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ORIGINAL CONTRIBUTION

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Individualised management of nasal septal perforations: cartilage-fascia graft compared to septal obturators*

Lukas S. Fiedler[1,2], Nina Widmer[3], Ralph Hohenberger[2], Firas Alissa[1], Burkard M. Lippert[1]

[1] Department for Otorhinolaryngology/Head and Neck, Plastic Surgery, SLK Kliniken Heilbronn, Germany

[2] Department of Otorhinolaryngology, University of Heidelberg, Heidelberg, Germany

[3] Department for Oral and Maxillofacial Surgery, University Medical Center of the Johannes Gutenberg University Mainz, Mainz, Germany

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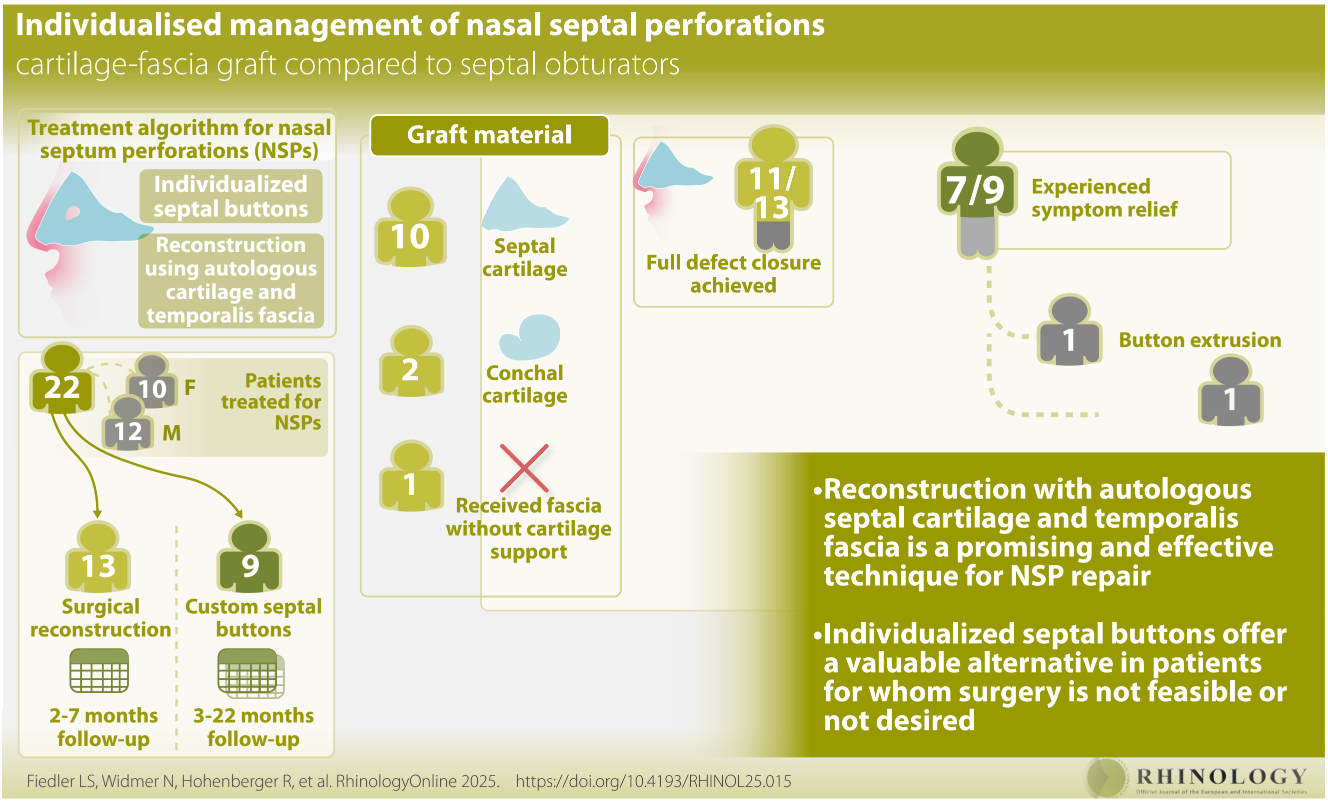

Abstract

Background: Nasal septum perforations (NSPs) can result from various etiologies and often lead to both functional and aesthetic impairments. While numerous techniques have been proposed for their management, this study presents a treatment algorithm incorporating individualized septal buttons and a novel reconstruction approach using autologous cartilage and temporalis fascia, inspired by the oto-surgical principle of re-epithelization.

Methodology: Over a two-year period, 22 patients (12 male, 10 female) were treated by a single surgeon at a tertiary care center. Thirteen underwent surgical reconstruction, and nine received customized septal buttons. The follow-up ranged from 2 to 7 months in the surgical group and from 3 to 22 months in the button group.

Results: Septal cartilage was the most used graft material (n=10), followed by conchal cartilage (n=2), with one patient receiving fascia without cartilage support. Full defect closure was achieved in 11 of 13 surgical cases (84.6%), while the two cases without

fascia resulted in only partial closure. Among the septal button group, 7 of 9 patients experienced symptom relief, though one case of button extrusion was noted.
Conclusions: These findings suggest that reconstruction with autologous septal cartilage and temporalis fascia is a promising and effective technique for NSP repair. Additionally, individualized septal buttons offer a valuable alternative in patients for whom surgery is not feasible or not desired.

