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OPERATIVE TECHNIQUES

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# Simple, but effective: Nasal splinting for airway securement in free flap reconstruction following orbital exenteration

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**Abstract**

Orbital exenteration is a disfiguring procedure that often results in free tissue transfer for reconstructive purposes. The reconstructive focus is the obliteration of dead space while sparing the nasal airway, particularly if the medial orbital wall was resected. Prolapse of transferred tissue into the nasal airway may cause breathing difficulties drastically compromising quality of life. The objective of this study was to demonstrate the effectiveness and feasibility of temporary nasal septum splints as mechanical support for transferred tissue, to prevent airway obstruction. This novel application technique was employed in three patients between 2017 and 2018. No flap loss or sino-orbital fistulas were observed. On postoperative MRI and endoscopy, a patent nasal airway was observed at all times. Temporary nasal splinting in combination with free tissue transfer proved to be a simple, but effective reconstructive option for securing the nasal airway following orbital exenteration with resection of the medial orbital wall.

**KEYWORDS**

gracilis muscle flap, nasal airway, nasal splints, orbital exenteration, reconstruction

## 1 | INTRODUCTION

Orbital exenteration is an aggressive and disfiguring procedure applied as an ultimate therapy option for malignant neoplasms of primary orbital, sinonasal mucosal, or periorbital cutaneous origin.[1–3] Management and treatment are complex as the variety of histological subtypes is vast, including squamous cell carcinoma, adenocarcinoma, adenoid cystic carcinoma, melanoma, sinonasal undifferentiated carcinoma, basal cell carcinoma, and others.[4–6] Thus, interdisciplinary management for the reconstruction of this complex anatomical area is mandatory.[7]

Radical surgical resection is indicated for orbital invasion, as it is associated with poor prognosis.[4] In cases of extended orbital exenteration with bony orbit resection, skull base defects, or defects reaching the maxillary or ethmoid sinus, free tissue transfer is the reconstructive method of choice.[8] Reconstructive aims include the prevention of fistula formation in an irradiated surgical field, the coverage of exposed osseous structures, and the obliteration of dead space.[9] Both adjuvant radiation therapy and medial orbital wall resection are identified risk factors for the development of sino-orbital fistulas.[10]

Furthermore, obstruction of the nasal cavity by free tissue after resection of the medial orbital wall needs to be avoided as it will negatively affect the patient's quality of life by causing nasal airway obstruction and breathing difficulties.[11–13] Health-related quality of life is paramount in disease management and functional rehabilitation to restore natural laminar airflow is a key factor in the recovery of these patients.[5,14]

This study presents the simple use of peri- and postoperative nasal septum splints to protect nasal airflow and prevent obliteration of the natural airway by transferred tissue during and after microvascular free flap reconstruction following extended orbital exenteration with resection of the medial orbital wall.

## 2 | MATERIAL AND METHODS

### 2.1 | Patients

Between August 2017 and August 2018, three patients ($n = 3$) underwent free tissue transfer combined with nasal septum splinting after orbital exenteration at our department. All patients were male. Two patients had undergone orbital exenteration due to an adenocarcinoma of the paranasal sinus and one patient due to a periorbital basal cell carcinoma of the lower eyelid. Orbital exenteration included bony resection and involvement of the maxillary and ethmoid sinus in all cases.

Detailed patient characteristics are presented in Table 1. One patient underwent adjuvant radiotherapy after exenteration and prior to reconstruction and one patient underwent adjuvant radiochemotherapy after exenteration and prior to reconstruction. The third patient received adjuvant immunotherapy after orbital exenteration due to a recurrent basal cell carcinoma. Three months after diagnosing this carcinoma, this patient additionally underwent adjuvant radiochemotherapy after pneumonectomy on the right side due to primary lung cancer. Mean age at reconstructive surgery was 62.3 ± 5.5 years.

All cases were preoperatively presented to an interdisciplinary tumor board consisting of otolaryngologists, plastic surgeons, pathologists, oncologists, radiologists, and radiation specialists. Therapy was performed according to the decision of the interdisciplinary tumor board acting on the recommendations of the National Comprehensive Cancer Network® (NCCN) in the current Head and Neck Cancers Guidelines (Version 1.2019). At the time of reconstruction all patients presented in full tumor remission and reconstruction was performed after an interval of at least 6–12 months without tumor recurrence, as recommended by the NCCN. Reconstructive surgery was performed in all patients by the same team of two senior surgeons. All patients underwent a secondary reconstruction following extended orbital exenteration using free gracilis muscle transfer in combination with nasal septum splinting.

