Aesth Plast Surg (2019) 43:1269–1278
https://doi.org/10.1007/s00266-019-01460-z

Vertical Alar Folding (VAF): A Useful Technique for Correction of Long and Concave Lateral Crura in Rhinoplasty

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Received: 18 April 2019 / Accepted: 2 July 2019 / Published online: 25 July 2019

Abstract

Background The tripod theory explains the dynamics of the nasal tip, where surgery is difficult because of anatomic variations and pathologies and the various surgical possibilities. Abnormalities or weaknesses of the lateral crura can result in concavity in ala or alar collapse and cause aesthetic and functional impairments of the nose. Several tip plasty techniques and lateral crura modifications are used in rhinoplasty.

Objective To describe the vertical alar folding (VAF) technique for making modifications in the lateral crura (LC) and rotation of the tip.

Methods Included in the study were 83 patients (59 women, 24 men) undergoing rhinoplasty using VAF with the senior author as surgeon between 2013 and 2018. The mean age was 26.3 years (range 18–47). Mean postoperative follow-up period was 26.7 months (range 12–64). Patients who completed the 1-year postoperative period completed the rhinoplasty outcome evaluation (ROE) questionnaire. Outcome measures were performed at examinations, and preoperative and postoperative photographs of the patients were analyzed.

Results In the span of 5 years, no revision surgery was required for technique-specific reasons. In patients who had a droopy or asymmetric tip or long and concave lateral crura, we saw remarkable functional and aesthetic improvements with VAF. According to the ROE questionnaire, 90.3% (75 out of 83) of the patients were content with the aesthetic and functional results.

Conclusion VAF is a useful and effective method for modifying the LC and tip of the nose. VAF allowed for controlling the rotation and projection of the tip, changing the length of the lateral crus and nose with durability and smooth, symmetric contours, and correcting concavity of a lateral crus for better functioning and aesthetics.

Level of Evidence IV This journal requires that authors assign a level of evidence to each article. For a full description of these Evidence-Based Medicine ratings, please refer to the Table of Contents or the online Instructions to Authors www.springer.com/00266.

Keywords Vertical alar folding · Rhinoplasty · Nasal tip · Lateral crura · Tip plasty · Dome division

Introduction

The tripod theory explains the dynamics of the nasal tip, with the tip as a tabletop and three legs of the table being the left and right lateral crura and both medial crura together [1, 2]. The tripod predicts the length, rotation, and projection of the nasal tip along with many auxiliary techniques performed in rhinoplasty. The desired form is obtained via any of a number of alternative methods, including suturing, excision, grafting, and repositioning [3].

The soft tissues and cartilage of the tip and ala provide support and aesthetic appearance through the form they make. All of them are interrelated, and each of the surgical

Electronic supplementary material The online version of this article (https://doi.org/10.1007/s00266-019-01460-z) contains supplementary material, which is available to authorized users.

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maneuvers or combinations thereof are performed only after thoroughly analyzing these relationships [4]. In other words, the surgical methods are individualized for each patient.

Nasal tip surgery is difficult due to several anatomic variations and pathologies and the variety of surgical possibilities [5]. The shape and function of the ala are significantly affected by the lateral crura. That is, the shape, orientation, length, and resiliency of the lateral crura are very important. Additionally, the major support mechanisms of the nasal tip are gathered in and around the lateral crura [6]. Weakness of lateral crura can result in a concave alar rim deformity or even alar collapse, and such weaknesses can cause both aesthetic and functional impairments of the nose.

Several tip plasty techniques and lateral crus modifications are used in rhinoplasty, such as lateral crural struts, dome divisions, vertical alar resection, tip grafts, and many others.

Vertical alar folding (VAF) is an ala plasty technique that gives good results in true indication. For 5 years, we have used VAF in select patients, sometimes in combination with other methods of tip plasty. VAF provides a functional structure for and aesthetic appearance of the lateral crura in the nose, and at the same time, it helps with flexibility, symmetry, and refinement of the nasal tip, controlling its rotation and projection.

We retrospectively analyzed rhinoplasty patients on whom we performed VAF, and in this paper, we discuss the advantages and disadvantages of this novel technique.

Materials and Methods

Ethics committee approval was obtained for this study, which received decision number 1615 dated December 21, 2018.

