# Differences between Primary and Revision Rhinoplasty: Indications, Techniques, Grafts, and Outcomes

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PATIENT SAFETY


**Background:** The nose is at the center of the face and has essential functional and aesthetic properties. Over recent years, rhinoplasty has gained increasing popularity through the influence of "selfies" and social media. As a result, a growing demand for secondary correction has also emerged. Revision rhinoplasty is more complex than primary cases and often requires the use of extranasal grafting material. The authors sought to analyze the indications, techniques, and outcomes after primary and revision rhinoplasty.
**Methods:** A total of 245 patients (153 primary cases and 92 revisions) undergoing surgery at the authors' specialized clinic for facial plastic surgery were included. All patients were treated by an experienced facial plastic surgeon according to the authors' established clinic standards. A retrospective data analysis was performed to evaluate the differences between the groups regarding the indications, intraoperative techniques, and postoperative outcomes.
**Results:** Although more patients sought revision surgery for aesthetic reasons alone than isolated functional issues, almost two-thirds of the revision patients had functional and aesthetic problems in combination. Complex reconstructive techniques, extracorporeal septoplasties, and extranasal grafts were more commonly used in revision cases. The occurrence of another revision during the follow-up period was significantly higher after revision surgery compared to primary rhinoplasty cases (primary rhinoplasty, 10.5 percent; revision surgery, 23.9 percent; $p = 0.006$).
**Conclusions:** There are differences between primary and revision rhinoplasty that must be appreciated by the treating surgeon. The patient should be informed about the increased complexity of the secondary procedure, the possible need for extranasal grafts, and the increased risk of a further revision. (*Plast. Reconstr. Surg.* 148: 532, 2021.)
**CLINICAL QUESTION/LEVEL OF EVIDENCE:** Therapeutic, IV.

Rhinoplasty remains among the most popular procedures with plastic surgery patients, and the number of cases performed has been on the rise in recent years.[1,2] The growing acceptance of aesthetic procedures combined with the expanding popularity of "selfies" and social media has led to an increase in patients wanting and willing to undergo surgery to enhance their physical appearance, especially the face.[3–5] Because of the broad spectrum of possible preoperative deformities, rhinoplasty is generally considered to be among the most challenging procedures for facial plastic surgeons.[6] There is a delicate interaction between function and aesthetic form that has to be considered by any rhinoplasty surgeon, as patient satisfaction can only be achieved when both aspects are addressed.[6] Functional problems

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and realistic aesthetic goals should be addressed in detail during the patient's consultations.[1,7]

Grafting techniques are frequently required to achieve a stable framework or to improve aesthetics. In case of insufficient septal cartilage, the most common donor sites for extranasal grafting material are auricular cartilage and costal cartilage.[8,9] The possibility of extranasal grafting needs to be discussed with the patient preoperatively, as any additional donor site is associated with an increased morbidity.[8]

Revision rhinoplasty is more complex than primary rhinoplasty. This is because of the presence of scar tissue (with associated additional bleeding), the disruption of the anatomical structures of the nose, and often an insufficient osseocartilaginous framework.[10] In addition, the patients' expectations are higher in revision cases, as they are often traumatized or disappointed by the previous surgery.[11] Therefore, a revision rhinoplasty requires more preoperative planning and a broader repertoire of intraoperative techniques than a primary case. The problems requiring revision include both functional and aesthetic aspects.[12] In secondary rhinoplasty, breathing problems are often aggravated by postoperative scarring, insufficient central support, sidewall instability, and overly narrowed airways. Many patients seek the expertise of another rhinoplasty surgeon for the secondary surgery, as they have lost trust in the primary surgeon.[13] According to previous reports, the overall revision rate for rhinoplasty was reported to be as high as 20 percent. This rate depends on various variables, but especially the complexity of the surgical procedure.[14–16] Taking into consideration the total increase in rhinoplasty numbers performed worldwide, revision case workload will also be growing.

Revision rhinoplasty requires a different surgical approach, and frequently also the use of extranasal donor material to create a stable osseocartilaginous framework and the desired aesthetic result. However, despite the increasing significance of this procedure, only limited data are available on the differences between primary and revision rhinoplasty regarding the indications, techniques, grafts, and postoperative outcomes.[8,17,18] This article aims to elucidate these differences among a homogenous patient cohort at our specialized clinic for facial plastic surgery.

## PATIENTS AND METHODS

The study was performed in accordance with the Declaration of Helsinki and our local ethical standards. We conducted a retrospective, single-center analysis of all consecutive patients undergoing either primary or revision rhinoplasty at our tertiary referral center from January to June of 2015. The time interval was chosen to allow for the analysis of a homogenous patient cohort and to ensure long-term follow-up to 4 years. Patients were treated according to our established clinic protocols for rhinoplasty surgery and postoperative care. An open approach was used in most cases, as this is the departmental standard. Patients with functional, aesthetic, and combined indications were included in the study. The patient charts and surgical reports were analyzed retrospectively for data set variables. Patient demographics, follow-up times, preoperative problems and indications for surgery, intraoperative techniques, grafts and donor sites, postoperative complications, and revisions were all recorded and analyzed between the study groups. Exclusion criteria included nasal deformities caused by autoimmune disorders, surgery for closure of septal perforations, tumor reconstructions, and total nasal reconstructions. All patients were operated on by an experienced member of our department of facial plastic surgery (a total of nine facial plastic surgeons).