Key words: nasal septum perforation, cartilage-fascia grafting, septal obturators, autologous cartilage, temporalis fascia, re-epithelization, nasal reconstruction

Introduction

Nasal septum perforation (NSP) is a defect in the three distinct contiguous layers of the nasal septum, within the cartilage and/or bony areas, and it mostly occurs in the anterior part [1,2]. Therefore, NSP are classified according to their site and topography (cartilaginous, osseocartilaginous or intermediate) and to their size. They can be classified as small perforations when <1cm in diameter, medium with 1-2 cm and over 2cm as large [3]. In most cases, the perforation is less than two centimeters in diameter and shows smooth borders [1].
NSP impacts the normal physiology of the nose, and it can lead to distinct impairment in health-related quality of life [4], while some patients stay completely asymptomatic [2,5,6]. Symptomatic patients' complaints range from subjective sensation of nasal obstruction, hemorrhage, crusting, and dryness to headache or whistle-sounds [2]. Further, large NSP can cause a saddle nose deformity or a loss of the columella support [3].
The etiology of NSP is numerous and can be traumatic including iatrogenic, idiopathic [1], and a result of auto-immune diseases like Granulomatosis with polyangiitis, relapsing polychondritis or cocaine-induced midline lesions [7]. Further, NSP can be induced as a side effect of chemotherapy with bevacizumab in breast cancer patients or primary neoplastic causes [3,8]. In literature, the iatrogenic or trauma-induced NSP due to septoplasty is described in 2% of the septoplasty cases [9]. Given the fact that septoplasty is the most frequently performed operation by Otorhinolaryngologists around the world [9], it makes this "rare" complication a matter of great impact for the reconstructive surgeon. Closing a nasal septum perforation can be accomplished by prosthesis use or surgical repair.
Over 40 techniques are described to surgically treat nasal septum perforations [5,10,11]. Whether done endoscopically [12] or with a septoplasty/rhinoplasty approach, the post-operative repair rates differ widely [12-14]. Within endonasal approaches, mucoperichondrial or combined flaps are described with either the interposition of septal cartilage, uncinate process, middle and inferior turbinate, auricular and costal cartilage or temporalis fascia [3]. Further, the interposition of quadrangular cartilage or synthetic materials like a polydioxanone plate construct are described as feasible methods [3,10,15,16]. To superficially seal the NSP, posterior rotation flaps are preferred due to major septal blood supply from branches of the sphenopalatine artery, but inferiorly based flaps are also a viable way for repair for perforations located in the anterior septum [17].
In large perforations, extended approaches with reconstructive techniques using labial-buccal sulcus flap or even expander to elevate the available graft material can be the choice of reconstruction [3,18].
Bier et al. recently proposed a "fascia taco" technique for NSP repair, using conchal cartilage wrapped in temporalis fascia [19]. We evaluated a modified version of this approach, including the use of septal cartilage as an alternative graft, even in revision cases. Additionally, we assessed 3D-printed magnetic septal buttons in a non-surgical cohort. Although septal buttons do not achieve anatomical closure, they can offer symptomatic relief by restoring nasal airflow and reducing crusting [19]. By comparing both treatment strategies, we aim to inform treatment choices based on functional and anatomical outcomes, introducing our algorithm [20].

Materials and methods

Study design and patient cohort

We present a retrospective, exploratory cohort study presenting data in line with the STROBE guidelines.
A total of 22 patients (12 male, 10 female) underwent NSP treatment performed by the lead author L.S.F at the Department for Otorhinolaryngology/Head and Neck, Plastic Surgery, SLK Clinics Heilbronn, Germany, between April 2023 and March 2025 (Table 1). Of these, 13 patients received surgical reconstruction using autologous fascia and cartilage grafts, while 9 were managed conservatively with septal buttons. The patients ranged in age from 16 to 71 years (born between 1952 and 2009) (Table 1). The follow-up period ranged from 2 to 7 months in the surgical cohort and 3 to 22 months in the button group. Throughout the manuscript, the terms 'magnetic septal button,' '3D-printed septal obturator,' and 'septal button' refer to the same individualized, patient-specific obturator device.

Statistical analysis

All data were retrospectively collected and analyzed. Descriptive

Table 1. Patient characteristics.