Before surgery, all patients signed an informed consent, and for patients whose preoperative, perioperative, and postoperative photographs were used in this study, an additional informed consent was acquired, per the Helsinki Declaration.

This case series consisted of 83 patients (24 men and 59 women), and all of these primary rhinoplasty operations were performed by the senior author between 2013 and 2018. The follow-up period was a minimum of 12 and a maximum of 64 months. The mean age was 26.3 years (range 18–47).

All of the rhinoplasty operations were performed under general anesthesia. The selected indications for use of the VAF method included a deformed or asymmetric nasal tip, droopy nose caused by an overdeveloped lateral crus of the lower lateral cartilage, a need to equalize the lengths of the right and left lateral crus, a wide dome, a pinched nose, or a nose with low rotation and concave and convex lateral crura. Patients whose tip, dome, or alar pathology was due to skin, septum, or dorsum problems were excluded from the study, and only patients with tip, dome, or alar problems caused by alar cartilages were included.

Surgical data were taken from the computerized rhinoplasty database of operations that contains the information about patient demographics, analyses of patients preoperatively and postoperatively, surgical techniques used, and complications encountered, if any.

Patients and surgeons each evaluated the aesthetic and functional results. Surgical outcomes were assessed by examinations and comparisons of the nose in the preoperative and most recent postoperative photographs (with a minimum of 12 months after surgery for the postoperative photos). The preoperative and postoperative photographs were all standard and were taken in the same settings, keeping the subject distance and angulation constant. Nasal tip and dome contours, function and aesthetics of the lateral crura, and function and aesthetics of the whole nose were evaluated postoperatively. Additionally, the patients were asked for their evaluation of the rhinoplasty outcomes through the rhinoplasty outcome evaluation (ROE) questionnaire (validated by Alsarraf et al.) [7], at the time of an outpatient visit that was at least 1 year after the operation.

Surgical Technique

An illustration of the VAF technique is shown in Fig. 1.

All operations were performed under general anesthesia, and local infiltration anesthesia was applied into the nose as lidocaine (2%) with epinephrine 1:200,000, for controlling intraoperative hemorrhaging. Endonasal or open (mostly) rhinoplasty approaches were preferred in select cases, and dissections were made step-by-step for proper and gentle elicitation of the cartilaginous architecture.

In the endonasal technique (Figs. 2, 3, 4, 5, 6, and 7), after hemi-transfixion and intercartilaginous and bilateral marginal incisions, a supraperichondrial dissection plane was followed to the rhinion under the raised skin and soft tissue envelope. It is important to see the dome and crural cartilages as a whole and free of surrounding soft tissues, and there should be cautious exposure for evaluating orientation, form, flexibility, width, thickness, and symmetry of the lateral crura. Then, a subsequent dissection was conducted under the periosteum of the nasal bones. After exposing the caudal nasal septum, mucoperichondrial and mucoperiosteal flaps were raised on both sides of the nasal septum. After septoplasty and dorsum and bone work procedures (if necessary), time was allotted for dome plasty and the VAF.

