Detailed Analysis of Graft Techniques for Nasal Reconstruction following Wegener Granulomatosis

Ali Sepehr, MD, Ashlin J. Alexander, MD, Nitin Chauhan, MD, and Andres Gantous, MD, FRCSC

ABSTRACT

Background: Saddle nose deformity secondary to Wegener granulomatosis (WG) presents a significant challenge for the reconstructive surgeon. Various grafting options have been proposed, but achieving good outcomes can be difficult.

Methods: We conducted a retrospective analysis of 10 patients with WG who underwent reconstruction of saddle nose deformities by the senior author (A.G.) between 2005 and 2009. All patients were reconstructed using costal cartilage grafts.

Results: Primary surgery was functionally and cosmetically successful in 8 of 10 patients. Two patients experienced complications (graft resorption and columellar necrosis) requiring revision surgery; subsequently, they achieved good outcomes, with no further complications. There were no complications at the costal cartilage donor site. At the conclusion of the study, all patients were satisfied with their reconstructions.

Conclusions: With a multidisciplinary team approach to pre- and postoperative patient management and careful surgical technique, reliable and excellent functional and cosmetic outcomes can be achieved with costal cartilage grafts.

SOMMAIRE

Contexte: La déformation en selle du nez, consécutive à la granulomatose de Wegener (GW), présente des difficultés importantes pour la reconstruction de l'organe. Différentes possibilités de greffe s'offrent au chirurgien, mais il est difficile d'obtenir de bons résultats.

Méthodes: Nous avons procédé à une analyse rétrospective des dossiers de 10 patients atteints de la GW, qui ont subi une reconstruction du nez pratiquée par l'auteur en chef (A.G.), entre 2005 et 2009, pour la correction d'une déformation en selle. Dans tous les cas, la reconstruction a été réalisée à partir de greffons de cartilage costal.

Résultats: La chirurgie première a donné des résultats fonctionnels et esthétiques satisfaisants chez 8 patients sur 10; les deux autres ont connu des complications (résorption du greffon et nécrose de la columelle), qui ont nécessité une reprise chirurgicale; celle-ci a, par la suite, donné de bons résultats, sans autres complications. La zone donneuse de cartilage costal a été exempte de complications. À la fin de l'étude, les patients se sont tous montrés satisfaits de la reconstruction.

Conclusions: Les greffes de cartilage costal peuvent donner des résultats fonctionnels et esthétiques à la fois fiables et excellents avec le concours d'une équipe pluridisciplinaire en phase pré- et postopératoire et par l'application minutieuse de la technique chirurgicale.

Key words: *nasal reconstruction, Wegener granulomatosis*

Ali Sepehr, Ashlin J. Alexander, *and* Nitin Chauhan: *Division of Facial Plastic and Reconstructive Surgery, Department of Otolaryngology–Head and Neck Surgery, University of Toronto;* Andres Gantous: *Division of Facial Plastic and Reconstructive Surgery, Department of Otolaryngology–Head and Neck Surgery, University of Toronto, and St. Joseph's Health Centre and St. Michael's Hospital, Toronto, ON.*

Address reprint requests to: Andres Gantous, MD, FRCSC, *Division of Facial Plastic and Reconstructive Surgery, Department of Otolaryngology–Head and Neck Surgery, St. Joseph's Health Centre, St. Michael's Hospital, 30 The Queensway, Sunnyside Wing East, Suite 230, Toronto, ON M6R 1B5; e-mail: drgantous@torontofacialplastic.com.*

Saddle nose deformities can be psychologically devastating for patients and technically challenging for reconstructive surgeons. Obtaining adequate intraoperative correction can be difficult in any setting, but the complexity of reconstruction is magnified by the variable healing that accompanies an inflammatory etiology. The most well known of these inflammatory diseases is Wegener granulomatosis (WG).

WG is a rare, multisystem, autoimmune, vasculitic syndrome of unknown etiology. It is characterized by necrotizing granulomatous inflammation of the upper and lower airways and kidneys and necrotizing vasculitis of small and medium-sized vessels. In the nose, destruction of

the nasal cartilaginous framework is a common sequela. These patients present with nasal airway obstruction and a saddle nose cosmetic defect.

The aesthetic defects depend on the location and extent of the septal defect and can range from loss of dorsal height to a shortened nasal length with tip deprojection and retraction of the nasolabial angle. The latter, more severe loss of dorsal and caudal support is more common in patients with rheumatologic disease, such as WG.