Written informed consent for surgery, data, photo, and image processing was obtained from all patients. A waiver for review was granted by the head of the local institutional review board due to the retrospective nature of this study.

### 2.2 | Surgical technique

#### 2.2.1 | Step 1: Reconstructive preparation

The gracilis muscle flap was harvested in the conventional manner as described elsewhere.[15] Prior to tissue transfer, scraping of the orbit was performed in all cases after healing by secondary intention in two cases and a previous attempt of defect coverage by temporoparietal fascia flap in one case. The superficial temporal artery and vein, or the facial artery and vein, served as recipient vessels and were prepared under microscopic vision parallel to flap harvest.

#### 2.2.2 | Step 2: Placing of nasal septum splints

In order to prevent obstruction of the nasal cavity by medial prolapse of the gracilis muscle to the contralateral

**TABLE 1** Patient characteristics

| Case No. | Age | Sex | Diagnosis | TNM classification | Adjuvant therapy | Comorbidities | Complications |
|---|---|---|---|---|---|---|---|
| 1 | 57 | Male | Adenocarcinoma of the paranasal sinus | T4a N0 M0 | CRT | Depression | |
| 2 | 68 | Male | Adenocarcinoma of the paranasal sinus | T4a N0 M0 | RT | Hypertension | |
| 3 | 62 | Male | Sclerodermiform BCC | | RT | Arterial fibrillation; CRI; COPD; Npl. Bronchi | Hematoma |

Abbreviations: BCC, basal cell carcinoma; COPD, chronic obstructive pulmonary disease; CRI, chronic renal insufficiency; CRT, chemoradiation therapy; RT, radiation therapy.

FIGURE 1 Depiction of nasal septum splint preparation [Color figure can be viewed at wileyonlinelibrary.com]

side, two septum splints were placed along the lateral nasal wall before positioning free tissue. Conventional septum splints (Bess Pro GmbH, Berlin, Germany), normally applied during septorhinoplasty, were used. The two septum splints were tied to each other at one end using a random suture (Figure 1). Then, the tied septum splints were positioned transnasally in a fan-like manner (Figure 2(A,B)). One single-knot bolster suture to the alar base was made to fixate the septum splints. Additionally, nasal packing was positioned.

#### 2.2.3 | Step 3: Flap positioning and microvascular anastomosis

The gracilis muscle was placed at the recipient site to fill the orbital defect. Exact placement of the gracilis muscle in order to prevent fistula formation was important in all three cases as defects reached into the maxillary and ethmoid sinus. In each case, one arterial and one venous end-to-end anastomosis were performed under microscopic vision. Arterial anastomosis was performed using 8.0 Ethilon interrupted microsutures (Ethicon LLC, Guaynabo, PR). Venous anastomosis was performed with a microvascular anastomotic coupler device (Synovis Micro Companies Alliance, Inc., Birmingham, AL). In two cases ($n = 2$), the facial artery and its concomitant vein were used for microsurgical anastomosis. In one case ($n = 1$), the temporal artery and its concomitant vein were used. To cover exposed muscle, a split-thickness skin graft from the thigh was used (Figure 2).

#### 2.2.4 | Step 4: Postoperative course

The nasal packing was removed 10 days after surgery. The septum splints were removed approximately 4 weeks after surgery.

