Septal Batten Graft to Correct Cartilaginous Deformities in Endonasal Septoplasty

Jee Hye Wee, MD; Ji-Eun Lee, MD; Sung-Woo Cho, MD; Hong Ryul Jin, MD

Objective: To evaluate the usefulness of septal batten grafts to correct cartilaginous septal deformities in endonasal septoplasty.

Design: Retrospective study.

Setting: University medical center.

Patients: Of 430 patients who underwent endonasal septoplasties from January 2006 to January 2011, 30 received septal batten grafts and were enrolled in the study. Twenty-eight patients were male and 2 were female.

Main Outcome Measures: Thirty consecutive patients received septal batten grafts and were followed up for more than 6 months. Patterns of septal deformity, materials used for batten graft, surgical results, symptom improvement, findings of acoustic rhinometry, and surgical complications were investigated.

Results: Among the 30 patients, 5 were revision cases. Most of the deformities were characterized as moderate to severe degrees of curved or angulated deviations of the cartilaginous septum. The batten graft was performed with either septal cartilage (n=21) or bony septum (n=9). A straight septum was achieved in 90% of all procedures. Subjective symptoms of nasal obstruction were improved in all patients, as evaluated by the Nasal Obstruction Symptom Evaluation scale. Acoustic rhinometry revealed that after surgery the mean minimal cross-sectional area changed from 0.33 cm² to 0.42 cm² (P=.02) and the nasal volume from 4.71 mL to 6.28 mL (P=.02). There were no major complications, e.g., septal perforation or saddle nose, and no revision surgery was needed.

Conclusion: Endonasal septal batten graft is a safe, useful, and effective technique to straighten moderate to severe septal cartilage deformities that are otherwise not correctable via conventional septoplasty techniques.


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EOPTOPLASTY IS ONE OF THE most common surgical procedures performed in the field of otorhinolaryngology. The patterns of septal deformities are so diverse that no single technique can consistently and uniformly handle all of them. Among the various deformities of septal cartilage, the most common findings are convexity, concavity, and angulation. The essential and most important aspect of septoplasty is correction of the inherent deformity of the septal cartilage after release of all extrinsic deforming forces. The corrective surgical procedure is technically challenging for even minor deviations but is especially difficult in cases in which the deformity involves the L-strut region, which consists of the caudal and high cartilaginous septum.

Many conventional surgical techniques, including submucous resection, cross-hatching incision, wedge resection, and suture method, have demonstrated limitations in achieving uniformly predictable results. In many cases, the septum deviates after surgery as a result of either undercorrection or overcorrection or because of the secondary healing process. An overzealous manipulation of the septum can also result in adverse complications, such as saddle nose, loss of nasal tip support, retraction of the nasal columella, or collapse of the nasal valve. These difficulties in obtaining consistently satisfactory and predictable outcomes with the use of the previously published endonasal septoplasty techniques led us to seek a different approach. The aim of the present study was therefore to evaluate the usefulness of septal batten grafts to correct the cartilaginous deformities in endonasal septoplasty.

METHODS

A retrospective study was performed on 430 patients who underwent endonasal septoplasty at Boramae Medical Center, Seoul National University College of Medicine, Seoul, Korea, from January 2006 to January 2011. The criteria for exclusion were open approach septoplasty, rhinoseptoplasty, and a follow-up period of less than 6 months. Thirty patients who received batten grafts and were followed up for more than 6 months were enrolled in the study; of those, 28 were male and 2 were female, and the age range was 16 to 61 years (mean age, 31.6 years).
either general or local anesthesia. A left hemitransfixion incision was set at the septum. The postoperative status of the nasal septum was described as cartilaginous, bony, or both, depending on the location of the major deformity. The degree of deviation was categorized as mild, moderate, or severe based on the distance measured between the most deviated portion in reference to an imaginary midline and/or the corresponding lateral nasal wall. The degree was considered mild when the most deviated part of the septum did not reach half that distance. In cases in which the most deviated portion of the septum was in physical contact with the lateral nasal wall, the degree was considered severe.

