Reconstruction of the Nasal Septum Using Polydioxanone Plate

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Objectives: To evaluate the usefulness of resorbable polydioxanone plate attached to nasal septal cartilage in external septoplasty, to assess its mechanical stability until healing of cartilage fragments, and to describe the surgical technique and clinical experience.

Design: External septoplasty with polydioxanone plate has been performed in 396 patients since 1996. Indications were severe septal deformities (usually posttraumatic). Surgery included removal of the quadrilateral cartilage and division into straight fragments, which were sutured to resorbable polydioxanone plate and replaced as a free graft. If the nasal septal cartilage was partly or completely missing because of prior surgery or trauma, the missing cartilage was supplantated with auricular conchal cartilage. The study settings were Medicent Linz, Linz, Austria, and the Ear, Nose, and Throat Department, General District Hospital Steyr, Steyr, Austria.

Results: Functional and cosmetic outcomes were satisfactory. All patients experienced varying degrees of improvement in nasal blockage. There were no immediate (bleeding, septal hematomas, inflammatory reactions, or necrosis) or long-term (septal perforation, thickening of the nasal septum, or rejection of the implant) complications.

Conclusion: Use of polydioxanone plate attached to nasal septal cartilage facilitates surgical correction of severe septal deformities and supports the nasal dorsum until healing.

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Company, Langhorne, Pennsylvania) to support damaged orbital floor until bony healing. The need in extracorporal septum reconstruction is similar, and polydioxanone seemed advantageous to support divided cartilage fragments, as long as solid tissue formation eventually ensues to strengthen the nasal dorsum.

Polydioxanone is degradable by hydrolysis and is completely resorbed by the body, avoiding long-term complications associated with other artificial implants. Polydioxanone plates are available in various sizes and gauges, and they have been used successfully for years in the restoration of bone discontinuities. Polydioxanone plate serves as supporting material.

To use polydioxanone plate for nasal septum reconstruction, the quadrangular cartilage is removed in toto in a manner similar to extracorporal septum reconstruction. After removal of the cartilage, it is divided into its straight fragments. Trimmed fragments are easily fixed to foil by polydioxanone suture material, and polydioxanone plate supports the nasal dorsum until stabilization of cartilage fragments by scar tissue (Figure 1).

The graft described herein consisting of autologous cartilage and polydioxanone plate is called a compound graft.

The settings of the present study were Medicent Linz, Linz, Austria, and the Ear, Nose, and Throat Department, General District Hospital Steyr, Steyr, Austria.

**METHODS**

**SURGICAL TECHNIQUE**

After infiltration of lidocaine (2%) with 1:80 000 epinephrine, the surgical procedure usually begins with a broken columna incision, followed by marginal incisions for an external approach, which is appropriate in extracorporal septum reconstruction.

As usual in an external approach, the next step is excision of the skin and the soft tissue over the tip and the cartilaginous and bony dorsum in the right surgical plane. After separation of the medial crura of the lower laterals, the caudal end of the nasal septum is reached. From here, the mucoperichondrium is dissected free on both sides.

After performing a posterior chondroty, the upper lateral cartilages are separated from the nasal septum. After detaching the nasal septal cartilage from the maxillary crest and vomer, the nasal septal cartilage is completely free and can be removed as a single piece.

The removed septal cartilage is used as a template for cutting the polydioxanone plate. It is placed on the polydioxanone plate, and the outline of the removed cartilage is drawn on the polydioxanone plate to determine the exact size of the nasal septum to be reconstructed.

Using scissors, the polydioxanone plate is cut along the marked outline, and the deviated cartilage can now be separated into straight fragments. These fragments are arranged on the polydioxanone plate, ideally covering most of it. Particular attention should be paid to cartilage fragments comprising the dorsal and caudal septal borders. In each of these 2 cases, a single cartilage fragment should be used regardless of its former position. After all of the fragments are satisfactorily placed, they are sutured to the polydioxanone plate using polydioxanone suture material, usually 6-0 (Figure 2A and B), creating a straight and stable graft that is ready for immediate reimplantation.

After correction of any possible deformities of the perpendicular polydioxanone plate and vomer, the reconstructed part of the nasal septum, now combined with polydioxanone plate, is placed between the 2 layers of septal mucosa and adjusted to the correct position (Figure 2C). To hold the graft in place, it is fixed with polydioxanone suture to the upper laterals in the K-area and to the peristomeum of the anterior nasal spine.