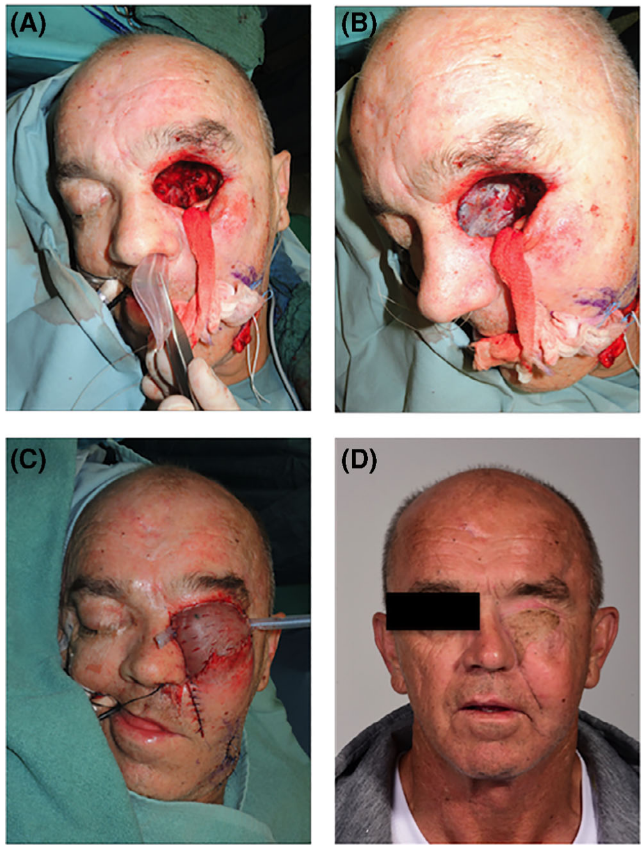


FIGURE 2 Transnasal application of nasal septum splints (A). Intraoperative orbital defect with fan-like positioned nasal septum splints (B) and after positioning of gracilis muscle flap covered by a split-thickness skin graft (C). Result 4 months postoperatively (D) [Color figure can be viewed at wileyonlinelibrary.com]

### 2.3 | Clinical follow-up and investigations

Follow-up examinations, including 30-degree rigid endoscopy of the paranasal sinuses, were performed as recommended by the National Comprehensive Cancer Network® (NCCN) in the current Head and Neck Cancers Guidelines (Version 1.2019): every 1–3 months in the first and every 2–6 months in the second year after initial diagnosis at the Department of Otorhinolaryngology, Head and Neck Surgery. Prereconstruction baseline imaging, including contrast-enhanced computed tomography and contrast-enhanced magnetic resonance imaging (MRI) of the original primary tumor site and the neck, was performed within 6 months after initial primary surgical treatment and once a year thereafter, as recommended by the NCCN. The first MRI after free tissue reconstruction was performed within a time frame of 2 months postoperatively. The second MRI was performed 6–8 months postoperatively. The minimum distance between the midline and the far medial border of

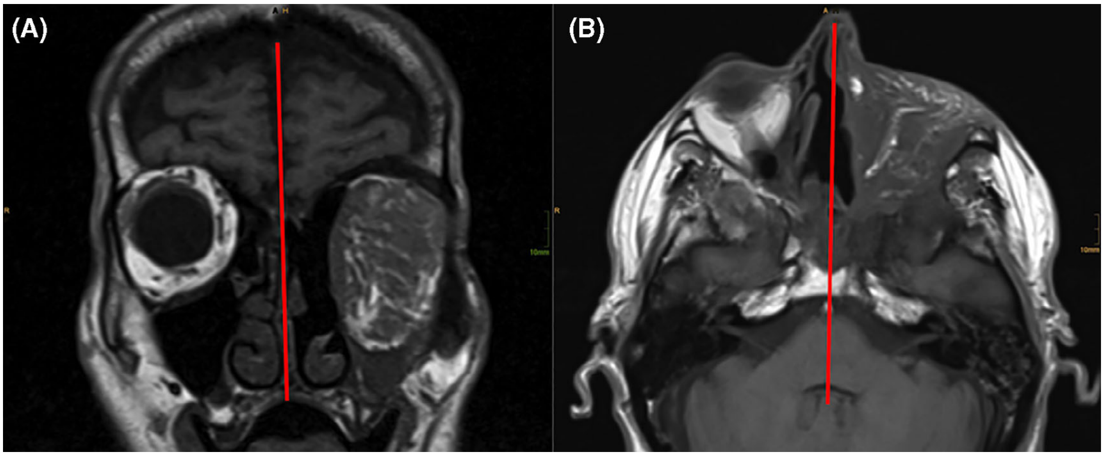


**FIGURE 3** T1-weighted images of two patients in coronal (A) and axial (B) orientation. The minimum distance between the midline and the far medial border of the transferred tissue was measured [Color figure can be viewed at wileyonlinelibrary.com]

the muscle overlap was measured on each MRI. Measurements from the first and second MRI were compared to detect changes in size of the transferred muscle flap. MRI was performed using a 1.5T scanner (AvantoFit, Siemens Healthineers, Erlangen, Germany). Patients were placed in supine position using a dedicated head-coil. For the measurements we used T1-weighted images in axial and coronal orientation (TE 9.4-16ms; TR 561-666ms; matrix 384 × 384; FOV 180–200 × 180–200; slice thickness 3–4 mm).