All surgical procedures were performed by the senior author (H.R.J.), who also used anterior rhinoscopy and endoscopy to evaluate the preoperative and postoperative status of the septum. The postoperative status of the nasal septum was classified into 3 categories: straight, improved but with residual deviation, and no change or even worse deviation. The minimal cross-sectional area (MCA) and the nasal volume were measured before and after surgery using acoustic rhinometry after the effects of the nasal cycle were minimized with mucosal decongestion by application of phenylephrine spray, 0.25%. At the 6-month follow-up visit, the subjective symptoms of nasal obstruction were evaluated using the NOSE scale (Figure 1).

Comparative analyses of average scores for MCA, nasal volume, and subjective symptoms were carried out with the Wilcoxon signed rank test. Statistical analyses were performed using SPSS version 12 (SPSS Inc). The criterion for statistical significance was set at $P < .05$. The institutional review board of the Clinical Research Institute at the Boramae Medical Center approved the study protocol.

Surgical procedures were performed with the patient under either general or local anesthesia. A left hemitransfixion incision was made according to the senior author’s preference, regardless of the laterality of the concavity or convexity, via an endonasal approach. A mucoperichondrial flap was elevated by sharp dissection. The cartilaginous septum was released from the perpendicular plate of the ethmoid, vomer, and maxillary crest. After removal of the deviated bony septum, a large, straight piece of bone was harvested, when possible, and set aside for subsequent use as a batten graft in that same individual. Vertical and horizontal cartilaginous strips were excised to fully release the cartilaginous septum from the bony septum. If the remaining cartilaginous septum was not considered to be completely corrected with the aforementioned techniques, a batten graft was then used.

The posteroinferior cartilaginous septum was harvested, leaving a generous L-strut, while preserving the keystone area and the caudal septum. Excess cartilage from the inferior portion of the remaining L-strut was removed after careful consideration of the eventual vertical height of the newly adjusted septum and after transformation from a curved to a straight plane. The excised posteroinferior cartilaginous septum or bony septum was used as a batten graft. Harvested cartilage or bone was fashioned into a batten graft with sufficient length to reach the distance from the anterior nasal spine to the cartilaginous dorsum. Adequate length of the batten graft was important to prevent possible saddle deformity due to excessive cartilage removal. The batten graft and the septum were sutured together with 4-0 polydioxanone sutures. Small holes were drilled into the harvested bony septum to facilitate the placement of sutures without breaking the bone. The batten graft–septum complex was sutured to the anterior nasal spine with polydioxanone sutures, and quilting sutures were placed through the redraped mucosal layers with 4-0 plain gut (Figure 2).

The batten graft was usually placed in the concave side of the septal cartilage. If the left side was concave, a limited elevation of the mucoperichondrium on the right side was found to be sufficient for secure sutures. In contrast, when the right side was concave, a full bilateral elevation of the mucoperichondrium was necessary to place the batten graft on the right side (Figure 3). After the procedure, the nasal cavity was lightly packed with gauze soaked in clindamycin solution. The gauzes were removed the next day. A submucosal turbinoplasty or radiofrequency turbinate reduction was performed when turbinate hypertrophy was combined with septal deviation.

Among the 30 batten recipients, 25 (83%) presented for primary surgery and 5 (17%) presented for revision septoplasty. The type of deviation was either curved ($n = 20$ [67%]) or angulated ($n = 10$ [33%]). There was no patient with a localized or a linear type of deviation. The deviation was located either in the cartilaginous portion ($n = 17$ [57%]) or in the bony-cartilaginous junction ($n = 13$ [43%]). The severity of deviation was mostly either moderate ($n = 18$ [60%]) or severe ($n = 10$ [33%]) (Table). The concomitant procedures included bilateral inferior turbinoplasty, unilateral inferior turbinoplasty, and endonasal dorsum augmentation, as shown below.

