**Objective:** To describe a technique of extracorporeal septal reconstruction to correct the markedly deviated nasal septum.

**Design:** Retrospective medical chart review of 2119 patients undergoing extracorporeal septoplasty from January 1, 1981, through July 31, 2004, by the author in a tertiary care facial plastic surgery center. The main outcomes measured included surgical complications, revision rate, and the surgeon’s subjective determination of functional and aesthetic outcomes.

**Results:** Of the 2119 patients, 2 cohorts were available for review. From January 1, 1981, to July 31, 1987, the author performed the operation on 459 patients. Fifty-seven complications (12%) occurred, with irregular contour of the dorsum or saddling noted in 38 (8%). Twenty patients (4%) elected to have revision septoplasty. From January 1, 1996, to December 31, 1996, the author supervised residents performing extracorporeal septoplasty in 108 patients. Fourteen postoperative complications (13%) occurred, with dorsal irregularity noted in 12 (11%). Eight patients (7%) elected to have revision septoplasty.

**Conclusions:** Extracorporeal septal reconstruction is an important surgical option for the correction of the markedly deviated nasal septum. Fixation of the straightened and replanted septum at the nasal spine and dorsal septum border with the upper lateral cartilages is essential. Spreader grafts for stabilization of the internal nasal valve and dorsal onlay grafts to prevent dorsal irregularity are strongly encouraged.

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THE NASAL SEPTUM HAS A DECISIVE INFLUENCE ON THE FORM AND FUNCTION OF THE NOSE. This dual aspect is often neglected in the evaluation and surgical correction of the deviated septum. The implications of nasal septal deviation are also frequently underestimated during the correction of the crooked nose. Severe nasal septal deviations usually arise as a result of nasal trauma, previous surgery, or congenital malformation. These cases are characterized by a massive deformation in all levels of the septum with consecutive blockage of 1 or both airways.

Classic septoplasty and septorhinoplasty techniques are not usually capable of reliably correcting severe nasal septal deformities. As early as the 1950s, King and Ashley and Perret suggested that the complete septum should be removed and corrected in such cases. The author began performing extracorporeal septoplasty in the early 1980s. In the past 20 years, the functional and aesthetic results have been evaluated constantly and the technique has been revised with the goals of improving and standardizing the procedure.

A cartilage and bony septum deformed in all 3 levels was a regular occurrence in patients with unilateral cleft lip and palate deformities. The unilateral cleft lip and palate deformity typically presented with the following nasal deformities: shortened columella on the cleft side, asymmetric and displaced nasal tip, asymmetric retrodisplaced nostril, displaced lateral crus, flattened ala, and, most important, to correction of the nasal septum, deflection of the caudal edge of the septum and anterior nasal spine to the non-cleft vestibule.

The traumatized nose also presented with a cartilage and bony septum with deformities in all 3 levels of the nasal septum. These usually were caused by a torn cartilage, which in time caused a deviation. If the fractured cartilage healed in the wrong position, angled deformities often appeared that were difficult or impossible to correct using classic techniques.
Traumatized nasal septums will also frequently present with thickened and redundant cartilage that could make elevation of the mucoperichondrial flaps difficult. In their article on the management of the traumatized nose, Rohrich and Adams commented that the incidence of postreduction deformity requiring subsequent septrhinoplasty ranges from 14% to 50%. They attributed this high revision rate to unrecognized or uncorrected septal deviation. TerKonda and Sykes attributed many twisted noses and markedly deviated septums to trauma. They even attributed those cases without a history of trauma to unrecognized birth trauma or early childhood trauma that disrupts the growth centers of the septum and results in marked abnormal development that manifests at puberty.

Recurrent nasal septal deviation after extensive septal resection with cosmetic deformity is a difficult case to solve, especially when the remaining framework is deviated or destabilized. Frequently, little material to work with remains. We believe that a permanently straight septum, a precondition for a straight outer nose, could only be achieved with an extracorporeal septrhinoplasty in these cases.