Patient ID	Group	Age	Sex	Defect size (cm)	Location (cottle Area)	Smoking	Diabetes	Prior nasal surgery	Cartilage source	Fascia used	Closure achieved	Symptom relief
1	Surgical	23	M	1.2×0.8	II–III	No	No	Yes	Septum	Yes	Yes	Yes
2	Surgical	35	F	1.0×1.0	II–IV	No	No	Yes	Septum	Yes	Yes	Yes
3	Surgical	58	M	2.0×1.5	II–III	Yes	No	Yes	Septum	Yes	Yes	Yes
4	Surgical	49	M	1.4×1.2	II–IV	No	No	No	Septum	Yes	Yes	Yes
5	Surgical	42	F	0.5×0.7	II–III	Yes	No	Yes	Concha	Yes	Yes	Yes
6	Surgical	29	M	1.3×1.0	II–IV	No	No	Yes	Septum	Yes	Yes	Yes
7	Surgical	53	F	1.0×0.8	II–III	No	No	No	Septum	Yes	Yes	Yes
8	Surgical	16	M	1.5×1.1	II–III	No	No	No	Concha	Yes	Yes	Yes
9	Surgical	61	M	1.8×1.2	II–IV	No	Yes	Yes	Septum	Yes	Yes	Yes
10	Surgical	44	F	2.0×1.5	II–IV	No	No	Yes	Septum	Yes	Partial	Yes
11	Surgical	38	M	1.0×1.0	II–IV	No	No	No	Septum	No	Partial	Yes
12	Surgical	26	F	1.2×1.0	II–III	Yes	No	No	Septum	Yes	Yes	Yes
13	Surgical	63	M	1.5×1.0	II–IV	No	No	Yes	Septum	Yes	Yes	Yes
14	Button	26	F	2.8×2.5	II–III	No	No	Yes	—	—	—	Yes
15	Button	33	M	3.0×3.0	II–IV	Yes	No	Yes	—	—	—	Partial
16	Button	48	F	1.0×0.7	II–IV	No	No	Yes	—	—	—	Yes
17	Button	71	M	2.0×1.7	I–IV	Yes	No	Yes	—	—	—	No
18	Button	52	F	2.5×2.0	II–IV	No	No	Yes	—	—	—	Yes
19	Button	39	M	3.0×2.2	II–III	No	No	Yes	—	—	—	Yes
20	Button	66	F	2.2×1.5	II–IV	No	Yes	Yes	—	—	—	Yes
21	Button	61	M	2.5×1.5	I–IV	Yes	No	Yes	—	—	—	Yes
22	Button	35	F	2.0×1.4	II–IV	No	No	Yes	—	—	—	Extrusion

statistics summarized patient demographics, defect characteristics, treatment modalities, and outcomes. Continuous variables (e.g., age, perforation size, follow-up duration) were presented as medians with ranges, while categorical variables (e.g., sex, prior nasal surgery, symptom relief, closure success) were summarized as frequencies and percentages. Comparative analysis between the reconstruction group (autologous fascia and cartilage grafts) and the septal button group used the Mann–Whitney U test for continuous variables and the Chi-square test (or Fisher's exact test for expected cell counts <5) for categorical variables, with a p-value < 0.05 considered significant. Due to the limited sample size and exploratory nature of the study, no multivariable analysis was performed. Statistical analyses were performed using https://www.socscistatistics.com/tests. Comparisons included age distribution, defect size range, sex distribution, success rate of complete closure, symptom relief rate, presence of smoking or diabetes, and previous nasal surgery distribution.

Clinical pathway

The proposed clinical algorithm for patients with NSP is depicted in Figure 1. Usually, the patient presents with symptoms typical of NSP, such as nasal crusting, obstruction, bleeding, or whistling sounds. An ENT examination, including nasal endoscopy, assesses the size, location, and mucosal condition of the perforation. Medical history and potential causes like trauma, prior surgery, drug use, or autoimmune disease are reviewed. Smoking status, substance use, and general health are also assessed.

A decision is made about surgical candidacy based on perforation size, health status like Diabetes or anticoagulation, smoking status, age and willingness for surgery. Surgical reconstruction is preferred for those fit for surgery. If contraindications exist or surgery is declined, a septal button (obturator) is recommended. For surgical reconstruction, the technique involves using septal cartilage if available or concha cartilage combined with temporalis fascia graft if not. The procedure requires general anaesthesia and postoperative nasal splints for 8 weeks. Follow-up monitors healing.

For septal button placement, patients undergo imaging to aid planning via Computer Tomography or cone beam-CT. A custom septal button is created and inserted in two steps under local anesthesia. Patients receive education on care and maintenance, monitoring for issues like crusting or discomfort.