<table>
<thead>
<tr>
<th>Procedure</th>
<th>No. of Patients</th>
</tr>
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<tbody>
<tr>
<td>Turbinoplasty (bilateral)</td>
<td>10</td>
</tr>
<tr>
<td>Turbinoplasty (unilateral)</td>
<td>10</td>
</tr>
<tr>
<td>Dorsal augmentation</td>
<td>6</td>
</tr>
<tr>
<td>Cartilage-weakening incision</td>
<td>5</td>
</tr>
<tr>
<td>Anchoring suture</td>
<td>17</td>
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</tbody>
</table>

Materials used for the batten graft were septal cartilage ($n = 21$) or bony septum ($n = 9$). Weakening incisions to facilitate straightening of the septal cartilage was deemed nec-

![Figure 1. The Nasal Obstruction Symptom Evaluation Scale for evaluating subjective nasal symptoms.](http://archotol.jamanetwork.com/pdfaccess.ashx?url=/data/journals/otol/23420/)

The following data were extracted from the medical records for analysis: nasal septal deviation type, location, and degree; surgical procedures combined with septoplasty; materials used for the batten graft; surgical complications; postoperative symptom improvement and septum status, as determined by the Nasal Obstruction Symptom Evaluation (NOSE) scale; and findings of acoustic rhinometry.

The types of septal deviation were divided into 4 categories: localized, curved, angulated, and linear. Localized deformity was defined as a localized septal spur or ridge. Curved deviation was described as concavity or convexity of the septum, while angulated was defined as a fracture-type angulation of the septum. Linear deformity was a linear deviation of the septum, as is usually associated with dislocation of the caudal septum. The location of deviation was described as cartilaginous, bony, or both, depending on the location of the major deformity. The degree of deviation was categorized as mild, moderate, or severe based on the distance measured between the most deviated portion in reference to an imaginary midline and/or the corresponding lateral nasal wall. The degree was considered mild when the most deviated part of the septum did not reach half that distance. In cases in which the most deviated portion of the septum was in physical contact with the lateral nasal wall, the degree was considered severe.

All surgical procedures were performed by the senior author (H.R.J.), who also used anterior rhinoscopy and endoscopy to evaluate the preoperative and postoperative status of the septum. The postoperative status of the nasal septum was classified into 3 categories: straight, improved but with residual deviation, and no change or even worse deviation. The minimal cross-sectional area (MCA) and the nasal volume were measured before and after surgery using acoustic rhinometry after the effects of the nasal cycle were minimized with mucosal decongestion by application of phenylephrine spray, 0.25%. At the 6-month follow-up visit, the subjective symptoms of nasal obstruction were evaluated using the NOSE scale (Figure 1).

Comparative analyses of average scores for MCA, nasal volume, and subjective symptoms were carried out with the Wilcoxon signed rank test. Statistical analyses were performed using SPSS version 12 (SPSS Inc). The criterion for statistical significance was set at $P < .05$. The institutional review board of the Clinical Research Institute at the Boramae Medical Center approved the study protocol.

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essary in 5 patients. In 17 patients, the batten graft and the septal cartilage were anchored to the anterior nasal spine with sutures.

Postoperative anterior rhinoscopy and endoscopy showed that a straight septum had been accomplished in 27 patients (90%). In 3 patients (10%), mild residual deviation of the septum was observed, even though much improvement was shown as compared with the preoperative status. No patients had septal deviation that remained unchanged or became worse after surgery.