**METHODS**

Retrospective chart reviews were performed for all patients undergoing extracorporeal septrhinoplasty by the author from January 1, 1981, through July 31, 1987, and by residents supervised by the author from January 1, 1996, to December 31, 1996. The main outcomes measured included surgical complications, revision rate, and the surgeon’s subjective determination of functional and aesthetic outcomes. The cause and degree of nasal septal deviation were determined when possible. Informed consent for nasal septrhinoplasty or septrhinoplasty with photographic documentation was obtained from the patients or their parent or legal guardian in all cases.
General anesthesia or intravenous conscious sedation was provided in all cases. The patient was positioned, prepared, and draped in a standard fashion. The external nose and internal nasal septum underwent local anesthesia with 0.2% ropivacaine hydrochloride and epinephrine (Naropin) in a 1:100 000 ratio, followed by topical cocaine hydrochloride–saturated cot-

Figure 3. One option for dealing with cartilage that is straight but soft and unstable. A, The removed nasal septum demonstrates cartilage that is thin, weak, and without support. A thin piece of the perpendicular plate of the ethmoid was harvested for stabilization of the cartilage. B, Reconstructed septum as cartilage-bone sandwich transplant. Multiple small holes have been drilled in the lamina perpendicularis to allow suture placement and tissue ingrowth.

Figure 4. A second option for dealing with cartilage that is straight but soft and unstable. A, The removed nasal septum was marked for partial excision of redundant cartilage to be used as a spreader graft. B, The excised cartilage was turned 180° and sutured to the new upper septum border as a spreader graft to strengthen the dorsal support and widen the inner nasal valve.

Figure 5. Extracorporeal septrplasty in a patient who has had multiple previous nasal surgical procedures. A, The segments of the nasal septum. B, The segments were used to reconstruct a straight septal plate. The ruler is given in centimeters.
ton pledgets. In most cases, a closed approach was used (an open approach was used when indicated for external nasal deformity). A right-sided hemitransfixion incision was extended to combine with an intercartilaginous incision. During an open approach, a standard midcolumellar incision with marginal incisions followed by dissection of the membranous septum was used to expose the anterior edge of the cartilaginous septum. Subperichondral dissection was initiated on the concave side of the nasal septum to minimize the risk of tearing the mucosa during the open and closed approaches. This step was followed by bilateral extramucosal dissection of the junction of the border between the caudal septum and upper lateral cartilage to preserve an intact mucosal cover. If dorsal hump reduction was planned, it was undertaken at this point in the operation to enable dissection of the mucosa from a cranial approach on the convex side. This approach was easier and safer when dealing with severe septal deformities. If dorsal hump reduction was not planned, the upper lateral cartilages were incised bilaterally at their junction with the septum after extramucosal dissection. This maneuver made the nasal septum more flexible and made mucosal dissection easier and more accurate. The premaxilla was removed and lower tunnels were dissected according to the technique described by Cottle et al. If hump reduction had been undertaken, the bony septum was vertically fractured as far as possible posteriorly by pressure with a 5-mm chisel. If dorsal hump reduction was not performed, a paramedian osteotomy was necessary to remove the bony septum from the dorsum. The complete cartilaginous and bony septum was then removed in 1 piece.