### Surgical Techniques

The open approach by means of an inverted-V incision at the narrowest part of the columella was used to gain access to the nasal framework. After submucoperichondrial dissection of the septum, the preoperative plan was reviewed to confirm the intraoperative techniques required and to establish the amount of extranasal grafts necessary. We used standardized techniques to take auricular or rib cartilage where needed. Conchal cartilage was harvested by means of a retroauricular incision. Costal cartilage was taken at a length of approximately 6 cm by means of an anterior chest incision and was used when a thin and straight graft was needed. We routinely use the eighth or ninth rib for the cartilage harvest because this yields a sufficiently long and straight piece of cartilage, even for total reconstructions of the nasal framework. Conchal cartilage was mostly added as a double-layered graft, which led to increased thickness. In cases with a severely deviated septum, an extracorporeal septoplasty was used.[19–21] The septum was dissected submucoperichondrially, and released from the anterior nasal spine and the maxillary crest. The upper lateral cartilages were split from the dorsal septum to gain full access to the septum. It was then removed in one piece together with parts of the perpendicular plate of the ethmoid

bone after fracturing. If the anterior septum was severely deviated but the dorsal part of the septum was straight, we performed a partial extracorporeal septoplasty. In these cases, only the anterior portion of the septum was removed and reconstructed, whereas the dorsal part remained intact. If needed, allogenic fascia material was used in the form of Tutoplast (RTI Surgical, Marquette, Mich.). In patients with a saddle nose deformity, fascial material was often required to augment the dorsum using diced cartilage in fascia. Free diced cartilage was used frequently as described previously.[16] The dorsal fixation of the framework was achieved using the previously described transcutaneous-transosseous cerclage suture, or the crisscross suture (Figs. 1 and 2).[22,23]

### Statistical Analysis

We used IBM SPSS Version 24.0 (IBM Corp., Armonk, N.Y.) for data analysis. The nonparametric Mann-Whitney *U* test was used to compare values between two independent groups. Nominal variables were compared using the Fisher's exact test. We further performed univariate and multivariate logistic regression models to calculate the effect of independent variables on outcome variables. For the multivariate model, only variables with a value of $p < 0.10$ in the univariate model were included in the analysis. We performed a receiver operating characteristic curve analysis with the predicted probabilities of the multivariate regression model to investigate the fitting behavior of the model. If not stated otherwise, results are given as median and interquartile range. In all calculations, a value of $p < 0.05$ was considered statistically significant. The *p* values were not adjusted for multiple comparisons.

## RESULTS

### Demographic Data

A total of 245 patients (162 female and 83 male) were included over the 6-month study period. There were 153 cases of primary rhinoplasty and 92 revision cases. The patients in the revision group were significantly older (33.7 years versus 28.9 years), but there was no difference in the female-to-male ratio. We found a significant difference in the indication for surgery between the groups. As many as 31.5 percent of the patients in the revision group underwent surgery for aesthetic reasons without any functional problems, whereas only 13.7 percent of the patients did so in the primary rhinoplasty group. In both groups, the majority of patients had a combined functional-aesthetic indication for surgery. The majority of patients (88.1 percent) in the revision group had undergone

**Fig. 1.** The transcutaneous-transosseous cerclage suture technique was used for the dorsal fixation of the nasal framework. (*Above*) A 20-gauge needle is positioned percutaneously and drilled through the skin, the nasal bones, the upper lateral cartilages, and the septum. A 4-0 polydioxanone suture is fed through the needle tip until it emerges from the needle hub. (*Center*) The needle is removed, and the suture is left in position. (*Below*) The suture is led back to the other side through a second drill hole created by the 20-gauge needle. The suture is tied and the knot is placed on the side of the dorsum. Surgeon's perspective.