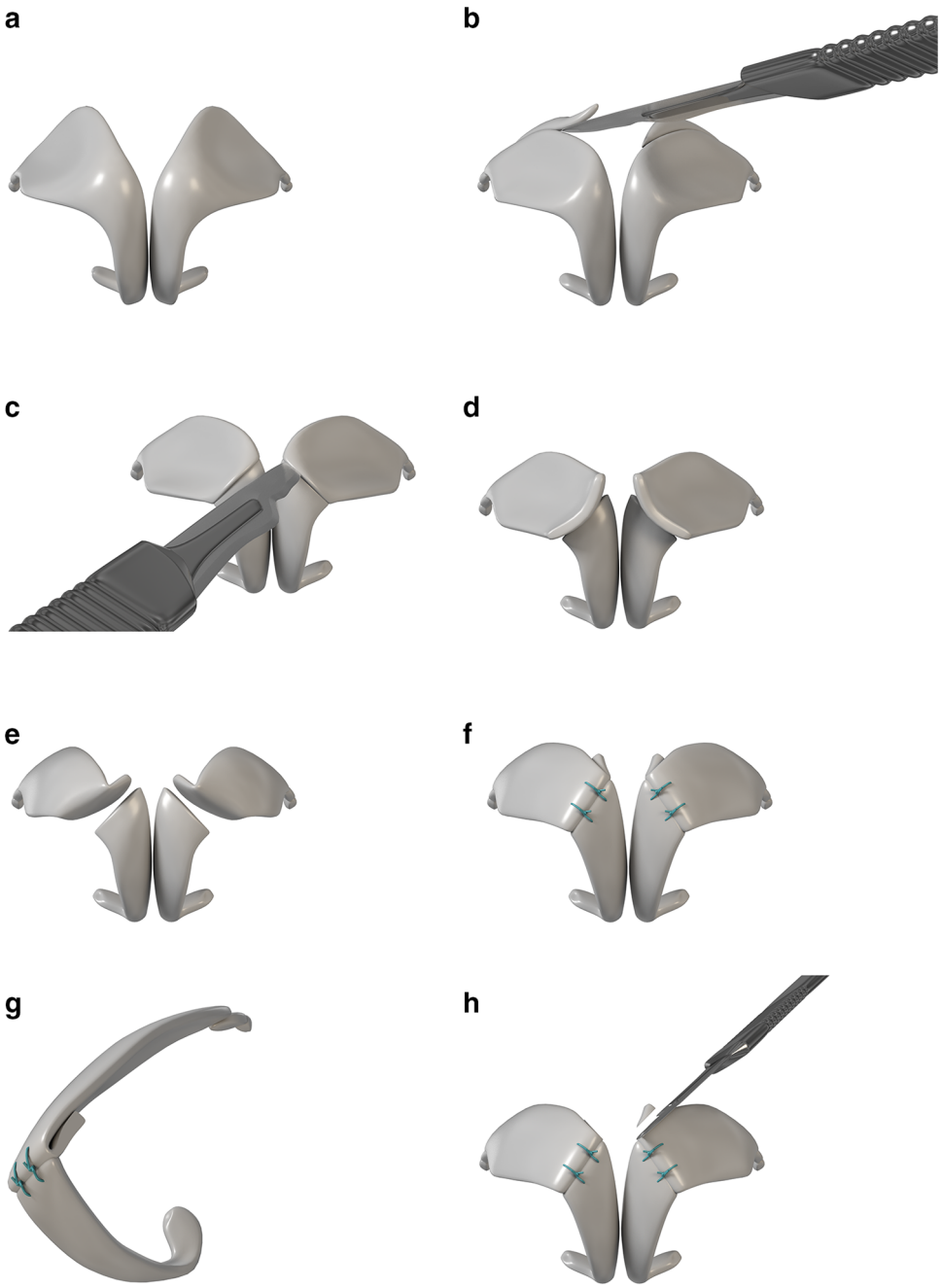


Fig. 1 Illustration of the VAF technique. **a** Concavities of the lateral crura, **b** cephalic resection of the lateral crura, **c** division of the dome with incision at the desired level, **d** deciding time for the caudal length of cartilage to be folded after dissection between the lateral crura and skin, **e** VAF, **f** formation of the final dome with sutures, **g** side view of the dome after VAF in the underlay fashion and **h** manipulations on the new dome

In this technique, after the cephalic resection of the lateral crus (of the lower lateral cartilage), the present dome points were marked using a marker pen, and then, we performed a vertical dome division by cutting the caudal end of the lateral crus with a no. 15 scalpel blade. The incision line was determined such that an adequate upward rotation would be possible for the nasal tip after suturation. From the dome incision, the dissection began between the cut end of the lateral crus cartilage and the underlying skin (the skin was preserved) and continued for as much as twice the length of the lateral crus cartilage we planned to fold back. The view of the incised domal cartilage with its two divided ends determined the new proper tip projection and rotation that needed, and in this way, we decided the proper length of the cartilage to be folded. Then, we folded the lateral crus backward as an overlay (mostly) or underlay flap on the body of the lateral crus.