There are several technical options for creating a straight septal plate. The ideal reconstructed plate would be as large as possible, with stable upper and anterior borders. Redundant cartilage and fracture lines can be excised and sutured together to provide a stable reconstructed nasal septum (Figure 1). Bent deformities can be straightened by unilaterally reducing tension on the cartilage (Figure 2). Partial-thickness releasing incisions were combined with advancement or transposition flaps to achieve optimal external results.
cisions on the concave side of the cartilage with a knife may straighten the bent cartilage. Alternatively, smoothing the cartilage and bone with a sharp drill may be necessary. If the cartilage was straight but soft and unstable, 2 options exist to stabilize it. Smoothly filed pieces of the lamina perpendicularis of the ethmoid bone could be sutured to the cartilaginous septum (Figure 3), or cartilaginous spreader grafts could be sewn to the upper border of the septum to stabilize it and reinforce the internal nasal valve (Figure 4). In posttraumatic cases with multiple fractures sites and cartilaginous fragments healed in the wrong position, it was often possible to dissect and preserve many pieces of straightened cartilage. These could be used to construct a neoseptum (Figure 5). Occasionally, a polydioxanone (PDS) foil to provide a template for suturing and stabilizing the cartilage pieces is necessary (Figure 6). In postoperative and saddle deformity cases with little residual cartilaginous septum, the bony septal fragments could be used to construct a stable septal frame with straight upper and caudal borders (Figure 7). In that case, the bony pieces were filed until smooth and contoured appropriately, and then multiple holes were drilled. The holes were necessary for secure fixation intraoperatively and postoperatively when tissue grows through them. If thickened bone and cartilage occurred at their junction, these could be removed with a sharp fraise, resulting in a straight septum. Reorientation of the septum to provide maximal stability of the caudal and dorsal aspect was sometimes necessary (Figure 8). The neoseptum was then replanted between the subperichondrial and subperiosteal layers.

Figure 8. Patient who had undergone multiple previous nasal surgical procedures. A, Removed nasal septum demonstrates that no residual septal cartilage was present and only thickened bone remained. B, The bony piece of the septum was filed with a burr until it was smooth and straight. Multiple holes were drilled in the bony section for use in the caudal aspect of the reconstructed nasal septum. The holes allowed bony ingrowth and suture stabilization of the replanted nasal septum. C, The straightened septum from an anterior view.

Figure 9. Possible ways of securing the replanted nasal septum. A, Fixation on the spina nasalis anterior and on the lateral cartilage with polydioxanone suture. B, Fixation on the spina nasalis anterior and with transcutaneous U-shaped suture.
Stable fixation of the replanted septum was essential for permanent aesthetic and functional success (Figure 9). The new upper septum border was positioned at the height of the lateral cartilage, temporarily fixed with needles if necessary, and reconnected to the lateral cartilages using 2 sutures. Use of a U-shaped suture pattern is recommended to secure the cartilage and allow final modifications of the dorsum without cutting the suture if indicated. Next, the spina nasalis anterior was positioned in the midline, and a notch and hole were drilled for anterior fixation of the cartilage. The caudal septum border could be shortened if necessary, to adjust the dorsal septum height. A double suture was placed through the drill hole and the lower septum border to anchor it firmly in the region of the nasal spine and the spina nasalis anterior. To avoid postoperative irregularities in the area of the nasal spine, a cartilage caudal strut graft could be placed. To avoid postoperative irregularities of the nasal dorsum, a homologous or autologous fascia onlay graft could be placed onto the dorsum.

The hemitransfixion incision was closed. A quilting suture was placed in the anterior septum, leading from caudal to cranial and back, to approximate the nasal mucosa, prevent dead space/hematoma formation, and further stabilize the replanted septum. After splitting silicone foil was sewn in, antibiotic-soaked (a combination of neomycin sulfate and bacitracin [Nebacetin] and xylometazoline hydrochloride [Otriven]) foam tamponades were inserted, and the patient was awakened and taken to the recovery room.

RESULTS

The extracorporeal septoplasty technique was used in 2119 patients from January 1, 1981, through July 31, 2004, to correct severe deformities of the nasal septum. Nearly half of the patients indicated a previous nasal trauma as the cause of the massive deformities. Cleft lip and palate deformity accounted for 11% of patients, and previous surgery accounted for 21% of patients. In the cleft group, 50% of the patients had undergone previous surgery for correction of the cleft nose deformity. In 10% of the patients, the cause of the severe septum deformity could not be established.

From January 1, 1981, through July 31, 1987, the author performed extracorporeal septoplasty on 459 patients. Based on the subjective opinion of the surgeon and patients and the findings of the clinical examinations, a good to excellent functional result was obtained in 96%. Despite the complex deformity and the complicated operative procedure, postoperative complications were rare (Table), and only 20 patients (4%) elected to have revision septoplasty. Fifty-seven complications (12%) occurred, with the most common complaint being irregular contour of the dorsum (32 patients [7%]).

