consensus, there is evidence that narrower L-struts are subject to increased tensile stresses, increasing the likelihood for cartilaginous deformity and fracture.\(^7\)\(^,\)\(^8\)

To our knowledge, there has been no prior study examining the dimensions of the L-strut preserved during endonasal or endoscopic septoplasty. We hypothesized that differences would be seen between the endonasal and endoscopic techniques based on the differences in exposure and visualization afforded in each case. Indeed, a statistically significant difference was identified in the mean minimum and maximum width of the dorsal segment between the endonasal and endoscopic techniques, with endoscopic technique resulting in a narrower minimum width (mean 10.8 vs 13.2 mm, \(p = 0.03\)) and narrower maximum width (mean 12.6 vs 16 mm, \(p = 0.01\)). We have theorized that this occurred because the magnification afforded by the endoscope results in a distorted sense of distance, causing a segment of cartilage to appear larger than its actual size. Additionally, improved visualization of this region with the endoscope may have resulted in greater dissection of the mucoperichondrial flaps and more aggressive resection of cartilage.

Notably, our results are influenced by the performance of 1 resident surgeon. Interoperator variation in performance contributed significantly to our findings, with 1 resident surgeon’s performance accounting for the differences seen in dorsal width. This highlights the small size of our study as a major weakness. Nonetheless, we feel the findings of interoperator variability are noteworthy, illuminating a potential pitfall with the endoscopic technique. At the very least, this finding highlights the importance of resident oversight in performance of septoplasty. Fortunately, the endoscopic technique is well-suited to direct supervision and teaching of surgical skills.

One potential weakness of this study is the use of a cadaveric model, as the absence of bleeding may lead to increased visibility, especially with the endoscopic technique. However, because of the extensive nasal decortication required to obtain measurements of the L-strut, we feel that this study would be prohibitive without the use of a cadaver model.

Finally, it should be mentioned that the clinical significance of the differences identified in dorsal width is not clear. Indeed, both the minimum and maximum values for each technique fall within or exceed the generally accepted range for width of cartilage preservation. It should also be noted that several factors are thought to contribute to the stability of the nose after septoplasty, including the degree to which the mucoperichondrium is left undissected,\(^7\)\(^,\)\(^8\) and preservation of the “keystone” region.\(^7\)\(^,\)\(^8\) Nonetheless, our results suggest that, because of improved visualization and magnification, care should be taken with the endoscopic technique to prevent overly aggressive resection of septal cartilage.

**TABLE 2.** Analysis of variance for surgeon results

<table>
<thead>
<tr>
<th>Segment of L-strut</th>
<th>Endonasal</th>
<th>Endoscopic</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(F)</td>
<td>(p)</td>
</tr>
<tr>
<td>Columella</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum</td>
<td>1.25</td>
<td>0.35</td>
</tr>
<tr>
<td>Maximum</td>
<td>0.84</td>
<td>0.51</td>
</tr>
<tr>
<td>ASA</td>
<td>1.40</td>
<td>0.31</td>
</tr>
<tr>
<td>Dorsum</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum</td>
<td>1.41</td>
<td>0.31</td>
</tr>
<tr>
<td>Maximum</td>
<td>3.08</td>
<td>0.09</td>
</tr>
</tbody>
</table>

ASA = anterior septal angle.

**TABLE 3.** Width of L-strut septal cartilage segments excluding outlier surgeon

<table>
<thead>
<tr>
<th>Segment of L-strut</th>
<th>Width (mm)</th>
<th>SD</th>
<th>Width (mm)</th>
<th>SD</th>
<th>(p)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Columella</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum</td>
<td>9.8</td>
<td>2.4</td>
<td>9.6</td>
<td>2.9</td>
<td>0.91</td>
</tr>
<tr>
<td>Maximum</td>
<td>11.3</td>
<td>2.3</td>
<td>10.9</td>
<td>3.3</td>
<td>0.74</td>
</tr>
<tr>
<td>ASA</td>
<td>13.2</td>
<td>2.3</td>
<td>12.4</td>
<td>1.9</td>
<td>0.46</td>
</tr>
<tr>
<td>Dorsum</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum</td>
<td>12.6</td>
<td>2.1</td>
<td>11.9</td>
<td>1.1</td>
<td>0.43</td>
</tr>
<tr>
<td>Maximum</td>
<td>15.0</td>
<td>1.9</td>
<td>13.6</td>
<td>1.2</td>
<td>0.09</td>
</tr>
</tbody>
</table>

ASA = anterior septal angle; SD = standard deviation.
Conclusion

Differences in exposure and visualization between endoscopic and endonasal septoplasty techniques may result in differences in preserved L-strut dimensions. Care should be taken with the endoscopic technique to prevent overly aggressive resection of septal cartilage, particularly with learners of this technique.

References