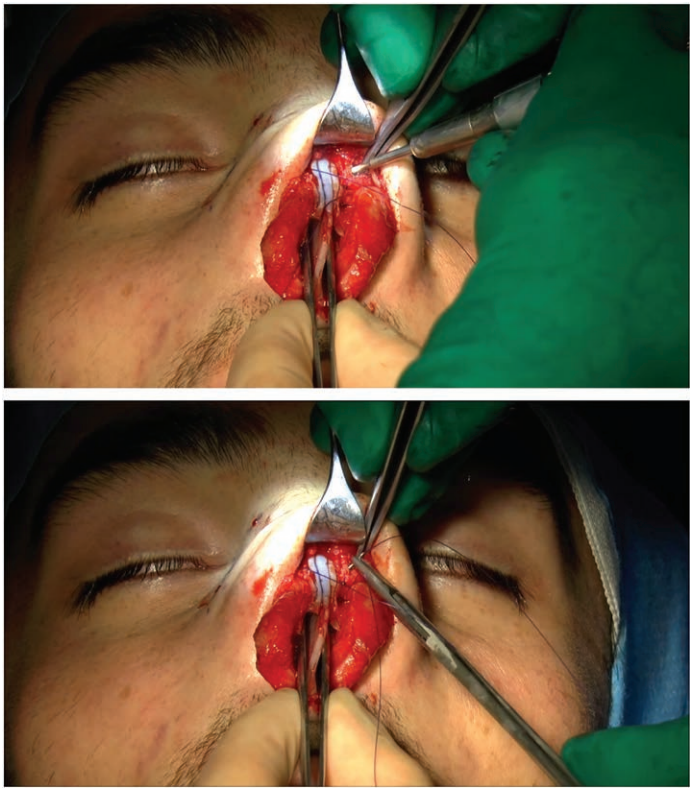

**Fig. 2.** In case of longer nasal bones, the criss-cross suture technique was used. (*Above*) A diagonal drill hole is created through the caudal border of the nasal bone above the keystone area. (*Below*) A 4-0 polydioxanone round needle suture is passed through this drill hole, the upper lateral cartilages, and the septum, appearing on the contralateral side at the level of the middle part of the upper lateral cartilage. A second drill hole is created on the other side. The fixation suture is passed back to the initial side and finally tied, creating a firm fixation in a criss-cross pattern.

surgery at another clinic and then underwent revision surgery at our clinic. There was no difference between the groups regarding the type of surgical approach, as the open approach is the preferred method at our clinic. The median follow-up period was significantly longer after revision surgery (0.69 year versus 0.59 year) (Table 1).

### Preoperative Findings Indicate More Functional Problems in Primary Rhinoplasty

We found significant differences in the preoperative problems and the resulting indications for surgery between primary cases and revision cases. The majority of patients undergoing primary rhinoplasty suffered from functional impairments and had difficulties with breathing (86.3 percent), septal deviation (87.6 percent), or hypertrophy of the inferior turbinate (72.5 percent). The ratio of the functional problems was markedly lower in the revision group. Interestingly, we still found a residual septal deviation in 52.2 percent and difficulties with breathing in 66.3 percent of the revision cases. A dorsal hump was seen in 64.1 percent of the primary cases and in 25.0 percent of the revision rhinoplasty cases. In addition, we saw significant differences between the groups regarding the aesthetic aspects of the nose. As expected, alar cartilage deformities (27.2 percent), dorsal irregularities (39.1 percent), saddle nose deformities (19.6 percent), a short nose (8.7 percent), or a hidden columella (8.7 percent) were more prevalent in the revision group, whereas an undefined nasal tip (21.6 percent) was more common among patients undergoing primary rhinoplasty. All preoperative findings and the differences between the primary and revision rhinoplasty groups are depicted in Table 2.

**Table 1. Demographic Data***

| | All Patients (%) | Primary Rhinoplasty (%) | Revision Rhinoplasty (%) | *p* |
|---|---|---|---|---|
| No. | 245 | 153 | 92 | |
| Age, yr | | | | 0.006 |
| Median | 30.8 | 28.9 | 33.7 | |
| IQR | 24.9–40.6 | 24.1–39.6 | 27.8–42.0 | |
| Sex | | | | 0.210 |
| Female | 162 (66.1) | 106 (69.3) | 56 (60.9) | |
| Male | 83 (33.9) | 47 (30.7) | 36 (39.1) | |
| Indication | | | | 0.003 |
| Functional | 33 (13.5) | 24 (15.7) | 9 (9.8) | |
| Aesthetic | 50 (20.4) | 21 (13.7) | 29 (31.5) | |
| Both | 162 (66.1) | 108 (70.6) | 54 (58.7) | |
| Surgical approach | | | | 0.156 |
| Open | 237 (96.7) | 150 (98.0) | 87 (94.6) | |
| Closed | 8 (3.3) | 3 (2.0) | 5 (5.4) | |
| Mean no. of prior operations ± SD | | | 1.78 ± 1.11 | |
| At our clinic | | | 11 (12.0) | |
| At another clinic | | | 71 (77.2) | |
| Both | | | 10 (10.9) | |
| Follow-up, yr | | | | 0.033 |
| Median | 0.63 | 0.59 | 0.69 | |
| IQR | 0.12–1.31 | 0.08–1.07 | 0.38–1.72 | |

IQR, interquartile range.
*Patients in the revision group were significantly older and had a longer follow-up period than patients undergoing primary rhinoplasty. Aesthetic indications were more common in the revision group.