The severity of the saddle nose deformity[1] determines the method of reconstruction necessary, ranging from a one-dimensional dorsal repair[2] using onlay grafts or extended spreader grafts to two-dimensional L-shaped strut grafts.[3,4] Many grafting options exist, including autografts, homografts, and alloplasts; however, allografts have inherently higher rates of complication, such as infection and extrusion.[5–8] The senior author has used irradiated, cadaveric rib cartilage (however, not in the setting of WG) in the past and found it to be unpredictable and cost-prohibitive in the setting of universal health care; he therefore does not employ these reconstructive options. A detailed description of allografts can be found in the cited references and is beyond the scope of this article. Various autogenous grafting sources are available, including osseous grafts from the calvarium and iliac crest, as well as cartilaginous grafts from the septum, auricle, and rib. The ideal biomaterial retains its shape and volume, is nonresorbable, is easily removed, does not migrate, does not incite inflammation, is resistant to infection, is readily available, and is cost-effective.[9]

Shipchandler and colleagues used an L-shaped strut graft fashioned from calvarial bone in a series of four patients with WG, with an average follow-up of 20.8 months.[10] Other than dorsal contour irregularities, they did not note any complications. However, other studies show long-term resorption of calvarial bone.[11,12]

Costal cartilage has been strongly advocated as the current gold standard for reconstruction in cases of significant contour deformity and loss of structural support.[13] In WG, the amount and integrity of septal cartilage are frequently compromised by the disease process. Moreover, the defect is often too large for septal and auricular cartilage to provide sufficient volume and support for the osteocartilaginous framework reconstruction. Therefore, in advanced WG nasal reconstruction cases, costal cartilage grafting is the ideal graft source.

Following reconstruction, outcomes are further debilitated by the potential for adverse medical events in WG. The compromised vascularity of the recipient site[14] and the immune-modulating medications used to treat WG (eg, prednisone, methotrexate, and cyclophosphamide) can worsen the clinical scenario as both the disease and its treatment may increase the complication rates. Furthermore, WG patients suffer from a hypercoagulable state, which can potentially impair the reconstructive effort.[15] Congdon and colleagues used costal cartilage for dorsal augmentation in six patients with WG; one patient developed a postoperative wound infection.[16] There have also been reports of local axial flaps based on the infraorbital artery[17] and the facial artery[18] used in conjunction with costal cartilage grafts to provide increased vascularity for the graft recipient site. This study provides the largest series of nasal dorsal reconstruction using costal cartilage grafts for advanced saddle nose deformity from WG.

Methods

A retrospective chart review was performed on all patients presenting between January 1, 2005, and December 31, 2009. The inclusion criteria were the use of costal cartilage autograft reconstruction in the setting of WG and saddle nose deformity. Of note, this is a tertiary level practice, to which severe cases are referred in anticipation of costal cartilage graft reconstruction. The indications for reconstruction were saddle nose deformity, nasal foreshortening, nasal collapse, and nasal airway obstruction. All reconstructions were performed by the senior author (A.G.) at a university hospital. All patients were reconstructed using autologous costal cartilage. The catalogue of grafts used included dorsal onlay grafts, spreader grafts, septal L-strut grafts, columellar strut grafts, and columellar plumping grafts. The dorsal onlay graft was first sculpted to the proper dimensions. In the cases of cantilever dorsal onlay grafts, the bony nasal pyramid was mildly to moderately rasped to accommodate the onlay graft when necessary. The graft was then positioned and secured with a 5-0 nylon suture that was placed through the mid- to lateral portion of the upper lateral cartilage (ULC), through the graft, and through the contralateral ULC and tied over the graft (Figure 1). Usually, two of these sutures, one at the rhinion and the other more caudally, suffice for secure placement of the graft. This technique had the dual purpose of stabilizing the graft during the healing process and widening the internal nasal valve.

Owing to the risk of intranasal exposure, spreader grafts were avoided if the patient had a concomitant septal perforation (Table 1). Instead, the dorsal onlay graft, used for camouflage of the cosmetic defect, also functioned to improve the nasal airway at the internal valve, as described

Figure 1. Patient with saddle nose deformity owing to Wegener granulomatosis. *A* to *C*, Preoperative frontal, lateral, and basal views. *D* to *F*, Postoperative frontal, lateral, and basal views following reconstruction with costal cartilage cantilever dorsal onlay and columellar strut grafting techniques.