Afterward, a series of continuous transseptal through-and-through sutures are positioned to fix the septal flaps, thereby closing all dead space and firmly stabilizing the septal component. This mattress suture also prevents septal hematoma; therefore, endonasal packing is not required. Subsequently, the medial crura of the lower laterals are sutured over a columellar strut to maintain tip projection.

Depending on the deformity, all the other well-known steps of rhinoplasty such as trimming of the lower laterals, tip suturing, and osteotomies are performed. Further explanation of these steps is beyond the scope of this article.

After meticulous closure of the skin incision with nylon 6-0, the nose is dressed from the outside with a Denver splint. The external fixation is removed on the sixth day together with the columellar suture.

Patients routinely receive antibiotic prophylaxis (eg, amoxicillin) for 3 days. For local treatment, a saline spray solution is used. Patients can usually return to their daily routine after 2 weeks.

**FURTHER APPLICATIONS OF COMPOUND GRAFT: COMBINING NASAL SEPTAL CARTILAGE AND AURICULAR CONCHAL CARTILAGE**

If little septal cartilage remains because of prior surgery or trauma but septum reconstruction is required to restore the function of the nose, then the missing cartilage can be supplanted with...
auricular conchal cartilage. This cartilage is extracted in a single session using the following procedure. After infiltration into the subperichondrial plane at the anterior side of the concha using the same local anesthetic solution as in the nose, the posterior side of the auricle is infiltrated into the supraperichondrial plane. After incising the skin on the posterior side, the posterior perichondrium and cartilage are incised in a line just below the antihelix. Next, blunt subperichondrial tunneling is performed on the anterior side of the cavum and cymba conchae, followed by dissection on the supraperichondrial posterior side. After incision of the cartilage lateral to the ear canal, leaving the radix helicis intact and a 3-mm strip to avoid stenosis of the meatus acusticus externus, the entire cartilage fragment is removed and placed in saline solution. After meticulous hemostasis, the skin incision is closed with 5-0 atraumatic sutures in single stitches. Carefully applied conchal packing with through-and-through mattress sutures for 4 days will prevent hematoma.

As usual, the approach to the nasal septum is with a columellar incision. After dissecting the remaining nasal septal structures of mucoperichondrium and mucoperiosteum, the septal cartilage is removed in toto. Any existing deviations in the nasal bone or osseous area of the nasal septum are straightened. To create a compound graft, one first must assess the approximate size of the polydioxanone plate graft needed and place it between the mucoperichondrial sheets of the nose.

Using polydioxanone foil, the existing nasal septal cartilage and the harvested auricular conchal cartilage are arranged such that the largest and most stable cartilage fragments are located along the dorsal and caudal borders. Next, cartilage fragments are fixed to foil with polydioxanone sutures and are then reimplanted and fixed to the nose as usual (Figure 3).

With the polydioxanone plate, missing nasal septal cartilage (eg, after septal abscess) can be reformed as a straight and stable nasal septum using auricular conchal cartilage, although it is inadequate for nasal septum reconstruction because auricular conchal cartilage is cambered and not as stable as nasal septal cartilage. To ensure that the nasal septum remains straight, the polydioxanone plate supports the auricular conchal cartilage until sufficient stability is obtained by tissue healing.

**Figure 2.** Surgical technique. A, Cartilage fragments are sutured to polydioxanone plate. B, The finished graft. C, The graft is reimplanted into the nose.

**Figure 3.** Combining nasal septal cartilage and auricular conchal cartilage. A, The cartilage is arranged on polydioxanone plate. B, The finished graft with nasal septal cartilage and auricular conchal cartilage.
CASE 1

Figure 4 shows preoperative and postoperative views of a 46-year-old patient with nasal deformity after 4 nasal traumas, leading to complete blockage of the right nasal cavity after nasal septum fracture and a C-shaped deviation of the entire nose toward the right. The defect was corrected with nasal septum reconstruction using a compound graft. The first postoperative photographs were taken 6 months after surgery, and the second postoperative photographs were taken 8 years after surgery. They demonstrate stable results years after surgery.

CASE 2

Figure 5 shows preoperative and postoperative views of a 25-year-old man with severe saddle nose deformity due to septal abscess after nasal trauma 1 year previ-
ously. The septal abscess had destroyed the entire nasal septal cartilage. The nose was reconstructed with auricular conchal cartilage from both ears; one cartilage was used as a compound graft to reconstruct the nasal septum, and the other cartilage was used as a dorsal onlay graft and columellar strut to restore tip support.