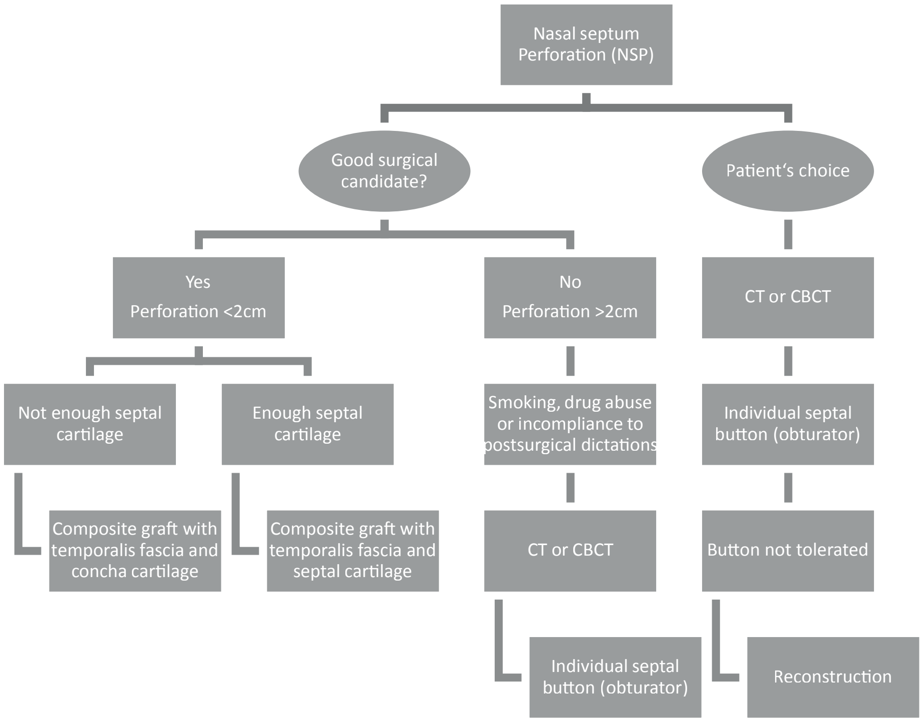

Figure 1. NSP clinical decision algorithm *CB-CT: Cone-beam CT.

3D-printed individualised septal button

Based on CB-CT or CT imaging results, a custom septal button is designed and created using 3D printing technology (Figure 2).

Fabrication of the 3D-printed nasal obturator

The implants are printed from a medical-grade, platinum-cured silicone (not sterile) with biocompatible properties, selected for its flexibility, durability, and mucosal tolerance. The printing process is performed using a multi-material extrusion system allowing the integration of small neodymium magnets into the lateral wings of the device to ensure stable retention within the nasal septum. Each prosthesis is custom-fitted to the individual patient's perforation dimensions and anatomy. The base production cost per device was approximately €2,400 (excluding magnets), with total costs reaching ~€4,000 after the addition of embedded magnets and post-processing. While the implants are not manufactured under sterile conditions, they were disinfected prior to clinical use and placed under endoscopic control without evidence of local intolerance or infection.
Before the insertion procedure, local anaesthesia is administered to the nasal cavity. This typically involves packing the nasal cavity with cotton swabs soaked in a local anaesthetic solution to numb the area and minimize discomfort. The custom septal button is inserted into the perforation in two steps. The follow-up includes regular appointments to monitor the patient's symptoms and ensure the septal button remains in place and functions effectively.

NSP reconstruction technique

The procedure begins with nasal packing using Ultracain (3 mL with 1:100,000 epinephrine). A right-sided hemitransfixion incision provides access to the cartilaginous septum, followed by careful subperichondrial dissection to expose both sides of the quadrangular lamina, while preserving the mucosa at the perforation edges. The perforation is identified endoscopically, incised circumferentially, and bilateral tunnels are created. Any septal deviation is corrected or resected.
Cartilage grafts are harvested either from the posterior septum—provided that at least 12 mm of the anterior L-strut remains intact—or, if there isn't enough cartilage, from the auricle via a small lateroauricular incision between the concha and the scapha on the rim. Conchal cartilage can be safely removed without altering ear shape (Figure 3A-C).

Temporalis fascia is harvested through an incision in the hairy scalp using Clonidine hydrogel on top via a preauricular and supraauricular thundershaped incision. The fascia is hydrodissected from the underlying muscle and excised according to the desired size.
To prepare the composite graft, the fascia is dried and folded around the cartilage to form a stable construct, secured with 5-0 PDS sutures. This graft is inserted into the defect from one side and fixed on the slightly overstanding mucosa. Bilateral silicone splints are placed and fixed with transseptal 3-0 Prolene sutures for approximately eight weeks (Figure 4).

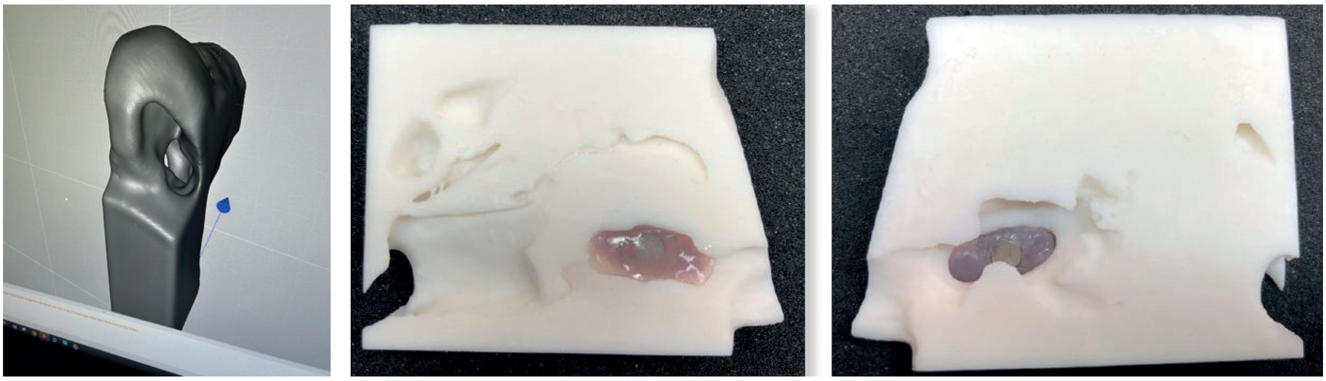

Figure 2. Graphical planning for 3D-printing of the septal button.