### Surgical Techniques Are More Complex in Revision Rhinoplasty

We found significant differences regarding the surgical techniques and their complexity between the study groups. The results are described in Tables 3 and 4. Notably, the need for extranasal cartilage was significantly higher in the revision group. In 66.3 percent of our revision cases, the use of costal or auricular cartilage was necessary, whereas only 7.2 percent of the patients undergoing primary surgery needed extranasal cartilage. In addition, the ratio of complex to routine septoplasty was twice as high in the revision group, with approximately one-third of the patients requiring a partial or total extracorporeal septoplasty. In contrast, an endonasal septoplasty was sufficient in 77.1 percent of the primary cases. Approximately one-third

**Table 2. Preoperative Findings***

| | All Patients | | Primary Rhinoplasty | | Revision Rhinoplasty | | |
|---|---|---|---|---|---|---|---|
| | No. | % | No. | % | No. | % | *p* |
| Total | 245 | | 153 | | 92 | | |
| Difficulty with breathing | 193 | 78.8 | 132 | 86.3 | 61 | 66.3 | <0.001 |
| Septal deviation | 182 | 74.3 | 134 | 87.6 | 48 | 52.2 | <0.001 |
| Hypertrophy of inferior turbinate | 126 | 51.4 | 111 | 72.5 | 15 | 16.3 | <0.001 |
| Dorsal hump | 121 | 49.4 | 98 | 64.1 | 23 | 25.0 | <0.001 |
| Crooked nose | 97 | 39.6 | 58 | 37.9 | 39 | 42.4 | 0.503 |
| Droopy nasal tip | 80 | 32.7 | 49 | 32.0 | 31 | 33.7 | 0.781 |
| Wide dorsum | 46 | 18.8 | 30 | 19.6 | 16 | 17.4 | 0.737 |
| Alar cartilage deformity | 45 | 18.4 | 20 | 13.1 | 25 | 27.2 | 0.010 |
| Undefined tip | 38 | 15.5 | 33 | 21.6 | 5 | 5.4 | <0.001 |
| Asymmetric nostrils | 37 | 15.1 | 20 | 13.1 | 17 | 18.5 | 0.272 |
| Irregularities | 37 | 15.1 | 1 | 0.7 | 36 | 39.1 | <0.001 |
| Saddle nose | 22 | 9.0 | 4 | 2.6 | 18 | 19.6 | <0.001 |
| Narrow dorsum | 21 | 8.6 | 14 | 9.2 | 7 | 7.6 | 0.815 |
| Tip overprojection | 21 | 8.6 | 15 | 9.8 | 6 | 6.5 | 0.482 |
| Inverted-V deformity | 11 | 4.5 | 6 | 3.9 | 5 | 5.4 | 0.751 |
| Short nose | 10 | 4.1 | 2 | 1.3 | 8 | 8.7 | 0.007 |
| Pinched tip | 10 | 4.1 | 4 | 2.6 | 6 | 6.5 | 0.183 |
| Hidden columella | 10 | 4.1 | 2 | 1.3 | 8 | 8.7 | 0.007 |
| Hanging columella | 6 | 2.4 | 5 | 3.3 | 1 | 1.1 | 0.414 |
| Septal perforation | 4 | 1.6 | 0 | 0.0 | 4 | 4.3 | 0.019 |
| Synechia | 3 | 1.2 | 0 | 0.0 | 3 | 3.3 | 0.052 |

*The majority of primary rhinoplasty patients had functional problems. A notable percentage of patients undergoing revision rhinoplasty still suffered from breathing problems.

**Table 3. Surgical Techniques***

| | All Patients | | Primary Rhinoplasty | | Revision Rhinoplasty | | |
|---|---|---|---|---|---|---|---|
| | No. | % | No. | % | No. | % | *p* |
| Total | 245 | | 153 | | 92 | | |
| Septoplasty | | | | | | | <0.001 |
| None | 39 | 15.9 | 9 | 5.9 | 30 | 32.6 | |
| Endonasal | 150 | 61.2 | 118 | 77.1 | 32 | 34.8 | |
| Partially extracorporeal | 21 | 8.6 | 10 | 6.5 | 11 | 12.0 | |
| Total extracorporeal | 35 | 14.3 | 16 | 10.5 | 19 | 20.7 | |
| Extranasal cartilage | | | | | | | <0.001 |
| None | 173 | 70.6 | 142 | 92.8 | 31 | 33.7 | |
| Auricular | 15 | 6.1 | 5 | 3.3 | 10 | 10.9 | |
| Costal | 55 | 22.4 | 5 | 3.3 | 50 | 54.3 | |
| Both | 2 | 0.8 | 1 | 0.7 | 1 | 1.1 | |
| Fascia | | | | | | | 0.002 |
| None | 201 | 82.0 | 136 | 88.9 | 65 | 70.7 | |
| Autologous temporal | 13 | 5.3 | 6 | 3.9 | 7 | 7.6 | |
| Autologous rectus | 10 | 4.1 | 2 | 1.3 | 8 | 8.7 | |
| Allogenic | 19 | 7.8 | 8 | 5.2 | 11 | 12.0 | |
| Autologous and allogenic | 2 | 0.8 | 1 | 0.7 | 1 | 1.1 | |
| Dorsal fixation | | | | | | | 0.016 |
| None | 184 | 75.1 | 123 | 80.4 | 61 | 66.3 | |
| TTC suture | 40 | 16.3 | 22 | 14.4 | 18 | 19.6 | |
| Criss-cross suture | 20 | 8.2 | 7 | 4.6 | 13 | 14.1 | |
| Both | 1 | 0.4 | 1 | 0.7 | 0 | 0.0 | |
| Fixation to anterior nasal spine | | | | | | | 0.286 |
| None | 61 | 24.9 | 33 | 21.6 | 28 | 30.4 | |
| Suture | 179 | 73.1 | 116 | 75.8 | 63 | 68.5 | |
| Other | 5 | 2.0 | 4 | 2.6 | 1 | 1.1 | |
| Total reconstruction with extranasal cartilage | | | | | | | <0.001 |
| None | 199 | 81.2 | 148 | 96.7 | 51 | 55.4 | |
| L-frame | 15 | 6.1 | 2 | 1.3 | 13 | 14.1 | |
| Alar cartilages | 5 | 2.0 | 0 | 0.0 | 5 | 5.4 | |
| Both | 5 | 2.0 | 1 | 0.7 | 4 | 4.3 | |
| Anterior septum | 21 | 8.6 | 2 | 1.3 | 19 | 20.7 | |
| Middle vault | | | | | | | <0.001 |
| No graft | 39 | 15.9 | 16 | 10.5 | 23 | 25.0 | |
| Spreader grafts | 44 | 18.0 | 32 | 20.9 | 12 | 13.0 | |
| Extended spreader grafts | 61 | 24.9 | 14 | 9.2 | 47 | 51.1 | |
| Spreader flaps | 92 | 37.6 | 83 | 54.2 | 9 | 9.8 | |
| Spreader grafts and spreader flaps | 9 | 3.7 | 8 | 5.2 | 1 | 1.1 | |