The first series of postoperative photographs was taken 6 days after surgery immediately following removal of the external dressing. They show no increased swelling or bruising due to the compound graft compared with other techniques. The second series of postoperative photographs was taken 6 months after surgery following complete resorption of polydioxanone plate. Figure 5A shows frontal views before surgery and 6 days and 6 months after surgery.

CASE 3

Figure 6 shows preoperative and postoperative views of a 21-year-old woman with an extremely underdeveloped and overrotated short nose due to trauma in childhood. She also reported breathing problems. Open sur-
gery was performed, and the missing cartilaginous nasal septum was reconstructed with auricular conchal cartilage and polydioxanone plate. The nose was elongated, and the tip was downward rotated. The missing bony projection was reconstructed with auricular conchal cartilage onlay graft.

**RESULTS**

For evaluation of the results, we used patient report, preoperative and postoperative photographs, and rhinomanometry at follow-up examinations after surgery (2 days, 1 week, 3 weeks, 8 weeks, 6 months, and then yearly). The mean follow-up period was 12 months (maximum, 10 years).

Since 1996, a total of 396 patients (217 male and 179 female [age range, 17-61 years]) have undergone external septoplasty with the polydioxanone plate compound graft. Three hundred eighty patients (96.0%) completed the first 4 postoperative follow-up examinations, 285 patients (72.0%) completed the 6-month follow-up examination, and 257 patients (64.9%) completed the later follow-up examinations.

No immediate complications such as bleeding, septal hematomas, inflammatory reactions, or necrosis occurred. Postoperative crusts disappeared after 2 weeks in almost all patients. The crusts remained 2 weeks longer in 2 patients. After surgery, 19 patients (4.8%) had a slight thickening of the nasal septum for about 3 weeks, which disappeared during the following 2 months.

A straight nasal septum after surgery was achieved in 369 patients (93.2%). In 18 patients (4.5%), revision surgery was performed to correct redeviation or slight polly beak deformity. In 8 patients (2.0%), redeviation caused no functional problems, or patients did not want revision surgery.

A total of 369 patients (93.2%) reported improvement of the nasal airway after surgery. To confirm this objectively, we performed rhinomanometry usually 2 months after surgery. The results showed remarkably improved nasal flow in 324 patients (81.8%).

One patient who was operated on for posttraumatic saddle nose deformity had nasal trauma 4 weeks after surgery that resulted in recurrent saddle nose deformity 5 months after polydioxanone foil resorption. Revision surgery was performed 7 months after the first surgery using the compound graft in association with auricular conchal cartilage, and the nose healed well after the second surgery.

There was no septal perforation even after intraoperative tearing of the mucosa. We have encountered no polydioxanone foil rejection (Table). Despite some cases of severe preoperative nasal deformities, the cosmetic results were satisfactory.

To date, 47 patients (16 female and 31 male [age range, 17-65 years]) have been operated on using the compound graft in association with auricular conchal cartilage. The follow-up period ranges from 4 months to 4 years. In 5 patients, the entire nasal septum was reconstructed with auricular conchal cartilage alone. There was no immediate complication such as septal hematoma or infection. The long-term results are good. In 3 patients, a slight dorsal irregularity occurred, which was corrected using auricular conchal cartilage from the other ear as a dorsal onlay graft.

**COMMENT**

Surgical correction of a deviated nasal septum is one of the most frequently performed surgical procedures. Racial/ethnic groups differ in the prevalence of septal deviations, with the highest incidence among persons of white

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**Table. Patient Demographics**

<table>
<thead>
<tr>
<th>Demographic</th>
<th>No. (%) (n=396)</th>
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<tbody>
<tr>
<td>Sex</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>217 (54.8)</td>
</tr>
<tr>
<td>Female</td>
<td>179 (45.2)</td>
</tr>
<tr>
<td>Nasal septum reconstruction</td>
<td></td>
</tr>
<tr>
<td>With polydioxanone implant</td>
<td>349 (88.1)</td>
</tr>
<tr>
<td>Partly with auricular conchal cartilage</td>
<td>42 (10.6)</td>
</tr>
<tr>
<td>Only with auricular conchal cartilage</td>
<td>5 (1.3)</td>
</tr>
<tr>
<td>Total complications</td>
<td>27 (6.8)</td>
</tr>
<tr>
<td>Immediate</td>
<td></td>
</tr>
<tr>
<td>Epistaxis</td>
<td>0</td>
</tr>
<tr>
<td>Septal hematoma</td>
<td>0</td>
</tr>
<tr>
<td>Infection</td>
<td>0</td>
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<tr>
<td>Long term</td>
<td></td>
</tr>
<tr>
<td>Rejection of polydioxanone implant</td>
<td>0</td>
</tr>
<tr>
<td>Septal perforation</td>
<td>0</td>
</tr>
<tr>
<td>Secondary deviation</td>
<td>26 (6.6)</td>
</tr>
<tr>
<td>Saddle nose deformity</td>
<td>1 (0.3)</td>
</tr>
</tbody>
</table>