Preoperative and postoperative acoustic rhinometry was performed in 20 patients. A statistically significant improvement in the MCA, from 0.33 cm² to 0.42 cm², was achieved in the convex side of the nasal cavity \((P = .02)\). The MCA in the concave side of the nasal cavity increased from 0.37 cm² to 0.40 cm², which was not statistically significant \((P = .14)\) \(\text{Figure 4}\). The nasal volume \((4.71 \text{ mL vs } 6.28 \text{ mL})\) was significantly increased by a mean 1.43 mL \((P = .02)\) in the convex side of the nasal cavity. The nasal volume of the concave side decreased after surgery \((6.77 \text{ mL vs } 6.20 \text{ mL})\), but the difference was not statistically significant \((P = .88)\) \(\text{Figure 5}\).

To identify the effect of turbinate modification surgery, we compared the findings of acoustic rhinometry and the changes in visual analog scale scores between patients treated with septoplasty alone \((n = 9)\) and patients treated with septoplasty and concomitant turbinoplasty \((n = 11)\). The MCA and the nasal volume on the concave side increased slightly more in the patients who were treated with both septoplasty and turbinoplasty, but the differences were not statistically significant \((both P = .10)\). The symptomatic improvement was greater in the patients who were treated with combined septoplasty and turbinoplasty but was found to be statistically insignificant \((P = .42)\).

The subjective symptoms measured by the NOSE scale indicated that significant improvements had been achieved \((P < .05)\) \(\text{Figure 6}\). A longer-than-usual swelling of the anterior septum developed in 2 patients who had bilateral flap elevation, although it eventually subsided. No complications, in terms of septal hematoma, septal perforation, or saddle nose, were observed after surgery.

\textbf{COMMENT}

Batten grafts are used in various anatomical areas to correct deformities in septorhinoplasty. However, the exact indications for using batten grafts in septal deviation are difficult to define. Minor curvatures and angulations can be managed with other conventional techniques carried out on the cartilage, including incisions and sutures. When the deformity is severe, however, and the cartilage is thin, which is a common finding in many Asians, correcting the deformed cartilage de novo becomes almost impossible. The need to apply stronger materials (eg, batten grafts) as structural supports to straighten the deformed cartilage becomes more evident.

In this study, the usefulness and safety of septal batten grafts to correct moderate to severe septal deviations not otherwise amenable to effective correction via conventional techniques were evaluated. The subjective and objective findings indicate the effectiveness of this technique. The observed increases in both MCA and nasal volume in the convex side were considered to be a direct consequence of space redistribution facilitated by the septal straightening. Postoperative nasal volume increased in the convex side and decreased in the concave side, re-
resulting in similar nasal volumes on both sides after surgery (6.28 mL vs 6.20 mL). The contribution of the turbinoplasty procedure to the improvement of the objective findings and the subjective symptoms has been ruled out by comparing the findings of acoustic rhinometry and the scores on the NOSE scale. The fact that there were no cases of major complications after an average follow-up of at least 6 months in all cases strongly suggests that this technique is a safe procedure.

According to our experience, several factors should be taken into consideration to ensure the successful application of the batten graft. First, although a unilateral mucoperichondrial flap elevation may be sufficient, a bilateral mucoperiosteal flap elevation is often necessary for the effective application of the batten graft; however, it is important to note that septal swelling is expected to persist longer in the former than in the latter. Second, when severely curved or angulated cartilage becomes straight and is brought to a midline position, oftentimes excessive cartilage remains. Proper removal of this excessive cartilage before the batten graft application is mandatory to prevent insufficient correction or occurrence of a saddle nose deformity. Third, once the caudal septum is separated from the anterior nasal spine for correction, the septum-batten graft complex needs to be securely reattached to prevent saddle nose deformity. Fourth, when separation of the septum from the upper lateral cartilage is needed for correction of severe deformity, batten grafts should extend to the