From January 1, 1996, through December 31, 1996, residents performed extracorporeal septoplasty in 108 patients under the supervision of the author. Results of the postoperative clinical examination revealed improved breathing in all but 2 patients. Fourteen postoperative complications (13%) occurred, with 12 patients (11%) noting dorsal irregularity and 2 (2%) noting recurrent septal deviation. Eight patients (7%) elected to have revision septoplasty. Two representative cases are presented in Figure 10 and Figure 11.

Table. Postoperative Complications of Extracorporeal Septoplasty for the Markedly Deviated Septum

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<td>Renewed septum deviation</td>
<td>2</td>
<td>2</td>
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<tr>
<td>Stiffness of the upper lip</td>
<td>12</td>
<td>0</td>
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<td>Saddling of the dorsum</td>
<td>6</td>
<td>0</td>
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<tr>
<td>Irregular contour of the dorsum</td>
<td>12</td>
<td>3</td>
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<tr>
<td>Abscess (healed without consequence)</td>
<td>1</td>
<td>0</td>
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<tr>
<td>Septum perforation</td>
<td>1</td>
<td>0</td>
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<tr>
<td>Synechia</td>
<td>3</td>
<td>0</td>
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<td>Total Complications</td>
<td>57</td>
<td>14</td>
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In cases of extensive complex nasal septal deformities, classic septoplasty techniques fail in their aim to create a straight septum, a prerequisite for a permanently straight nasal axis and physiological nasal breathing. King and Ashley1 as early as 1952 and Perrett2 in 1958 suggested that in such cases, the removal of the whole septum may be necessary to eventually obtain a straight nasal septum. Because extracorporeal nasal septal reconstruction constitutes radical mobilization of the whole nasal skeletal frame, it was used only in very severe, complex nasal deformities cases.

Although new procedures in septoplasty have been presented in recent years, they are not suitable for massive deformities.13-17 Despite the favorable results found on initial examination of the outcomes (only a 5% correction rate), the technically complex operation is continuously undergoing improvements so that the technique can be recommended to less-experienced surgeons (eg, the second cohort). The refinements were intended to simplify the technique and make it safer, and thus emphasis was placed on constructing a straight septum plate and securing fixation of the replant material.

A clear operative field can be obtained by minimizing blood loss via adequate local anesthetic. This was obtained using topical cocaine and careful injection of ropivacaine hydrochloride and epinephrine (1:100 000). Ropivacaine is a local anesthetic with vasoconstrictive properties and effects that last longer than those of epinephrine.18 A clear field allows precise tissue dissection, preserves mucosa, and enables accurate osteotomy site placement.

The use of a pneumatically powered fraise to straighten severe cartilaginous and bony septum deformities has proved valuable. A sharp fraise can be used to thin areas of thickened cartilage and areas of deviated cartilage unilaterally over the surface, so that they straighten automatically as a result of the change in tension. It is also possible to construct extremely thin septal plates using parts of the lamina perpendicularis. These can then be sutured to very soft cartilage to increase stability (cartilage-
Figure 10. Forty-eight-year-old woman who had undergone 2 previous septorhinoplasty procedures. A–C, Preoperative photographs show the patient’s obvious parrot-beak deformity in profile, asymmetric ala, and airway obstruction. D–F, Postoperative photographs of the same patient 1 year after closed extracorporeal septorhinoplasty. G, The removed nasal septum was deviated with an S-shaped configuration. H, The septum was straightened by scarification and turned 90°, so that the former cartilaginous dorsum now forms the anterior septum border.
bone sandwich transplant). The use of spreader grafts helps to guarantee the shape of the straightened septum cartilage permanently and to prevent a collapse of the nasal valves.18

Bonisch and Mink19 suggested that the use of PDS foil to stabilize transplants during the healing phase is a feasible alternative to the use of bone, and these results confirm that this is indeed the case. The PDS foil was used when it was necessary to approximate multiple small pieces of cartilage that would otherwise lack stability. No complications were caused by using the PDS foil as a septal splint, but its use is recommended only when the nasal septal mucosal covering is intact and not markedly atrophic or thinned. Investigations are under way to determine whether PDS foil can be used in situations where the subperichondrium is not intact.