Table 1. Patient Demographics, Grafts, and Complications

Patient	Age (yr)	Gender	Follow-up (mo)	Internal Nasal Pathology	External Nasal Deformity	Grafts	Complications
1	37	F	26	SP	Extruding silicone implant	NCDO, CS	None
2	21	F	29	Absent septal cartilage	SND	2 NCDOs, CS	None
3	25	F	20	Absent septal cartilage	SND	NCDO, CS, S	Resorption, migration
4	42	F	15	SP, absent septal cartilage	SND, FS	CDO, LS	None
5	35	F	17	SP, absent septal cartilage	SND, FS	CDO, CS	None
6	49	F	17	SP	SND	CS, LS	Dorsal infection
7	28	F	17	SP	SND	CDO, 2 CSs, NLAP	Columellar necrosis, resorption
8	48	F	16	SP	SND	CDO, CS	Columellar infection
9	49	F	15	SP	SND	CDO, CS	None
10	31	F	11	Absent septal cartilage	SND	CDO, CS, S	None

CDO = cantilever dorsal onlay graft (nasion to supratip); CS = columellar strut graft; FS = foreshortened nasal length; LS = L-strut grafts; NCDO = noncantilever dorsal onlay graft (rhinion to supratip); NLAP = nasolabial angle plumping graft; S = bilateral spreader grafts; SND = saddle nose deformity; SP = septal perforation.

above. In patients without septal perforation, if spreader grafts were absolutely necessary, meticulous dissection was used to prevent mucosal breach during placement, and postoperative nasal packing was positioned to minimize mucosal pressure in the region of the spreader grafts. The nasal packing was only in the immediate postoperative period ($\approx$ 3 hours) and removed in the recovery room prior to discharge home.

Data were collected on patient demographics, length of follow-up, extent of disease (including degree of external and internal deformity), state of disease, preoperative nasal symptoms, postoperative nasal symptoms, preoperative structural defects, specific types of grafts used for reconstruction, surgical outcome, and postoperative complications. An outcome was considered "successful" when (a) photodocumentation showed significant improvement and (b) the patient reported satisfaction with the form and function of the nose and, thus, did not require a revision operation. Nasal airflow studies were not performed routinely.

Results

Ten patients were identified. All were female, with an average age of 36 years (range 21–49 years). The average follow-up was 18.3 months (range 11–29 months) (see Table 1). The disease was limited to the upper airway in eight patients. One patient was noted to also have peripheral vasculitis in the lower extremities, and another had concomitant involvement of her lungs and joints. The disease was in a state of remission in all of the patients but did reactivate 3 months after the operation in one patient.

Preoperative international normalized ratio (INR) and partial thromboplastin time (PTT) blood tests were normal for all subjects. None of the patients had a previous history of venous thromboembolic disease.

All 10 patients had nasal airway obstruction owing to mucosal inflammation (crusting) and structural collapse. One of the patients presented owing to extrusion of a prior dorsal alloplastic implant, which was performed elsewhere. All patients underwent an open septorhinoplasty with autogenous costal cartilage graft harvest for reconstruction. We defined our success rate based on graft placement, structural support afforded by the rib graft, and patient satisfaction. The initial operation was deemed successful in eight patients (80%), with improvement in both function (diminished nasal airway obstruction) and form (improved appearance), such that they did not require revision surgery (see Figure 1, Figure 2, and Figure 3). The patient in Figure 1 underwent reconstruction using a cantilever dorsal onlay graft and a columellar strut. There were no complications at the costal cartilage donor site.

