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Case Series

Using a Custom Made Titanium Sheet to Reconstruct a Collapsed Nasal Valve -

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ABSTRACT

Aim: The aim of the study is to introduce a new technique to correct the nasal valve dysfunction using a custom made titanium sheet.

Materials and Methods: A prospective descriptive study was conducted on 15 patients suffering from nasal valve collapse during 2014 and 2019. All participants were confirmed to have nasal valve narrowing by direct examination in the clinic with an evaluation of nasal obstruction using the visual analogue scale.

Results: 8 males and 7 females between 25 and 61 years old with a mean age of 36 years underwent nasal valve implant. Prior to nasal valve surgery, the mean VAS was 7.4, which significantly decreased 12 weeks postoperatively to 1.9 (p-value < 0.001) with improvement of nasal obstruction

Conclusion: Our surgical results illustrate that the use of custom made titanium sheet for nasal valve reconstruction is a short and safe procedure with good functional and esthetic results. The preliminary outcome shows a high patient satisfaction rate, low complication rate, and is also cost effective.

Keywords: Nasal valve dysfunction; custom-made titanium sheets

INTRODUCTION

The nasal valve area is a complex structure that is divided into an external and internal portion. The external portion is formed by the columella, nasal floor and nasal rim. The internal portion, which is often referred as nasal valve, is formed by the nasal septum and the caudal end of upper lateral cartilage. The angle formed between the two portions is normally 10-15° and is a region of maximum nasal flow resistance [1]. Nasal valve collapse is becoming a frequent problem after rhinoplasty due to the flutter phenomenon during inhalation. Collapse can also result from accidents or for anatomical reasons [2]. Nasal valve reconstruction restores the nasal valve angle by rebuilding the major components of the nasal valve, including the upper lateral cartilage, the lower lateral cartilage and the septum [1]. Thus, the restoration of an effective and suitable support of the nasal ala and the septum is mandatory for the reconstruction of the nasal angle to prevent the flutter phenomenon. Patient cartilage is traditionally used for the reconstruction of the nasal valve [3,4]. However, conchal cartilage is weak and cannot tolerate the flutter phenomenon during inspiration, while removal of the conchal cartilage can cause hematoma of the ear and leave bad scars. Cartilaginous septum is effective, but most patients previously had surgeries like SMR, rhinoplasty, or both, and the remaining cartilage is insufficient for reconstruction.

To overcome these challenges, we used custom made titanium sheets to reconstruct the collapsed valve because titanium is highly compatible with surgical applications due to its resistance to corrosion from body fluids; bio-inertness, osseous integration capacity, and high fatigue limit [5]. It is biocompatible with soft tissue and often used in various surgical specialties such as maxillofacial surgery to rebuild the orbital floor, or by neurosurgeons in cranioplasty [6]. It is also safe to use as an implant in the nasal mucosa with a negligible rejection rate without any reported toxicity or tumorigenesis. Moreover, the implants are cost effective at \$50 per patient. Our positive surgical outcomes suggest that this is an effective method for reconstruction.

METHODS

A prospective study was conducted over a 5-year period (2014 - 2019) on 15 patients between the ages of 18 and 65 years old with nasal valve collapse. All patients had nasal valve

narrowing, which was confirmed in the clinic by direct evaluation of nasal obstruction using the visual analogue scale (VAS, Figure 1) [7]. Static or dynamic nasal valve collapse was detected by visual examination, a positive Cottle's test, a positive response to an overnight breathe right test, and a history of rhinoplasty (with or without). Patients who were excluded from the study included those who suffered from nasal obstruction due to chronic sinusitis and allergies, or patients with a deviated septum, turbinate hypertrophy, or polyps that could be causing nasal obstruction. Patients with an active nasal skin infection, diabetes, or immunodeficiency disorders were also excluded. Each patient underwent nasal valve reconstruction with the implementation of a custom-made titanium sheet designed to match their individual needs. One patient was excluded due to lack of follow up one week post-surgery. Patient evaluations were done using the VAS for measuring nasal obstruction 1 week preoperatively and 12 weeks postoperatively. Further assessments of short-term complications like implant extrusion, infection, and nasal deformity were done 12 weeks postoperatively at the clinic and at 1 year postoperatively via phone call. Prior to surgery, all surgical and non-surgical options were discussed with patients. Patients also submitted a signed informed consent form. Approval of this study was obtained from the Holy Spirit University of Kaslik School of Medicine Review Board (Junieh, Lebanon) and Eye and Ear Hospital International (Dbayeh, Lebanon).