TTC, transcutaneous-transosseous cerclage.
*The intraoperative techniques that were used in our patient groups are listed. Patients in the revision groups required significantly more complex types of septoplasty. They also needed more extranasal grafts from costal and conchal cartilage, fascia grafts, and total reconstructions of the cartilaginous framework.

of the revision cases did not require any further correction of the septum. We used significantly more fascia grafts in the revision group (29.3 percent versus 11.1 percent). Almost half of the patients in the revision group (44.6 percent) had a total reconstruction of the cartilaginous framework or parts thereof. As expected, the use of autologous spreader flaps was more common in the primary surgery group (54.2 percent versus 9.8 percent), whereas extended spreader grafts were used more frequently in the revision group (51.1 percent versus 9.2 percent). Free diced cartilage was frequently used in both groups (89.5 percent versus 81.5 percent). However, the use of diced cartilage in fascia was more frequent in the revision group (21.7 percent versus 2.6 percent). We performed osteotomies regularly in primary rhinoplasty cases and in approximately half of the revision cases.

### Revision Rhinoplasty Leads to More Revisions Than Primary Rhinoplasty

The revision rate after primary rhinoplasty at our clinic was 10.5 percent. However, after revision rhinoplasty, 23.9 percent of the patients had to undergo another revision during the follow-up period ($p = 0.006$). We performed a subgroup analysis and found that the majority of the patients who required another revision had previously been operated on at another clinic, or at both our clinic and another clinic. None of the patients who had undergone the primary and revision rhinoplasty exclusively at our clinic required an additional (tertiary) revision surgery. The most frequent indications for revisions of our own rhinoplasties were minor problems such as contour irregularity (8.2 percent), asymmetry (5.7 percent), or a persistent wide dorsum (2.4 percent). The statistical differences between the groups were marginal (Table 5).

**Table 4. Surgical Techniques***

| | All Patients | | Primary Rhinoplasty | | Revision Rhinoplasty | | |
|---|---|---|---|---|---|---|---|
| | No. | % | No. | % | No. | % | *p* |
| Total | 245 | | 153 | | 92 | | |
| Free diced cartilage | 212 | 86.5 | 137 | 89.5 | 75 | 81.5 | 0.084 |
| Tongue-in-groove | 179 | 73.1 | 128 | 83.7 | 51 | 55.4 | <0.001 |
| Osteotomies | 172 | 70.2 | 120 | 78.4 | 52 | 56.5 | <0.001 |
| Fracturing of turbinate | 143 | 58.4 | 115 | 75.2 | 28 | 30.4 | <0.001 |
| Rim grafts | 89 | 36.3 | 61 | 39.9 | 28 | 30.4 | 0.170 |
| Columella strut | 86 | 35.1 | 62 | 40.5 | 24 | 26.1 | 0.027 |
| Septal extension graft | 72 | 29.4 | 47 | 30.7 | 25 | 27.2 | 0.664 |
| Cap graft | 35 | 14.3 | 27 | 17.6 | 8 | 8.7 | 0.060 |
| Shield graft | 32 | 13.1 | 13 | 8.5 | 19 | 20.7 | 0.010 |
| DCF | 24 | 9.8 | 4 | 2.6 | 20 | 21.7 | <0.001 |
| Batten grafts | 21 | 8.6 | 8 | 5.2 | 13 | 14.1 | 0.019 |
| Lateral crural strut grafts | 15 | 6.1 | 3 | 2.0 | 12 | 13.0 | 0.001 |
| Supratip breakpoint suture | 6 | 2.4 | 5 | 3.3 | 1 | 1.1 | 0.414 |
| Spacer graft | 3 | 1.2 | 0 | 0.0 | 3 | 3.3 | 0.052 |
| Alar base resection | 3 | 1.2 | 2 | 1.3 | 1 | 1.1 | 1.000 |
| Nostril sill resection | 3 | 1.2 | 1 | 0.7 | 2 | 2.2 | 0.558 |
| Dome division | 3 | 1.2 | 2 | 1.3 | 1 | 1.1 | 1.000 |