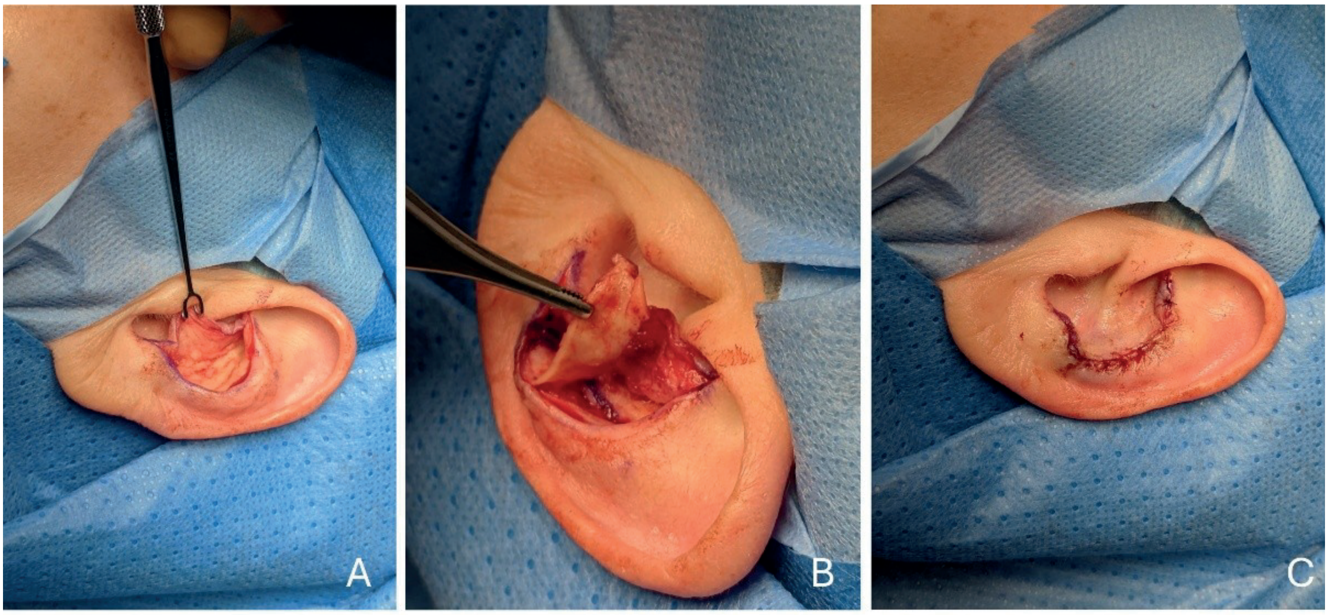

Figure 3. Concha cartilage graft elevation: (A) Incision between Scapha and Cavum, (B) Elevation of the cartilage graft, (C) Closure.

Postoperatively, patients receive Cefpodoxime 200 mg twice daily for five days. Follow-up is scheduled biweekly for up to eight weeks, including endoscopic inspection, suctioning, and topical care. All sutures are absorbable.

Results

NSP sizes varied from 0.5×0.7 cm to 3×3 cm, with most perforations located in Cottle's areas II–III and II–IV. In the surgical cohort, defects ranged from 0.5×0.7 cm to 2×1.5 cm, with most involving areas II–IV (n=6) and areas II–III (n=6). The non-surgical group showed larger and more extensive defects, ranging up to 3×3 cm, with locations II–IV (n=5), II–III (n=3), and I–IV (n=2).
As depicted in Table 2, septal cartilage was the preferred graft source (n=10), followed by concha cartilage (n=2), while one patient underwent reconstruction without cartilage support and in two cases no fascia was used for reconstruction. Graft sizes were matched or slightly larger than the defects. Temporalis fascia was harvested in 11 patients, ranging from 2×1.5 cm to 5×4 cm. No donor site complications were observed.
Defect closure was achieved in 11 of 13 surgical patients (84.6%), with two patients achieving partial closure (75% and 97% of area), these were the two patients where no fascia was used. Residual perforations were minor (1×1 mm and 3×3 mm), asymptomatic, and occurred in non-smokers without diabetes. Smoking was noted in 2 surgical and 3 non-surgical patients, while diabetes mellitus was present in one patient per group.
In the septal button cohort, all patients retained their prosthesis, though 7 out of 9 reported symptom relief in 3 to 22 months of follow up. One patient (11.1%) experienced septal button extrusion, and one suffered from crusting in the nose after septal button implantation.
Previous nasal surgeries were documented in 7 of 13 surgical patients and 8 of 9 non-surgical patients, with timespans between 2 months and 28 years before closure treatment. The etiologies included post-surgical (n=11), idiopathic (n=3), trauma (n=4), oncologic resection (n=1), and drug-induced (n=2) cases. The