Four patients experienced postoperative complications (40%), although only two of these led to an unsatisfactory result requiring revision surgery. Of the two who required a revision operation, the first patient experienced reactivation of her disease 3 months postoperatively. She developed resorption of both spreader grafts and partial destruction of the columellar strut with migration of the dorsal onlay graft. After the patient's rheumatologist felt that the patient had reached disease control (both disease remission and medication taper), she required a second open septorhinoplasty with a costal cartilage graft. This
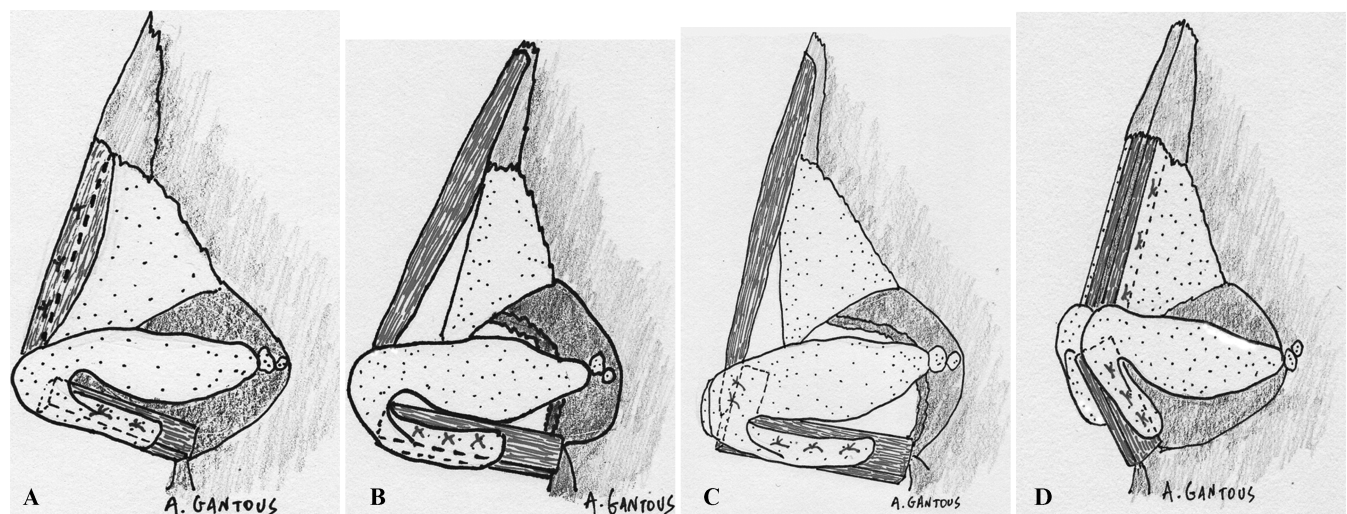
Figure 2. Diagrammatic representation of the grafting techniques used for the patient in Figure 1 (grafts shown in *red*, sutures shown in *green*). *A*, Noncantilever dorsal onlay graft and columellar strut graft. *B*, Cantilever dorsal onlay graft and columellar strut graft. *C*, Cantilever dorsal onlay graft reinforced onto an L-strut graft. *D*, Spreader grafts and columellar strut grafts.

Figure 3. Patient with saddle nose deformity owing to Wegener granulomatosis. *A* to *C*, Preoperative frontal, lateral, and basal views. *D* to *F*, Postoperative frontal, lateral, and basal views following reconstruction with costal cartilage grafts.

was performed 1 year after the original operation and produced a successful outcome with no further complications. The second revision surgery patient, who required three different types of columellar grafts at primary surgery, developed columellar necrosis on the seventh postoperative day and required a nasolabial flap reconstruction; this was performed 2 months after the first operation (Figure 4). Revision surgery produced a

Figure 4. Patient with columellar necrosis following primary surgery. *A*, Preoperative frontal view. *B*, Intraoperative basal view of defect. *C*, Intraoperative basal view post–nasolabial flap reconstruction. *D*, Four-month postoperative frontal view.

successful outcome, and no subsequent postoperative complications were noted (Table 2).

The other two patients with untoward events developed wound infections (one dorsum and one columella); these were successfully treated with clindamycin (cultures failed to grow any organisms), and neither required a second operation. At present, all 10 patients have maintained good function and are satisfied with their cosmesis and improved nasal function.

Discussion

In general, our outcomes following reconstruction of 10 complex nasal deformities secondary to WG have been positive. The success rate of the initial operative intervention was high (80%); although there was a 40% complication rate, only two patients experienced complications that required revision operations. It must be kept in mind that the parameters of optimal wound healing are also markedly compromised in this patient population, leading to complication rates that would be predictably higher than in an otherwise healthy comparable cohort.

In cases of nasal reconstruction for oncologic or traumatic defects, it is paramount to address all three nasal layers. However, the primary complaints of patients with WG deformities are related to nasal airway obstruction and external cosmesis. The internal lining defects in these patients vary between mucosal granulomas and total absence of the septum. The repair of septal perforations is tenuous at the best of times and, in the face of WG, is likely to fail. Therefore, in our series, reconstruction was directed at improving airflow and appearance by restructuring the

Table 2. Prevalence of Complications following Open Septorhinoplasty with Costal Cartilage Grafting for Wegener Granulomatosis Nasal Deformities

Complication	No. of Patients (%)
Recipient site	
Resorption	2 (20)
Migration	1 (10)
Extrusion	0 (0)
Infection	2 (20)
Necrosis	1 (10)
Epistaxis	0 (0)
Donor site	
Hematoma	0 (0)
Wound dehiscence	0 (0)
Pneumothorax	0 (0)

osteocartilaginous framework, without reconstitution of internal nasal lining.