We can use VAF unilaterally or bilaterally according to the side of the pathology. We can also use VAF in an asymmetric manner (asymmetric lengths folded on either side). We generally fold the cartilage along the long axis of the lateral crus but may prefer an angled fold using an

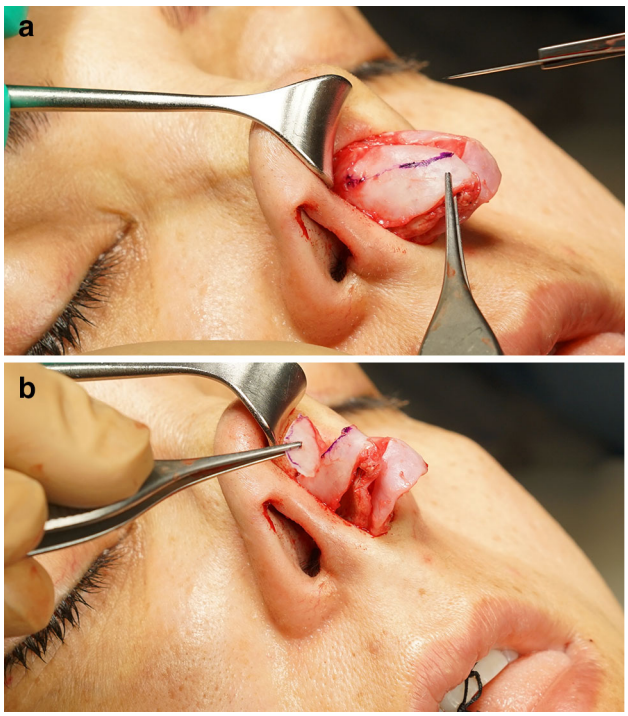


Fig. 2 VAF in the endonasal approach. **a** Marking for cephalic resection and **b** cephalic resection of lateral crura

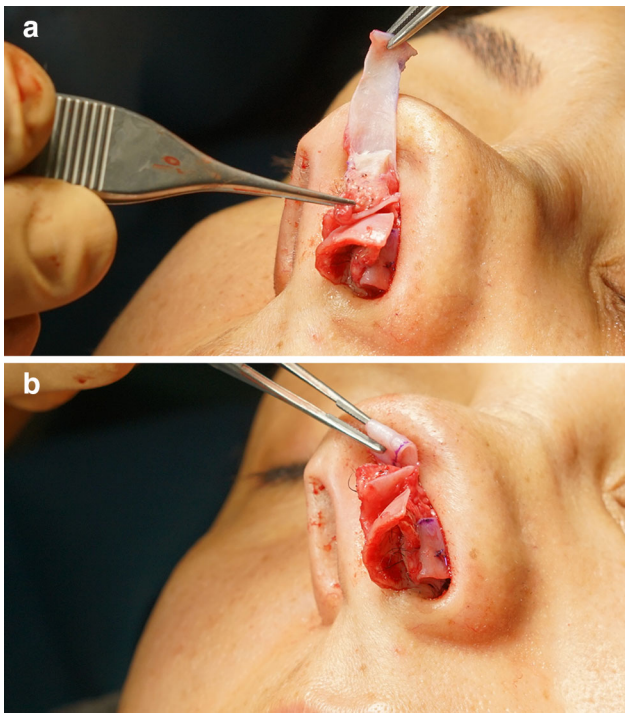
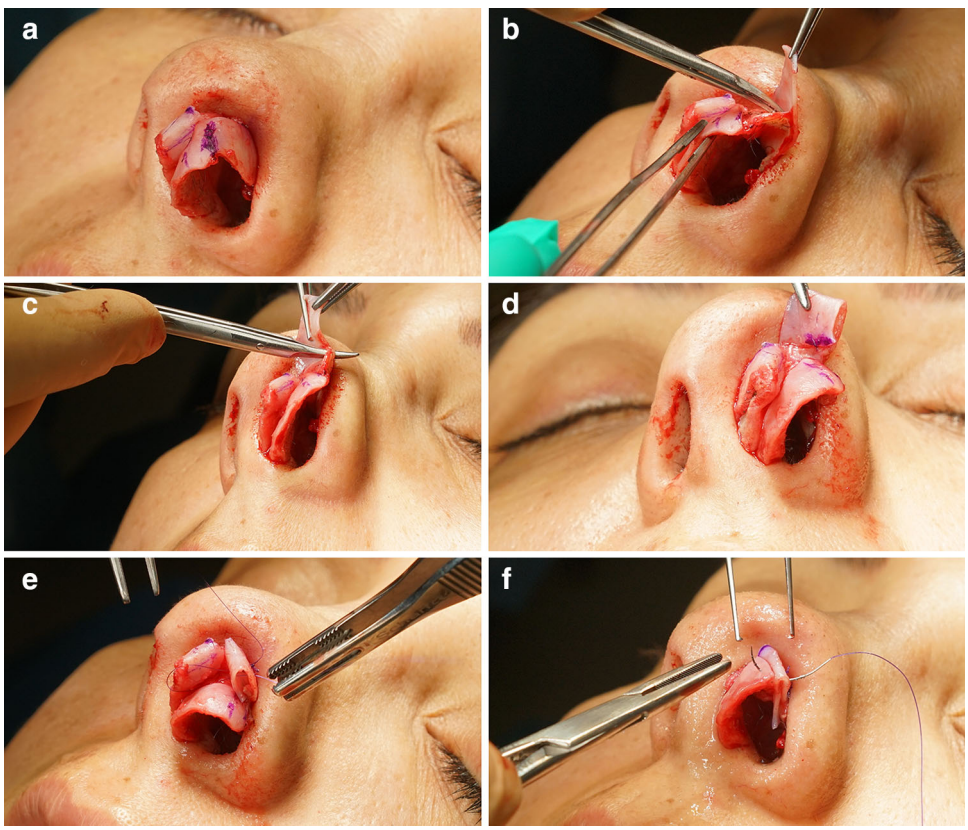