DCF, diced cartilage in fascia.
*The applied intraoperative techniques, sorted from the most frequently to the least frequently used technique, are listed. We found a significantly higher rate of tongue-in-groove technique, osteotomies, and fracturing of the inferior turbinate in the primary rhinoplasty group. Shield grafts, diced cartilage in fascia, alar batten grafts, and lateral crural strut grafts were more common in the revision group.

### Regression Models Show Independent Factors Leading to a Revision

We calculated univariate and multivariate logistic regression models to evaluate the factors associated with the need for a revision during the follow-up period. In the univariate analysis, patients after previous rhinoplasty surgery were more likely to require a revision compared to primary rhinoplasty patients (OR, 2.69; 95 percent CI, 1.33 to 5.45; $p = 0.006$). In addition, the use of extranasal cartilage was associated with higher rates of revision surgery (OR, 2.55; 95 percent CI, 1.26 to 5.18; $p = 0.010$); 25.5 percent of the patients after rib-cartilage grafts and 20.0 percent of the patients after ear cartilage grafts had to undergo revision surgery during the follow-up period, compared to 11.6 percent of the patients who did not require any extranasal cartilage grafts ($p = 0.041$). Total reconstruction of the nasal framework with extranasal cartilage was also associated with higher revision rates (OR, 3.19; 95 percent CI, 1.49 to 6.82; $p = 0.003$). The effects of the univariate models were not confirmed in the multivariate model. The fitting behavior of the multivariate model was investigated by means of receiver operating characteristic curve analysis using the predicted probabilities. The area under the curve was 0.669 (95 percent CI, 0.575 to 0.764;

**Table 5. Outcome***

| | All Patients | | Primary Rhinoplasty | | Revision Rhinoplasty | | |
|---|---|---|---|---|---|---|---|
| | No. | % | No. | % | No. | % | *p* |
| Total | 245 | | 153 | | 92 | | |
| Revisions during follow-up | 38 | 15.5 | 16 | 10.5 | 22 | 23.9 | 0.006 |
| Revisions after secondary surgery at our clinic | | | | | | | |
| Prior surgery at our clinic ($n = 11$) | | | | | 0 | 0.0 | |
| Prior surgery at other clinic ($n = 71$) | | | | | 19 | 26.8 | |
| Both ($n = 10$) | | | | | 3 | 30.0 | |
| Indications for revision | | | | | | | |
| Irregularities | 20 | 8.2 | 10 | 6.5 | 10 | 10.9 | 0.342 |
| Asymmetries | 14 | 5.7 | 9 | 5.9 | 5 | 5.4 | 0.047 |
| Wide dorsum | 6 | 2.4 | 3 | 2.0 | 3 | 3.3 | 0.682 |
| Crooked nose | 5 | 2.0 | 4 | 2.6 | 1 | 1.1 | 0.141 |
| Deformity of alar cartilages | 5 | 2.0 | 0 | 0.0 | 5 | 5.4 | 0.061 |
| Difficulty with breathing | 4 | 1.6 | 3 | 2.0 | 1 | 1.1 | 0.291 |
| Drooping of nasal tip | 4 | 1.6 | 3 | 2.0 | 1 | 1.1 | 0.291 |
| Residual dorsal hump | 4 | 1.6 | 2 | 1.3 | 2 | 2.2 | 1.000 |

*The revision rate after revision rhinoplasty was significantly higher than after primary rhinoplasty. The majority of the complications resulting in corrective surgery were minor and mainly included irregularities and asymmetries.

$p = 0.001$). All other variables did not have a significant effect on the occurrence of a revision during the follow-up period (Table 6).