In this series, the dorsal onlay grafts were the most robust. Even in the setting of inflammation or infection, these grafts tended to survive. Conversely, the spreader grafts and columellar grafts were less resilient and were more likely to resorb owing to inflammation or infection. If the degree of this resorption is significant, migration of the dorsal onlay graft can occur. This observation led to a change in technique, in which the dorsal onlay grafts were subsequently placed in a cantilever fashion; the result was improvement in the structural integrity of the dorsal onlay graft, even in the face of a weakened columella.

Two patients experienced graft disruption and loss of structural support that was sufficiently severe to warrant revision surgery. The first patient had a reactivation of her disease 3 months after her primary rhinoplasty. Three types of grafts were used in her first operation: columellar strut, spreader grafts, and a dorsal onlay graft (from rhinion to supratip area). The columellar strut and the spreader grafts both resorbed to some degree. Although the dorsal onlay graft did not resorb, it migrated owing to the resorption of the underlying supporting grafts. After control of the disease, a second open septorhinoplasty with costal cartilage graft was performed. During this operation, a new columellar strut was placed and the dorsal onlay graft was replaced. These grafts survived, and the patient healed uneventfully. Therefore, disease reactivation and appropriately aggressive therapy are believed to have been responsible for graft compromise in this individual.

The second patient had a cantilever dorsal onlay graft and three grafts placed in the columella, including a double-layer columellar strut graft and a columellar plumping graft at the nasolabial angle placed through a midsagittal incision in the upper gingivobuccal sulcus. Postoperatively, she developed columellar necrosis and resorption of the columellar grafts. The columella was then reconstructed using a nasolabial flap and healed uneventfully. Notably, contrary to the first revision case, this patient underwent placement of a dorsal onlay graft in a cantilever fashion; this maneuver afforded more stability to the dorsal onlay graft and allowed it to resist migration, in spite of weakening of the columellar support. Columellar necrosis is a rare event, and this was the only such occurrence in the senior author's experience with over 100 costal cartilage graft nasal reconstructions. The distinguishing factors in this case were the use of multiple layers of grafts in the setting of vasculitic disease and the placement of an extra incision through the gingivobuccal sulcus with a greater amount of dissection, which, on the

background of an already marginal blood supply, likely caused increased columellar ischemia.

Two other patients, who both had a columellar strut graft and a dorsal onlay graft, developed postoperative wound infections that were treated with antibiotics. The structural reconstruction did not break down, and there was no cartilage resorption. They did not require a second operation. This resulted in a 40% complication rate, which stresses how problematic complications (infection, migration, resorption, and necrosis) can be in this patient population. Although perioperative antibiotics were not routinely used, the 20% infection rate can be considered anecdotal evidence supporting the routine use of antibiotics in the peri- and postoperative setting.

Three patients were considered to have more aggressive disease, as defined by involvement of multiple systems, or as having more severe nasal collapse requiring a septal L-strut reconstruction. However, these patients all had successful reconstructions and healed without any postoperative complications. In these instances, success was achieved by ensuring that reconstruction was not undertaken in any patient with active disease and was considered only after all physicians involved in the patient's care agreed that the disease was optimally medically controlled and in remission. If the patients were on immune-modulating medications, these were continued. If they were on steroids, then they were covered with stress dosing. Otherwise, there were no alterations in medical therapy.

The medical implications of WG must be considered in the reconstructive approach. Both the vasculitis, which compromises blood supply, and the medications that modulate the immune system adversely affect the healing process. Therefore, one should always take great caution to use the minimum amount of dissection necessary to accomplish the reconstruction, especially near the columella. Moreover, the hypercoagulable state inherent in WG could further impair nasal blood supply and prevent a good result. All subjects had normal biochemical coagulability (INR and PTT) preoperatively, and there was no history of previous venous thromboembolic disease. However, more extensive hematologic workups were not conducted. Therefore, the precise role of hypercoagulability in these patients remains unclear.

The care of WG requires, first and foremost, a multidisciplinary approach, and a reconstructive surgeon would be wise to enlist the assistance of an otolaryngologist–head and neck surgeon and a rheumatologist experienced in the care of these challenging patients. Notably, the results indicate that nasal reconstruction can be undertaken safely, even in patients with more severe disease, as long as the disease is well controlled in remission.