Fig. 4 Contralateral VAF in the endonasal approach. **a** Lateral crura after dissection and **b** vertical alar folding

Fig. 3 VAF in the endonasal approach. **a** Marking the dome before incision, **b** dome division and then dissection under lateral crura, **c** end of dissection at the desired length, **d** underlay vertical alar folding of lateral crura, **e** suturing the folded caudal crural cartilage and **f** formation of new dome with suture connection of lateral and medial crura of the lower lateral cartilage



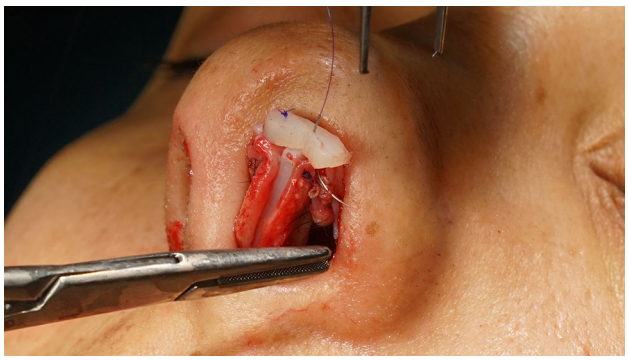


Fig. 5 VAF in the endonasal approach. New dome after VAF, strut graft, and tip graft combination

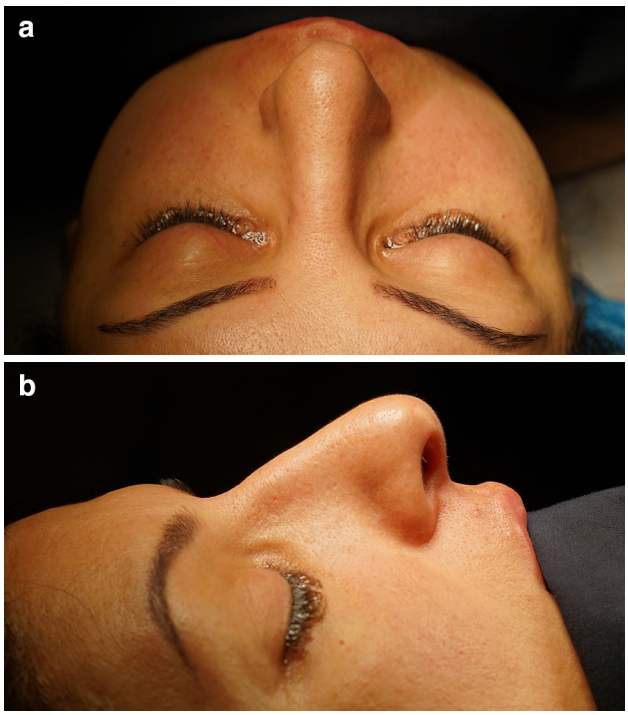


Fig. 6 VAF in the endonasal approach. Perioperative views of the patient before surgery; showing the length and concavity of the lateral crura: **a** superior view and **b** right lateral view

additional triangular portion of the cartilage that is folded at its base on the cranial rim of the lateral crus at the dome, resulting in an excess cartilage stump needing to be trimmed at the caudal rim of the lateral crus. This angled folding maneuver provides us the ability to modify divergence and helps us obtain a more convenient plane for the lateral crus.