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**Figure 6.** Patient in case 3 before surgery and after surgery (left to right). A, Frontal views. B, Oblique views. C, Lateral views.
race/ethnicity. Statistics from North America and Europe show a mean frequency of nasal septal surgery of 1.2 cases per 1000.

Ninety percent of these septal surgery procedures are routine, while the other 10% (usually combined functional and cosmetic deformities) require complex correction. External septoplasty or extracorporeal septum reconstruction seems to be a viable solution for these 10%. External septoplasty is recommended by several authors to correct severe septal deformities (usually post-traumatic).

However, extracorporeal septum reconstruction is time-consuming and technically demanding and is usually performed only by specialists. Even in their hands, there is risk of overlapping of cartilage fragments, leading to postoperative saddle nose deformity.

The use of resorbable polydioxanone plate facilitates this surgical technique. Trimmed nasal septal cartilage fragments are sutured to resorbable polydioxanone plate, creating a stable and straight free graft that can easily be reimplanted into the nose. Polydioxanone plate fixes cartilage fragments, supporting the nasal dorsum until the healing process stabilizes the cartilage. Polydioxanone is subsequently resorbed, avoiding long-term complications association with other artificial implants.

The general biologic properties of polydioxanone implantation in bone repair have been examined. The degradation products of the synthetic aliphatic polymer did not interfere with the normal healing process and stimulated regeneration of the osteoconductive properties of bone.

Alloplastic implants are generally used for their mechanical stability as supporting material, which is the case for cartilage and resorbable polydioxanone plate. Rhi-noplasty implants are necessary only during healing of the supporting tissue; they are subsequently removed to avoid long-term complications. This can be avoided by using resorbable implants, which are completely resorbed after a short period. Therefore, the combination of nasal septal cartilage and resorbable polydioxanone plate offers technical advantages during the operation and the benefits of a resorbable implant during the healing process.

At the time of writing, we had used this technique in 396 patients. Since its original conception, the technique has been further developed to include polydioxanone plate in combination with auricular conchal cartilage. This allows creation of a stable cartilaginous nasal septum auricular conchal cartilage only. Harvesting of rib cartilage is unnecessary, and surgery can be performed in an ambulatory setting.

To date, we have encountered no short- or long-term complications as a consequence of the use of polydioxanone plate. We have seen no allergic reactions, rejection of polydioxanone plate, or local necrosis or infection. The compound graft has proved sufficiently stable to support the cartilage of the nose. A sole occurrence of postoperative saddle nose deformity occurred not because of compound graft instability but because of postoperative nasal trauma. The cosmetic results remain satisfactory years after surgery (M.B., unpublished data, October 29, 2009).

The fundamental surgical goal, straightening of the nasal septum, was achieved in about 87% of patients. From the patients’ viewpoint, the success rate for improvement of nasal breathing was even higher and was supported by rhinomanometry results.

With further development and routine use of reconstruction of the nasal septum with polydioxanone plate, postoperative patient discomfort has decreased. Because of the special suture techniques, postoperative nasal packing is unnecessary. For 3 years, about 95% of all patients have been operated in an ambulatory setting, without negative consequences. The use of polydioxanone plate during septal surgery facilitates external se-toplasty, corrects several combined nasal deformities such as posttraumatic and iatrogenic irregularities, and avoids postoperative saddle nose deformity, without risk to the patient.

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Author Contributions: Study concept and design: Boenisch and Nolst Trenite. Acquisition of data: Boenisch. Analysis and interpretation of data: Boenisch. Drafting of the manuscript: Boenisch. Critical revision of the manuscript for important intellectual content: Boenisch and Nolst Trenite. Statistical analysis: Boenisch. Obtained funding: Boenisch. Administrative, technical, and material support: Boenisch. Study supervision: Boenisch and Nolst Trenite.

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Additional Information: This study was presented as a PhD thesis defense by Dr Boenisch to the Ear, Nose, and Throat Department, Medical Faculty of the University Pécs; February 12, 2008; Pécs, Hungary.

REFERENCES