During further clinical follow-up and after the second MRI, one patient was lost to follow-up as he died from metastasizing tumor progression.

Clinical follow-up was performed at our institution. During follow-up, postoperative nasal airflow was investigated using acoustic rhinometry. Acoustic rhinometry was performed in all patients by the same otolaryngologist using Rhino-Sys (Happersberger otopront GmbH, Hohenstein, Germany). Patient satisfaction and quality of life related to nasal breathing were assessed with the Sinonasal Outcome Test (SNOT-22) and the Nasal Obstruction and Septoplasty Effectiveness (NOSE) Scale questionnaire.[16,17]

## 3 | RESULTS

Mean operation time was 3.87 ± 0.96 h. One patient suffered from postoperative hematoma at the recipient site, which required surgery on the second postoperative day. No flap loss was experienced. Mean hospital stay was 8 ± 2 days.

Nasal septum splints were positioned intraoperatively to prevent blockage of the nasal airway by medial prolapse of transferred free tissue. Additionally, nasal packing was positioned on the reconstruction side and removed 10 days postoperatively. Nasal splints were removed approximately 4 weeks postoperatively. Patients tolerated both nasal packing and nasal splints well. No spontaneous displacements were observed.

All patients underwent two follow-up MRI examinations, at 2 and at 6–8 months after surgery. Measurements in axial and coronal orientation did not show a midline overlap of the transferred muscle tissue (Figure 3). At 2 months postoperatively, mean distance between the midline and the far medial border of the muscle flap was 4.3 ± 4.2 mm in coronal orientation and 4.7 ± 4.7 mm in axial orientation. At 6–8 months postoperatively, mean distance between the midline and the far medial border of the muscle flap was 3.7 ± 3.8 mm in coronal and 4.0 ± 4.4 mm in axial orientation. A tendency to muscle shrinkage was detected when comparing the first and the second MRI. The mean decrease in distance between the midline and the far medial border of the muscle flap was 0.7 ± 0.6 mm in coronal and axial orientation.

Assessment of postoperative nasal airflow using acoustic rhinometry failed to show reproducible results despite this standardized method. We assume that results were inconclusive due to the change in anatomy following orbital exenteration and microvasular reconstruction thereafter. However, during endoscopy a patent nasal airway and no obliteration by the transferred muscle tissue was observed (Figure 4). The transferred gracilis muscle was noted to have spontaneously integrated, appearing as nasal mucosa without having used additional skin transplants for inner lining (Figure 4).

According to the SNOT-22 questionnaire results, one patient reported moderate problems in reply to two items only, the need to blow his nose and nasal obstruction. All

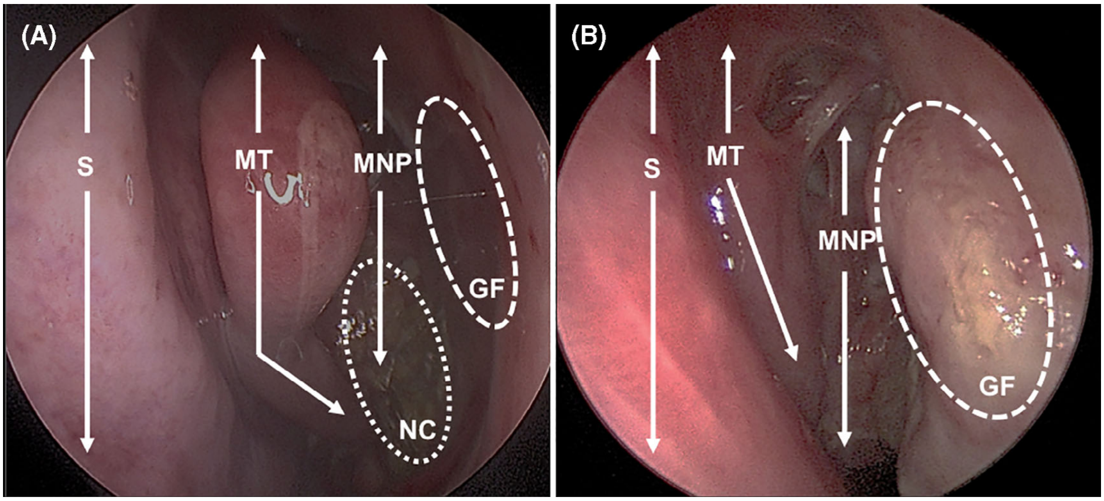


FIGURE 4 Endoscopic view of the postoperative nasal airway on the reconstruction side in two patients. GF, gracilis muscle flap; MNP, middle nasal passage; MT, middle turbinate; NC, nasal crusts; S, nasal septum [Color figure can be viewed at wileyonlinelibrary.com]

other responses from both patients designated no to mild problems. The NOSE questionnaire results showed a score of 10 in one patient, indicating mild nasal obstruction, and a score of 40 in the other patient, indicating moderate nasal obstruction.