We then stabilize the folded part of the lateral crus onto itself in the overlay version, or between the lateral crus and underlying skin in the underlay version, with two or three 6–0 polydioxanone mattress sutures, ensuring perfect adhesion.

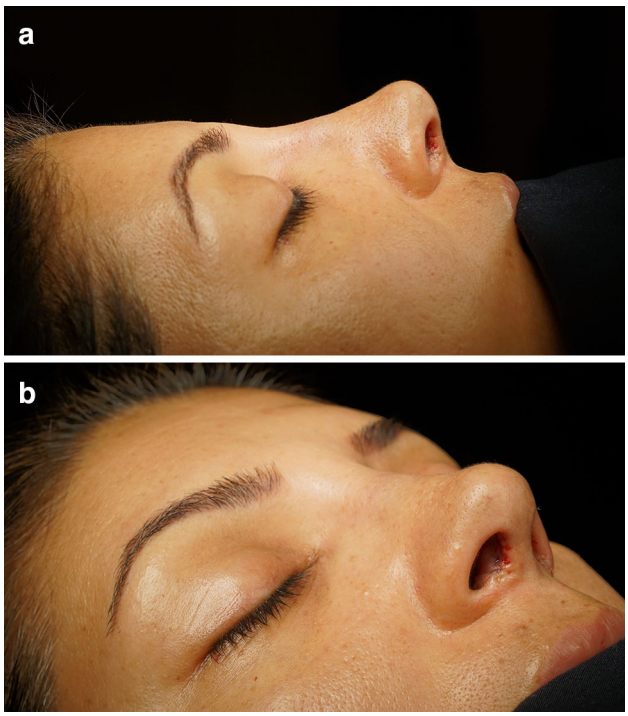


Fig. 7 VAF in the endonasal approach. Perioperative views of the patient after surgery. (a) Lateral view, (b) right inferior oblique view. Note the shortened lateral crura and its corrected concavity

After contralateral steps (if necessary), we suture the lateral crural cartilage back to the underlying detached skin with 5–0 vicryl rapide mattress sutures so that no dead space remains.

We form the new dome with this new, folded strong end of the lateral crus and the upper end of the ipsilateral medial crus with two 6–0 polydioxanone mattress sutures. The same maneuver is repeated on the contralateral lateral crus of the lower lateral cartilage. Interdomal sutures are inserted to preserve the divergence of the domes. A columellar strut of the cartilage is placed between the two limbs of the divided dome and sewn together. A tip graft onto the new dome can be located so that the planned tip height can be reached. The dome work ends with the placement of camouflage grafts, especially in thin-skinned patients, similar to vertical alar resection (VAR) (crushed or diced cartilages obtained from a cephalic resection of the lateral crus if this resection was planned; crushed or diced septal cartilage, if available; or excessive subcutaneous fibrotic tissue) [8].

In the open technique (Fig. 8), we perform the same steps after starting with a transcolumellar inverted V-shaped incision connected to the bilateral margin incisions.