Secure fixation of the extracorporeal septoplasty implant was essential for successful long-term aesthetic and functional outcomes. Fixation must prevent both the neo-septum from slipping out of the midline and dorsal sagging. To accomplish this, the spina nasalis anterior and nasal spine must be in the midline. If such is not the case, a minor dislocation of the bone can be achieved with a fraise unilaterally, so that the remaining bone is in the center. Occasionally, it was necessary to fracture the na-

Figure 11. Twenty-year-old woman with a saddle nose deformity following childhood trauma. A-C, Preoperative photographs. D-F, Postoperative photographs of the same patient 1 year after open extracorporeal septorhinoplasty. G, The removed nasal septum with thickened bone and minimal cartilage. H-I, Polydioxanone foil was necessary to stabilize the reconstructed nasal septum.
sal spine to secure it in the midline with microplates. Initially, fixation was solely in the area of the nasal spine and with transseptal mattress sutures. By drilling a hole in the nasal spine for more secure double-suture fixation anteriorly, the rate of slippage was decreased from 6.4% to 3.6%. An additional point of fixation at the area of attachment of the upper lateral cartilages to the dorsal septum is currently recommended. This is relatively easy during an open approach but is also possible through a closed approach. This additional level of stability helped decrease the rate of postoperative dorsal saddling from 1.5% to 0%. Alternatively, Numanoglu suggested a transcutaneous suture that, although it prevents slippage, is not as exact for restoring the nasal valve. Transseptal mattress sutures providing additional stability were initially done with resorbable suturing material that was removed after 14 days. Now, however, the technique uses PDS sutures, which guarantee a significantly longer stabilization and do not need to be removed.

The most common complications in both cohorts studied were postoperative irregularities of the nasal dorsum. In thin-skinned individuals, bony and cartilaginous irregularities could be palpated and occasionally visualized. These irregularities were along the whole dorsum and were not isolated to the osseocartilaginous junction. They were not caused by descent of the septum. In the author’s opinion, this problem can be dealt with best by covering the whole dorsum evenly with a cartilaginous onlay graft as suggested by McKinney or by using an autologous or homologous fascial onlay graft. A saddling of the dorsum occurred more frequently in the first series examined. At that time, only transseptal mattress sutures were being used to secure the septum. When the septum was also secured to the upper lateral cartilages, the incidence of saddling decreased dramatically. Although cerebrospinal fluid leak is a theoretical risk with the extensive removal of the septum, no leaks occurred as a result of extracorporeal septoplasty. A lateral movement of the chisel is used to fracture the thin perpendicular plate of the ethmoid bone. Owing to this technique, the fracture did not extend to the thicker skull base. An increased incidence of postoperative nasal fracture has not been found as a complication of this procedure. The nasal vault was supported postoperatively for 2 weeks by a combined forehead and nasal splint with a circular bandage around the forehead to secure it in place. This plaster cast helps to immobilize the facial and nasal musculature during the postoperative period.

This vast experience of extracorporeal septoplasty in 2119 patients spanning 20 years demonstrates that it is an important technique in the armamentarium of surgeons for correcting of extensive nasal septal deviations that result from trauma, previous surgery, or congenital anomalies. During the study period, the technique was improved to make it safe and practical for all surgeons dealing with this difficult problem. For a successful outcome, meticulous use of local anesthetics and hemostasis, fixation of the straightened septum at the nasal spine and upper lateral cartilages, quilting suture to approximate mucoperichondrium, and dorsal onlay grafts to camouflage any subsequent irregularities are recommended.

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