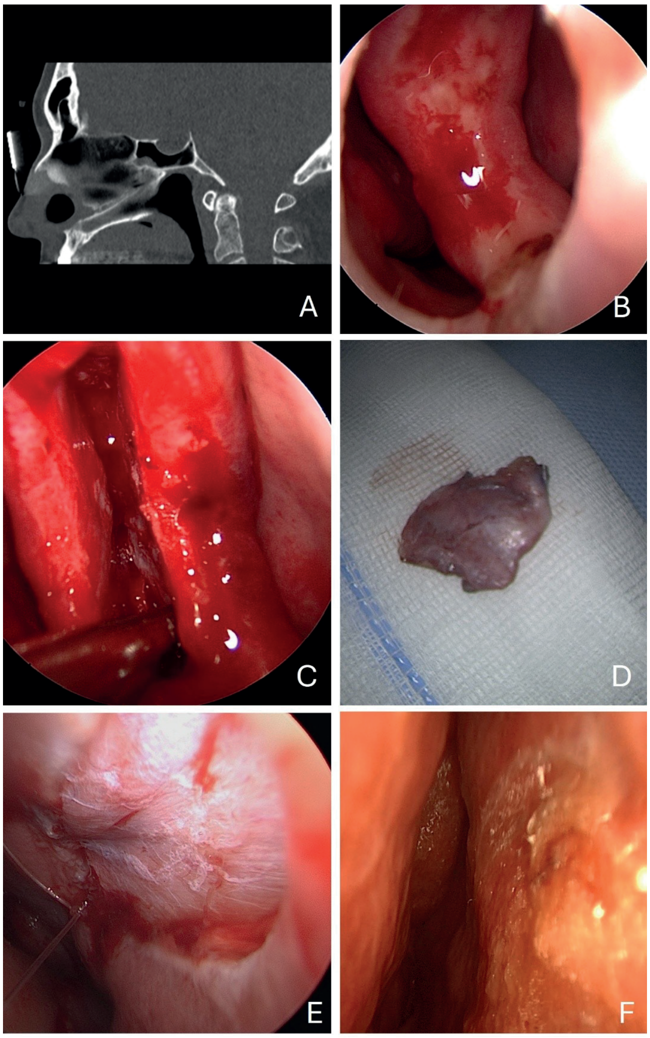

Figure 4. NSP reconstruction technique: (A) Septal perforation CT scan, (B) Septal perforation intraOP, (C) left subperichondral dissection posterior to the NSP, (D) cartilage-fascia composite graft, (E) composite-graft in proper position and sewed in, (F) postOP after 8 weeks.

cost of treatment differed markedly between groups. The 3D-printed magnetic obturator involves substantial material costs (~€4,000 per device), which are not fully reimbursed under current outpatient billing structures in Germany. In contrast, autologous reconstruction with temporalis fascia and cartilage grafts is typically reimbursed within inpatient DRG tariffs (e.g., G09B/G09A), with total costs ranging from €3,500 to €6,000 depending on case complexity. While the obturator offers a minimally invasive option with no donor site morbidity, its broader implementation may be limited by current reimbursement constraints.

Statistical analysis

The comparison between the reconstruction group (n=13) and the septal button group (n=9) showed that the median age did not differ significantly between groups ($p = 0.12$, t). A significant difference in defect size was observed between groups ($p = 0.03$, button group:x vs. surgery group:y). There was no significant difference in sex distribution between groups ($p = 0.64$, Fisher's exact test). Although a higher percentage of patients in the surgical group experienced symptom relief (11/13 vs. 7/9), the difference was not statistically significant ($p = 0.17$, Chi-square test).

The presence of smoking and diabetes did not differ significantly between groups ($p = 0.58$, Fisher's exact test), and these comorbidities did not appear to impact outcomes in either cohort, though further study with larger samples may be warranted. Patients in the reconstruction group showed a higher rate of symptom relief compared to the obturator group (84.6% vs. 77.8%, OR = 1.6). Although previous nasal surgery was common in both groups (surgical: 7/13, button: 8/9), the difference was not statistically significant ($p = 0.21$, Chi-square test). Prior surgery, therefore, does not appear to influence treatment choice or predict outcome in this study.

Discussion

In recent years, surgical reconstruction of NSP has significantly advanced, achieving success rates of 90% or more and shifting from a previously discouraged procedure to a reliable option [(21)]. Several techniques have been proposed. Despite its theoretical benefits, the use of inferior turbinate flaps has shown high failure rates and is therefore not favored as a first-line option [(22)]. In contrast, bipedicled mucoperichondrial or mucoperiosteal advancement flaps, especially when combined with interpositional cartilage grafts, have demonstrated high success rates, even in larger perforations [(23,24)]. While unilateral flap techniques preserve more respiratory mucosa and can be effective in select cases [(25)], bilateral flap coverage is generally associated with better vascularization and superior closure rates [(23)]. Like our technique, Anastasopoulos et al. reported a series of ten patients and placing a temporalis fascia graft between the septal mucosa without attempting direct mucosal closure, followed by protecting the repair site for six weeks using two thin silicone sheets that allow inspection and support healing. They achieved complete closure in nearly all cases, with minimal complications and good patient tolerance [(26)].