Thus, we conclude that an undisturbed nasal airflow can be obtained by this operation technique.

## 4 | DISCUSSION

Orbital exenteration was first described by Georg Bartisch in 1583 using a spoon-shaped knife to remove the eyeball and all surrounding contents of the orbit.[18] Although surgical techniques have progressed tremendously, modern orbital exenteration retains similarities to the original method.[19] Orbital exenteration remains a mutilating procedure resulting in a challenge for reconstructive surgery. Wound healing difficulties, including a prolonged healing process over several months or recurrent bleeding caused by the components of the eye socket, are recognized complications following orbital exenteration and irradiation therapy.[20] In order to avoid further morbidity caused by complications such as sino-orbital fistulas, cerebral fluid leaks, or other wound healing disorders in a previously irradiated area, free tissue transfer is the reconstructive method of choice.[21]

In complex cases, such as those we present in this study that included bony resection and involvement of the maxillary and ethmoid sinus after removal of the medial orbital wall, precise reconstructive planning must address the individual dimensions of resection and the extent of dead space to be obliterated.[22] Free flap reconstruction following orbital exenteration is indicated in cases of neoadjuvant or adjuvant radiation therapy, a history of wound healing difficulties, and in cases of bony resection with sinus involvement or skull base defects.[8]

Fasciocutaneous flaps such as the radial forearm flap, the parascapular flap, and the anterolateral thigh flap are ideal for defect coverage following solely orbital exenteration, but may be too thin to obliterate dead space after extended resection.[8] On the contrary, more bulky flaps such as the latissimus dorsi flap are reserved for obliteration of orbitomaxillary defects.[23] In our presented cases, we were seeking to compromise between obliteration of orbital dead space, while sparing the nasal airway from free tissue obstruction. Prevention of flap prolapse by suspension suture techniques or additional transfer of fascia lata has previously been described in reconstructive head and neck surgery.[24] To avoid additional remaining foreign suture material or additional donor site morbidity by harvesting fascia lata, we chose the free gracilis muscle flap as a less bulky alternative, combined with the mechanical support of nasal septum splints to prevent critical airway obstruction. The free gracilis muscle flap is especially suitable due to its size, shape, flexibility, and reliable vascular supply of one dominant pedicle.[25] Further advantages include predictable muscle shrinkage due to atrophy, color matching of a muscle flap covered by a split-thickness skin graft, and the low donor site morbidity with innocuous scarring.[26–28]

The nasal septum splints were tolerated well without displacement in all patients and were removed approximately 4 weeks after reconstructive surgery. On MRI within the first 2 months postoperatively, a patent nasal airway could be observed. During further MRI examination and clinical follow-up, muscle shrinkage during the first 6 months was detected, making a positive contribution to nasal breathing and aesthetic outcome as the muscle reaches the same level as the orbital margin. Satisfactory flap assimilation along the orbital margin also enables the future use of eye epitheses.

Management of nasal airway obstruction and symptoms presents a major challenge after midface reconstruction.[29] In our patients, postoperative endoscopy also revealed a patent nasal airway and a homogenous mucosal integration of transferred free tissue without having employed additional skin grafting for inner nasal lining (Figure 4(G,F)).

As orbital exenteration has a severe effect on a patient's quality of life regardless of the reconstructive method, special focus should be put on keeping further morbidity low.[30] We believe that aiming for improved functional outcome by securing the natural airway produces a positive effect on a patient's quality of life.

In conclusion, the free gracilis muscle flap remains a workhorse flap for moderate size defects in head and neck surgery. In combination with the use of nasal septum splints as mechanical support for transferred tissue, we herein present a novel refinement technique to ensure patency and long-term establishment of the nasal airway in free flap reconstruction following extended orbital exenteration with resection of the medial orbital wall, without creating additional donor morbidity.

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## CONFLICT OF INTEREST

The authors declare that there is no conflict of interest that could be perceived as prejudicing the impartiality of the research reported.

## DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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