To determine the point where the nasal valve collapses, patients were given a forced inspiration. We used a marker to draw the butterfly shaped custom-made titanium implant needed for the operation in the region of interest (Figure 2). Surgery was conducted under general anesthesia; each patient was prepped, draped, and injected with lidocaine solution at a ratio of 1:1000. Using an open rhinoplasty approach, we made a columellar and marginal incision. To reduce the visibility of the implant, we gently elevated the skin covering the nasal bone and cartilage to make a thick skin flap. Two lateral pockets were made over the

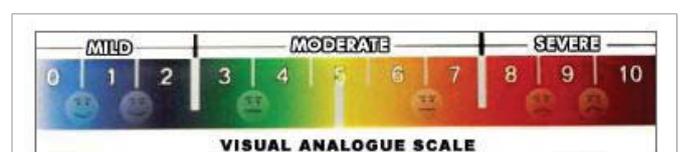


Figure 1: Visual analogue scale used for nasal obstruction.



lateral crus of the lower lateral cartilages to allow the insertion of the lateral edges of the titanium implant, which was placed and fixed on the caudal ends of the upper lateral cartilages using resorbable sutures through the perforations of the titanium sheet (Figure 3-5). This allowed us to increase the nasal valve angle and restore the normal function of the nasal valve area. The implant was then covered by a thin layer of cartilage to protect the skin. We could also modify the angle of the nasal valve in the clinic if the titanium implant collapsed.

RESULTS

8 males and 7 females between 25 and 61 years old with a mean age of 36 years underwent nasal valve implant. 9 patients (mean age = 32 yrs) had rhinoplasty prior to surgery and 5 patients (mean age = 43 yrs) underwent nasal valve implantation to correct for the collapse of the nasal valve due to anatomical reasons such as senile nasal changes. Prior to nasal valve surgery, the mean VAS was 7.4, which significantly decreased 12 weeks postoperatively to 1.9 (p -value < 0.001) with improvement of nasal obstruction (table 1). A single case of nasal tip infection occurred 5 weeks post-surgery and was treated with antibiotics without any sequela. A single case of nasal valve collapse occurred 4 weeks post-surgery due to nasal trauma causing a modification of the angle of the nasal valve. The correction of this complication



Figure 2: Identification of the nasal valve area and drawing the shape of the customized titanium implant prior to surgery.



Figure 3: Elevation of the skin flap and identification of the upper lateral cartilage, lower lateral cartilage and nasal valve area.



Figure 4: Checking the shape and the size and of the titanium implant before its fixation.



Figure 5: Fixation of the custom made titanium implant over the caudal end of the upper lateral cartilage using resorbable sutures.

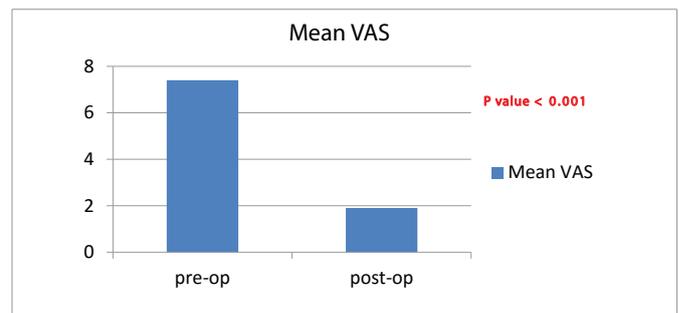


Table 1: Mean Visual Analogue Scale data: preoperative and 12 weeks postoperative.

was done in the clinic with closed reduction and restoration of the nasal valve angle. No other complications were observed.

DISCUSSION

This is a preliminary study to assess the efficacy of custom made titanium implants on the improvement of nasal airflow. In this study, patients underwent an implementation of the customized titanium prosthesis through an endonasal approach using a columellar and marginal incision to prevent scarring of the nasal tip, improve exposure of the lower and upper lateral cartilage and the scroll like area, and to allow suture fixation



of the implant over the nasal valve area [8]. The implants were customized to adapt to the anatomical variation of every single patient, which prevents extrusion of the implant, improves the esthetic outcome, reduces bulging and widening of the nasal tip, and most importantly, corrects the internal nasal valve angle. Our data suggests a significant improvement of nasal obstruction after surgery. Dynamic changes of the nasal valve during inspiration were further assessed by photographic images and video.

We had one case of nasal valve collapse 4 weeks post operatively due to nasal trauma. However, restoring the nasal valve angle in the clinic without anesthesia was a straightforward procedure due to elastic properties of titanium. Extrusion of the titanium implant was not observed in our cohort, but it is a common complication [6-9]. To reduce this risk of extrusion, we used crushed cartilage to cover the titanium implant and decrease the direct contact of the implant with the skin. We also removed the hard angles and softened the edges while customizing the shape of the implant. A *Staphylococcus epidermidis* infection at the tip documented 5 weeks after the surgery was successfully treated with a combination of rifampicin and levofloxacin for 10 days.

CONCLUSION

This is the first example of a custom-made titanium sheet used in nasal valve reconstruction. Our surgical results illustrate the efficiency and safety of the procedure and positive functional and esthetic results. Overall, the preliminary outcome of using titanium implants is associated with a high patient satisfaction rate, a low complication rate, and is also cost effective.

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