Free tissue grafts have often been met with scepticism due to their limited success rate due to poor vascular integration, particularly in the absence of a well-vascularized recipient bed [(27)]. In contrast, our approach using autologous temporalis fascia in combination with cartilage grafting has shown promising results. An advantage lies in the low donor site morbidity of temporalis fascia, which is easily accessible and well-tolerated, especially when compared to more invasive or multilayered flap-based reconstructions. Although pedicled flaps offer robust vascular supply, they often involve greater surgical complexity and longer operative times. The recently described anterior ethmoid

Table 2. Reconstruction and septal button groups.

Parameter	NSP reconstruction	Septal button group
Number of patients	13	9
Sex (M/F)	8 / 5	4 / 5
Age range	16–63 years	26–71 years
Defect size range	0.5×0.7 cm to 2×1,5 cm	1×0.7 cm to 3×3 cm
Defect location (Cottle areas)	II–III (n=6) II–IV (n=6)	II–IV (n=4) II–III (n=3) I–IV (n=2)
Previous nasal surgery	7 / 13 patients	8 / 9 patients
Etiology	Post-surgery (n=5) idiopathic (n=3) trauma (n=2) oncologic (n=1) drug-induced (n=1)	Post-surgery (n=6) trauma (n=2) drug-induced (n=1)
Cartilage source	Septum (n=10) concha (n=2) none (n=1)	—
Donor site complications	None	—
Silicone splints used	Yes (bilateral, 8 weeks)	No
Post-op antibiotics	Cefpodoxime 200 mg BID × 5 days	No
Follow-up period	From 2 (n=5) to 7 months (n=1)	3 (n=2) to 22 months (n=1)
Complete closure achieved	11 / 13 patients (84.6%)	-
Residual perforation	1×1 mm (n=1), 3×3 mm (n=1), asymptomatic	All patients retained septal button
Symptom relief	Yes (11/13)	Yes (7/9), partial or none (2/9)
Septal button extrusion Estimated cost per patient	— 3500-6000€	1 / 9 patients (11.1%) 4000€

artery (AEA) flap using the "tunnel technique" demonstrates a high closure rate of 94% in a selected cohort with anterior septal perforations averaging 1.5 cm in size (28). While this approach offers promising results with relatively low morbidity and avoids the need for distant graft harvest, it requires precise endoscopic dissection and is limited by the availability and mobility of the AEA flap. In contrast, our individualized strategy—tailoring treatment to perforation characteristics and patient factors—achieved comparable symptom relief and anatomical closure rates while offering greater flexibility in technique selection. Autologous cartilage-fascia reconstruction provides robust structural support for larger or centrally located defects, while 3D-printed obturators offer a minimally invasive, reversible alternative in cases unsuitable for surgery. Although our cohort was heterogeneous and follow-up shorter, our approach minimizes donor site morbidity in selected patients and allows adaptation to complex clinical scenarios where vascularized flap techniques may not be feasible or preferred. Another article by Hussain and Murthy describes the "sandwich graft technique", which is similar to the presented approach. They used a temporoparietal and deep temporal fascia and tragal cartilage graft with very successful results (29). The choice of cartilage source for reconstruction within our cohort varied between patients and was guided by intraoperative availability, defect size, and individual anatomical considerations. Septal cartilage was preferred when available, particularly in cases without prior septal surgery or significant septal scarring. In patients with limited septal cartilage due to previous interventions or anatomical constraints, conchal cartilage was used as an alternative. This tailored approach reflects the individualized nature of NSP repair and highlights the importance of surgical flexibility in optimizing graft fit and minimizing donor site morbidity.

In cases where surgical repair is contraindicated due to factors such as size, advanced age, comorbidities, or patient preference, septal buttons offer a non-surgical alternative for symptom relief (30). These prostheses, mostly manufactured from silicone, can be fitted under local anesthesia, making them an accessible short- or long-term solution. However up to 50% of patients experience poor tolerance, with complaints including discomfort, crusting, and recurrent dislodgement (19). Obturators can be uncomfortable for patients and may enlarge the defect over time due to their movement. Nowadays, the use of individualized septal buttons, that show an even lower dropout rate (31) are a valid alternative to reconstruction in pre-selected patients. The custom-made septal obturator based on an impression of the defect can provide a highly effective alternative (31). This approach significantly reduced symptoms and offers a practical and well-tolerated non-surgical solution. In our cohort larger perforations were treated with septal buttons. In most cases, patients chose this option over the surgical procedure. A downside to the custom-made 3D-printed septal button is the missing MRI-capability due to the inlaying magnets. The embedded magnets used for prosthesis stabilization can interact with the MRI's strong magnetic field, posing risks such as prosthesis displacement, tissue heating, or damage to surrounding structures. Additionally, the presence of magnetic material can cause significant image artifacts, particularly in the head and neck region, which may impair diagnostic quality. As a result, patients with magnetic nasal implants must be considered MRI-ineligible. In case of an MRI, the button needs to be removed for the examination.