Conclusion

This study presents the largest series in the literature to date using costal cartilage graft reconstruction for correcting complex nasal deformities secondary to WG. Several interesting observations and lessons have been gleaned from this experience that can assist the reconstructive surgeon in optimizing the chances of a successful outcome and minimizing the risk of complications. First, care should be multidisciplinary to ensure that the patient is ensured the best opportunity for successful medical management and surgical reconstruction. Second, surgical technique should be mindful of the tenuous vascularity available to support postoperative healing in the WG group. Lastly, the study found that although the dorsal onlay grafts are relatively robust, the underlying structural supporting grafts (columellar strut and spreader grafts) are more prone to resorption. Although there is a higher incidence of complication given disease characteristics and therapy, the results of reconstruction are generally predictable, durable, and excellent when meticulous attention is paid to patient selection, surgical technique, and postoperative care.

Acknowledgement

References

1. Daniel RK. Rhinoplasty: septal saddle nose deformity and composite reconstruction. Plast Reconstr Surg 2007;119:1029–43, doi:10.1097/01.prs.0000252503.30804.5e.
2. Farrior RT. Implant materials in restoration of facial contour. Laryngoscope 1966;76:934–54.
3. Demirtas Y, Yavuzer R, Findikcioglu K, et al. Fixation of the split calvarial graft in nasal reconstruction. J Craniofac Surg 2006;17: 131–8, doi:10.1097/01.scs.0000197388.89185.f0.
4. Maniglia AJ, Swim S. Parietal bone graft and titanium plate fixation in nasal reconstruction. Laryngoscope 1993;103:1066–72, doi:10.1288/00005537-199309000-00019.
5. Romo T III, Sclafani A, Sabini P. Reconstruction of the major saddle nose deformity using composite allo-implants. Facial Plast Surg 1998;14:151–7, doi:10.1055/s-2008-1064339.
6. Stoll W. The use of polytetrafluoroethylene for particular augmentation of the nasal dorsum. Aesthetic Plast Surg 1991;15: 233–6, doi:10.1007/BF02273864.
7. Beekhuis GJ. Polyamide mesh used in facial plastic surgery. Arch Otolaryngol 1980;106:642–4.

8. Okada E, Maruyama Y, Hayashi A. Nasal augmentation using calcium phosphate cement. J Craniofac Surg 2004;15:102–5, doi:10.1097/00001665-200401000-00028.

9. Vuyk HD, Adamson PA. Biomaterials in rhinoplasty. Clin Otolaryngol 1998;23:209–17, doi:10.1046/j.1365-2273.1998.00133.x.

10. Shipchandler TZ, Chung BJ, Alam DS. Saddle nose deformity reconstruction with a split calvarial bone L-shaped strut. Arch Facial Plast Surg 2008;10:305–11, doi:10.1001/archfaci.10.5.305.

11. Parsa FD. Nasal augmentation with split calvarial grafts in Orientals. Plast Reconstr Surg 1991;87:245–53, doi:10.1097/00006534-199102000-00005.

12. Powell NB, Riley RW. Facial contouring with outer-table calvarial bone. A 4-year experience. Arch Otolaryngol Head Neck Surg 1989;115:1454–8.

13. Moshaver A, Gantous A. The use of autogenous costal cartilage graft in septorhinoplasty. Otolaryngol Head Neck Surg 2008;137:862–7, doi:10.1016/j.otohns.2007.06.740.

14. Adams JS. Grafts and implants in nasal and chin augmentation: a rational approach to material selection. Otolaryngol Clin North Am 1987;20:913–30.

15. Seo P. Wegener's granulomatosis: managing more than inflammation. Curr Opin Rheumatol 2008;20:10–6, doi:10.1097/BOR.0b013e3282f18bef.

16. Congdon D, Sherris DA, Specks U, McDonald T. Long-term follow-up of repair of external nasal deformities in patients with Wegener's granulomatosis. Laryngoscope 2002;112:731–7, doi:10.1097/00005537-200204000-00025.

17. Noguchi M, Matsuo K, Hirose T. Reconstruction of short nose deformity using nasolabial flaps pedicled on the infraorbital vessels. Br J Plast Surg 1991;44:567–9, doi:10.1016/0007-1226(91)90089-3.

18. Duffy FJ, Rossi RM, Pribaz JJ. Reconstruction of Wegener's nasal deformity using bilateral facial artery musculomucosal flaps. Plast Reconstr Surg 1998;101:1330–3, doi:10.1097/00006534-199804050-00027.