## DISCUSSION

The success of any rhinoplasty surgery depends on preoperative planning, patient selection, and the applied intraoperative techniques.[2] The multitissue, three-dimensional nasal anatomy and the close relationship between functional and aesthetic aspects have to be considered preoperatively.[6] This preoperative plan has to be reevaluated during the operation to adjust the surgical techniques and to determine the need for extranasal cartilage. Revision rhinoplasty is mostly more challenging

**Table 6. Logistic Regression Models***

| | Univariate Regression Analysis | | | Multivariate Regression Analysis | | |
|---|---|---|---|---|---|---|
| **Characteristic** | **OR** | **95% CI** | ***p*** | **OR** | **95% CI** | ***p*** |
| Demographic data | | | | | | |
| Prior rhinoplasty | 2.69 | 1.33–5.45 | 0.006 | 1.46 | 0.52–4.12 | 0.477 |
| Age | 1.00 | 0.97–1.03 | 0.962 | | | |
| Sex | 1.33 | 0.65–2.72 | 0.429 | | | |
| Indication for surgery | 1.21 | 0.73–2.02 | 0.465 | | | |
| Preoperative findings | | | | | | |
| Difficulty with breathing | 0.85 | 0.37–1.92 | 0.687 | | | |
| Septal deviation | 0.61 | 0.29–1.29 | 0.195 | | | |
| Hypertrophy of inferior turbinate | 0.50 | 0.24–1.01 | 0.053 | 0.74 | 0.32–1.75 | 0.493 |
| Dorsal hump | 0.71 | 0.35–1.42 | 0.330 | | | |
| Crooked nose | 1.29 | 0.64–2.58 | 0.481 | | | |
| Droopy nasal tip | 1.25 | 0.61–2.56 | 0.550 | | | |
| Wide dorsum | 0.61 | 0.23–1.67 | 0.339 | | | |
| Alar cartilage deformity | 1.76 | 0.78–3.94 | 0.173 | | | |
| Undefined tip | 1.28 | 0.52–3.17 | 0.590 | | | |
| Asymmetric nostrils | 1.64 | 0.68–3.92 | 0.269 | | | |
| Irregularities | 1.07 | 0.41–2.76 | 0.898 | | | |
| Saddle nose | 1.69 | 0.59–4.91 | 0.332 | | | |
| Narrow dorsum | 0.55 | 0.12–2.46 | 0.434 | | | |
| Tip overprojection | 0.55 | 0.12–2.46 | 0.434 | | | |
| Inverted-V deformity | 0.53 | 0.07–4.29 | 0.554 | | | |
| Short nose | 2.45 | 0.60–9.93 | 0.210 | | | |
| Pinched tip | 2.45 | 0.60–9.93 | 0.210 | | | |
| Hidden columella | 2.45 | 0.60–9.93 | 0.210 | | | |
| Hanging columella | 1.09 | 0.12–9.62 | 0.937 | | | |
| Septal perforation | 1.84 | 0.19–18.15 | 0.602 | | | |
| Synechia | 2.77 | 0.25–31.34 | 0.410 | | | |
| Surgical techniques | | | | | | |
| Approach | ND | ND | 0.999 | | | |
| Type of septoplasty | 1.04 | 0.70–1.53 | 0.851 | | | |
| Extranasal cartilage | 2.55 | 1.26–5.18 | 0.010 | 1.14 | 0.40–3.25 | 0.801 |
| Fascia | 0.83 | 0.33–2.14 | 0.705 | | | |
| Dorsal fixation | 1.28 | 0.59–2.76 | 0.531 | | | |
| Fixation to anterior nasal spine | 1.56 | 0.65–3.76 | 0.318 | | | |
| Total reconstruction with extranasal cartilage | 3.19 | 1.49–6.82 | 0.003 | 1.98 | 0.70–5.63 | 0.201 |
| Middle vault | 1.73 | 0.58–5.19 | 0.328 | | | |
| Free diced cartilage | 1.03 | 0.37–2.87 | 0.951 | | | |
| Tongue-in-groove | 0.77 | 0.36–1.62 | 0.484 | | | |
| Osteotomies | 1.23 | 0.56–2.67 | 0.610 | | | |
| Fracturing of turbinate | 0.59 | 0.30–1.18 | 0.137 | | | |
| Rim grafts | 1.34 | 0.66–2.70 | 0.421 | | | |
| Columella strut | 0.72 | 0.34–1.53 | 0.389 | | | |
| Septal extension graft | 1.30 | 0.63–2.72 | 0.479 | | | |
| Cap graft | 1.78 | 0.74–4.28 | 0.199 | | | |
| Shield graft | 1.64 | 0.66–4.13 | 0.290 | | | |
| DCF | 1.10 | 0.35–3.42 | 0.869 | | | |
| Batten grafts | 1.81 | 0.62–5.27 | 0.278 | | | |
| Lateral crural strut grafts | 2.99 | 0.96–9.29 | 0.059 | 1.66 | 0.49–5.64 | 0.416 |
| Supratip breakpoint suture | 1.09 | 0.12–9.62 | 0.937 | | | |
| Spacer graft | ND | ND | 0.999 | | | |
| Alar base resection | 2.77 | 0.25–31.34 | 0.410 | | | |
| Nostril sill resection | 2.77 | 0.25–31.34 | 0.410 | | | |
| Dome division | ND | ND | 0.999 | | | |

ND, not determinable; DCF, diced cartilage in fascia.