Table. Classification of Nasal Septal Deviation

<table>
<thead>
<tr>
<th>Variable</th>
<th>No. of Patients/ Prevalence, %</th>
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<tbody>
<tr>
<td>Type of deviation</td>
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<tr>
<td>Curved</td>
<td>20/67</td>
</tr>
<tr>
<td>Angulated</td>
<td>10/33</td>
</tr>
<tr>
<td>Linear</td>
<td>0</td>
</tr>
<tr>
<td>Localized</td>
<td>0</td>
</tr>
<tr>
<td>Location</td>
<td></td>
</tr>
<tr>
<td>Cartilage</td>
<td>17/57</td>
</tr>
<tr>
<td>Bony septum</td>
<td>0</td>
</tr>
<tr>
<td>Both</td>
<td>13/43</td>
</tr>
<tr>
<td>Degree</td>
<td></td>
</tr>
<tr>
<td>Mild</td>
<td>2/7</td>
</tr>
<tr>
<td>Moderate</td>
<td>18/60</td>
</tr>
<tr>
<td>Severe</td>
<td>10/33</td>
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</tbody>
</table>

Figure 3. A batten graft showing a perpendicular plate of ethmoid (A) or cartilage (B) on the right side of the caudal septum. The septum is straight and well supported from the nasal spine to the dorsum.

Figure 4. Acoustic rhinometry was used to measure the minimal cross-sectional area (MCA) before and after surgery in 20 cases. The MCA is significantly increased in the convex side ($P = .02$).

Figure 5. Acoustic rhinometry was used to measure the nasal volume before and after surgery in 20 cases. The nasal volume is significantly increased in the convex side ($P = .02$).
upper lateral cartilage to properly support the graft and to prevent saddling of the dorsum. To effectively support the dorsum, the batten graft should be strengthened over the anterior nasal spine. Fifth, a septal cartilage–weakening incision may be necessary to facilitate the straightening of the septum. In cases in which the septal cartilage is thin, the batten graft possesses enough strength to overcome the deviation without any additional manipulation; however, in cases of thick or severely deviated cartilage, additional cartilage-weakening incisions may be necessary. Finally, in revision cases, the remaining septal cartilage may be insufficient or not strong enough to use as a batten graft. In such cases, the remaining bony septum is a good source of the batten graft. When bone is used, drilling holes into the bone is necessary to facilitate the securing sutures.

There are possible disadvantages to the use of batten grafts. First, the caudal portion of the septum can increase in thickness, but it rarely causes nasal obstruction. Second, when bony septum is used as a batten graft, there is a possibility of bone resorption and subsequent recurrence of the deviation. In the present study, 3 patients showed incomplete correction of the deviation; 2 were revision cases in which we used the perpendicular plate of ethmoid as the batten graft because there was a lack of viable cartilaginous structure. The possibility of resorption, on the other hand, is regarded as low when septal cartilage is used. Third, overly aggressive separation of the bony-cartilaginous junction or excessive resection of the caudal cartilage may result in an unexpected, albeit mild, saddle nose deformity. If this happens, an onlay dorsal graft through an intercartilaginous incision may resolve the problem. In this study, dorsal onlay grafts were performed in 6 of the patients, 3 of whom had obvious preexisting saddle nose deformities. In 1 case, an obvious mild saddle nose deformity occurred because of excessive caudal cartilage resection. In the other 2 cases, dorsal onlay grafts were used to aesthetically enhance suspicious preexisting dorsal saddling.

In conclusion, the batten graft is a safe and effective surgical technique to straighten moderate to severe deviations of the cartilaginous septum that is otherwise amenable to complete correction by conventional methods. Through careful patient selection and proper application planning, septal batten grafts can be regarded as one of the most useful endonasal techniques in the surgical armamentarium in septoplasty today.

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Author Contributions: All authors had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

Study concept and design: Jin. Acquisition of data: Wee, Lee, and Cho. Analysis and interpretation of data: Wee, Lee, Cho, and Jin. Drafting of the manuscript: Wee, Cho, and Jin. Critical revision of the manuscript for important intellectual content: Lee and Jin. Statistical analysis: Wee and Lee. Administrative, technical, and material support: Cho and Jin. Study supervision: Jin.

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