Therefore, still, considering that surgical techniques have significantly evolved, yielding improved closure rates and reduced recurrence, reconstruction should be prioritized in suitable candidates or in patients not tolerating the septal button. Especially with the integration of autologous grafts and multilayer techniques, surgery increasingly presents a more durable and better-tolerated solution compared to mechanical obturation. Considering intraoperative trauma, we underestimate the necessity in use of concha cartilage compared to the study of Bier et al. [20]. In our cohort, concha cartilage harvest was mostly not in need, given the fact that in mid-size perforations enough cartilage is present to harvest the cartilage graft from the septum. But, in line with others, the method shows good patient tolerance and low recurrence risk in our short-term study. These findings suggest that, under optimized conditions, free grafts, particularly fascia combined with cartilage, can be a viable and effective alternative for NSP repair with a successful outcome in most cases.

Furthermore, the proposed decision algorithm offers a practical, patient-centered approach to NSP management, not yet validated prospectively. Surgical reconstruction is favored when feasible, using septal cartilage if available or conchal cartilage with temporalis fascia. For patients unfit or unwilling to undergo surgery, individualized 3D-printed septal buttons offer a symptom-relieving alternative. Planning via imaging and staged insertion ensures precision and comfort, while patient education and monitoring address common issues like crusting or extrusion. By integrating both reconstructive and conservative options, this algorithm provides a clear, adaptable pathway to guide clinical decision-making and optimize outcomes.

Our findings align with the literature findings, that autologous grafts, particularly septal cartilage combined with temporalis fascia, lead to high closure rates and good patient outcomes. The two partial closures occurred in cases without fascia use, showing its relevance in multilayer reconstruction. There were no donor site complications observed, supporting the safety of temporalis fascia harvest. The septal button group showed symptom relief in most cases, though minor complications like extrusion and crusting confirm the known limitations of prosthetic approaches. Overall, the results support surgery as the preferred option in suitable patients.

Limitations

A limitation of the study is the relatively small sample size, which restricts the generalizability of the results. This is attributable to the fact that all procedures were performed by a single surgeon and the technique itself is newly introduced. Second, the retrospective nature of the analysis introduces potential bias, including incomplete documentation and lack of standardized follow-up protocols. Additionally, not the exact same surgical technique was used due to the individual clinical situations. These factors may influence the interpretation of the results and restrict definitive conclusions. Further, the absence of validated quality-of-life (QoL) instruments such as the SNOT-22 or NOSE score, impacts standardization. Symptom relief was assessed through structured clinical interviews and serial endoscopic examinations, which provided consistent yet subjective evaluations of patient outcomes. While this approach reflects real-world clinical practice, it lacks standardized patient-reported outcome measures. To enhance comparability and reproducibility, future prospective studies will incorporate validated QoL tools to more accurately quantify symptom burden and treatment response. No formal power calculation was performed, as this retrospective study included all eligible patients treated over a defined period. Given the rarity and heterogeneity of symptomatic septal perforations, an a priori sample size estimation was not feasible. The findings are exploratory and intended to inform future prospective studies. Another limitation is the relatively short duration of follow-up for some patients, which may not fully capture long-term outcomes such as delayed complications, graft resorption, or device intolerance. While all patients were monitored for at least two months post-intervention, longer-term follow-up is ongoing and will be necessary to evaluate the durability and stability of both treatment approaches. Future prospective studies with larger patient cohorts and standardized protocols are needed to further validate our findings.

Conclusions

The composite graft technique appears to be a successful method for treating NSP. Our data indicates that the use of fascia is crucial. Given that septal cartilage can serve as an excellent donor material, the need for concha cartilage is rare in the described composite graft technique with temporal fascia. For patients with contraindications or other reasons against reconstructive surgery, the 3D-printed individualized magnetic septal button is a viable option to reduce the burden of crusting and nasal discomfort.

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Authorship contribution

LSF and NW contributed to the conception and design of the study, LSF and FA for data acquisition, analysis, and drafting of the manuscript. FA participated in surgical management, clinical data collection, and RH was involved in critical review of the results. BML provided overall supervision, methodological guidance, and substantial revision of the manuscript for important intellectual content. All authors read and approved the final version of the manuscript and agree to be accountable for all aspects of the work.

Ethics approval and consent to participate

This study involving human participants adheres to ethical standards. Approval was obtained from the Ethics Committee of the University of Heidelberg (Votum: S-251/2025). The research conforms to the Declaration of Helsinki and its later amendments. Publication of images and individual participant information is contingent on the authors securing free prior informed consent. Consent for publication was affirmed by the authors within the publishing license agreement; individual consent forms were not submitted. A standard patient consent form from Thieme© was obtained by all patients.

Consent for publication

Given by the patients in (German) written consent forms.
We hereby declare that our article, fully complies with the guidelines set forth by the International Committee of Medical Journal Editors (ICMJE).

Availability of data and material

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Conflict of interest

The authors declare that they have no competing interests.

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Lukas S. Fiedler, MD, MBA
Department for Otorhinolaryngology
Head and Neck
Plastic Surgery
SLK Kliniken Heilbronn
Am Gesundbrunnen 20–26
74078 Heilbronn
Germany

E-mail: l.fiedler@gmx.at
ORCID ID: 0000-0001-9319-8260