*Univariate and multivariate logistic regression models are shown to evaluate the effect of demographic data, preoperative findings, and surgical techniques on the need for a revision surgery during the follow-up period. Variables with a value of $p < 0.10$ in the univariate model were included in the multivariate regression model.

than primary cases, as most of the original anatomy of the nose is altered and patients' expectations tend to be higher.[11,24] The need to revise occurs if either the patient is dissatisfied with the achieved result or the prior intraoperative techniques and preoperative assessment were inadequate.[25,26] The available data on the differences between primary and revision rhinoplasty remain scarce despite the rising popularity of these procedures. Several authors found differences with regard to preoperative problems and intraoperative techniques.[17,18,25] As the underlying data for these considerations are scarce, the much-needed communication with the patient is highly dependent on the individual experience of the surgeon. We therefore sought to further define the indications, techniques, and postoperative problems in a homogenous patient cohort to provide the supporting data for rhinoplasty surgeons and patients.

As expected, the majority of our primary rhinoplasty patients had functional problems to some extent. Consistent with previous studies, we found that the majority of our revision cases also had functional problems before surgery.[15,27] The underlying cause for these functional impairments is unclear, as either the failure to correct a septal deviation, nasal valve impairment, or turbinate hypertrophy during the primary surgery or iatrogenic, secondary changes such as scarring may be responsible. To prevent such secondary problems, we intraoperatively consider the functional aspects even in patients seeking solely aesthetic changes to their nose. Especially in these cases, a careful deliberation of the postoperative functional outcome is necessary because aesthetic interventions should never compromise the nasal airway ventilation. Functional issues, such as septal deviation, that remain unaddressed during surgery will become even more apparent after a reductive primary rhinoplasty procedure and may consequentially lead to a revision rhinoplasty.[28] This aspect becomes even more pronounced in secondary cases. We saw in our patient cohort a significant number of patients seeking revision surgery for a crooked nose, dorsal hump, or alar cartilage deformities. The correction of these problems often requires complex techniques but should not neglect the functional aspects of the nose. Therefore, we recommend discussing these considerations with the patient before surgery. The functional outcome should never be compromised by the aesthetic appearance of the nose.

Approximately one-third of our patients asking for a primary rhinoplasty required a partial or total extracorporeal septoplasty to correct or reconstruct a severely deformed septum. This technique requires the removal of the septum with the subsequent reconstruction and refixation to the bony framework using either the transcutaneous-transosseous cerclage technique or a criss-cross suture.[22] Despite the invasive nature of this method, we were able to show good long-term results.[20,21,29] The ratio of patients requiring an extracorporeal septoplasty was significantly higher in the revision group. This may be because of an insufficient septoplasty during the primary surgery or the need for a partial or total reconstruction of the cartilaginous framework during the revision. Normally, parts of the cartilaginous septum are excised during primary septorhinoplasty.[10] We could show that the need for additional grafts such as alar batten grafts, lateral crural strut grafts, and shield grafts was significantly higher in the revision group. The use of autologous spreader flaps to reconstruct the keystone area is mostly limited to primary cases, whereas extended spreader grafts were more commonly used in revision cases. Therefore, the need for extranasal cartilage and other grafting materials in our revision patients was significantly higher compared to primary cases. In our tertiary referral center, some of the patients had several operations before our revision surgery. In those cases, the use of autologous material from the septum is usually limited. We regularly used conchal or rib cartilage to reconstruct parts of the cartilaginous framework of the nose. The results were comparable to previously published reports.[11,15] The use of fascial material to augment the dorsum or to cover irregularities was also increased in the revision group. The use of free diced cartilage was comparable between the groups and has become a powerful tool for camouflage and augmentation in aesthetic and reconstructive rhinoplasty.[30]

We found significantly increased revision rates after revision rhinoplasty compared to the primary rhinoplasty patients. This finding was in line with previously published results.[14] The main reasons for patients' dissatisfaction after revision surgery at our clinic were minor complications such as dorsal irregularities and asymmetries. The higher expectations of a typical revision rhinoplasty patient may be the reason for the increased ratio of corrective surgery. There was no association between sex, age, or indication for surgery (functional or aesthetic) and the incidence of revision surgery. In the univariate regression model, prior surgery was a significant variable for the occurrence of another revision. The types of preoperative problems and

deformities were not associated with a higher rate of revision surgery. The use of extranasal cartilage material and the need for total reconstruction of the framework were the only factors associated with an increased rate of revision surgery in our patient cohort.

### Limitations

This study was not designed to find an effect of other covariates such as comorbidities on the outcome after rhinoplasty. Because of the monocentric characteristic of our analysis, we evaluated only the techniques used at our institution. Further studies are needed to compare the outcomes of patients after preservation rhinoplasty.

## CONCLUSIONS

Revision rhinoplasties are more complex than primary cases and regularly require the use of extranasal grafts to reconstruct a sufficient framework. Functional aspects of the nose must be considered during any revision case. The patient should be informed about the required techniques and possible outcomes, as the likelihood for another corrective surgery increases after a revision rhinoplasty.

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## PATIENT CONSENT

*Patients provided written consent for use of their images.*

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