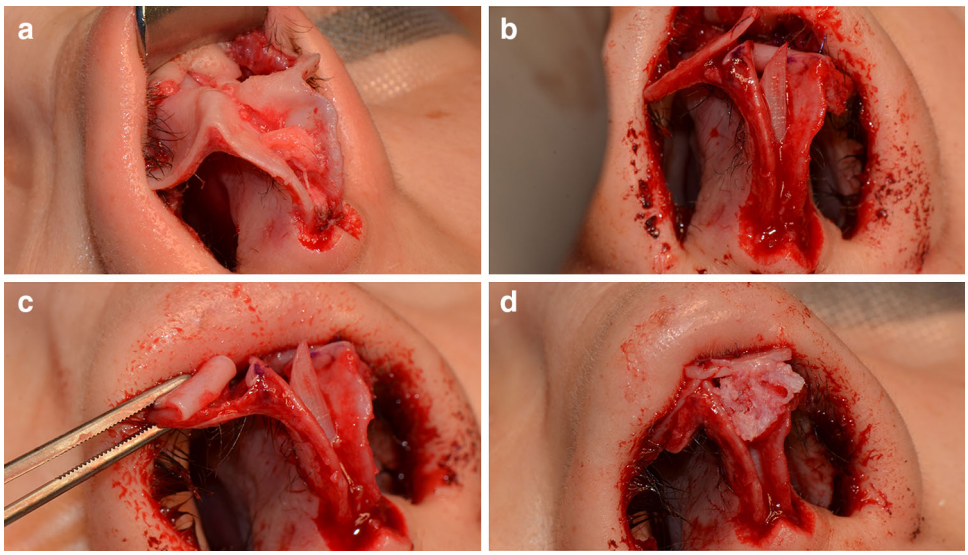


Fig. 8 VAF in the open approach. **a** Length, width, and concavity of the lateral crura, **b** divided dome, **c** vertical alar folding and **d** new dome combined with grafts

Results

Out of the 83 patients (59 women, 24 men), who underwent a primary rhinoplasty operation; 66 (79.5%) were with the open approach, and 17 (20.4%) were with the endonasal approach. Only those rhinoplasties that included the VAF technique completed by the senior author were included in this study. The mean age of the patients was 26.3 years (range 18–47). The mean postoperative follow-up period was 26.7 months (range 12–64).

In this case series, concavity of the lateral crura was seen in 19 patients (22.8%), long lateral crura without concavity that caused a droopy nasal tip was seen in three (3.6%), and long and concave lateral crura were detected in 61 (73.4%) patients.

Outcome measures were performed during an outpatient visit through examinations and comparisons of the preoperative and postoperative photographs, with the postoperative photographs taken at least 1 year after the operation. The follow-up examinations revealed that the symmetry, projection, and rotation of the nose and the alar patency provided by surgery were all preserved. According to the ROE questionnaire, 90.3% (75 out of 83) of the patients are content with the aesthetics and functional results of their rhinoplasty. Over a period of 5 years, none of the patients required a revision surgery. However, in two patients, there was a graft visibility problem, but these patients have not required a secondary operation. No other complications were seen.

In the patients who had lateral crus concavity, long or asymmetric lateral crura, or droopy or asymmetric nasal tip, there have been remarkable functional and aesthetic improvements with VAF. Preoperative and postoperative pictures of three patients in this study are shown in Figs. 9, 10, and 11.

Discussion

The tripod concept (proposed by Anderson) remains a helpful means of understanding the relationship between the rotation and projection of the tip [1, 9]. A long lateral crus resists against upward rotation of the nasal tip, whose location is dependent on the position of the caudal septum and lower lateral cartilages [10–12].

Lateral crura are supports for the alar wings, and they define both its shape and functionality. Zelnick and Gingrass [13], and Oneal et al. [14] described several variations in the shape of the lateral crura and reported different concavity types (involvement of their medial, central, or lateral portion).

Costantian, Courtiss, and Goldwyn noted the important role of the shape, robustness, and position of the lateral crura for the functioning of the external nasal valve [15, 16]. Concavity of lateral crura can lead to external nasal valve problems, a pinched tip, or alar retraction. Collapse occurs in the anterior two-thirds of a nasal wing that is supported here only by the lateral crura [17].

For straightening concavity of the lateral crura, excision and regrafting with a rotation of 180 endonasally, as described by Tardy et al. [18], and lateral crural strut grafts [19–21] are alternative methods. In addition, a lateral crural graft can be used for filling in the concavity [19]. Alar battens [22, 23] and a lateral crus turnover graft as initially proposed by McCollough and Fedok [24] are other options. The use of mattress sutures has also been reported [25], and Tellioğlu et al. described turn-in folding of the cephalic part of the lateral crus in 2007 [26]. A similar technique was reported by Murakami et al. [27]. In 2010, Boccieri et al. described the barrel roll technique [17], and in 2014, Kuran and Öreroğlu described the sandwiched lateral crural reinforcement graft [28].

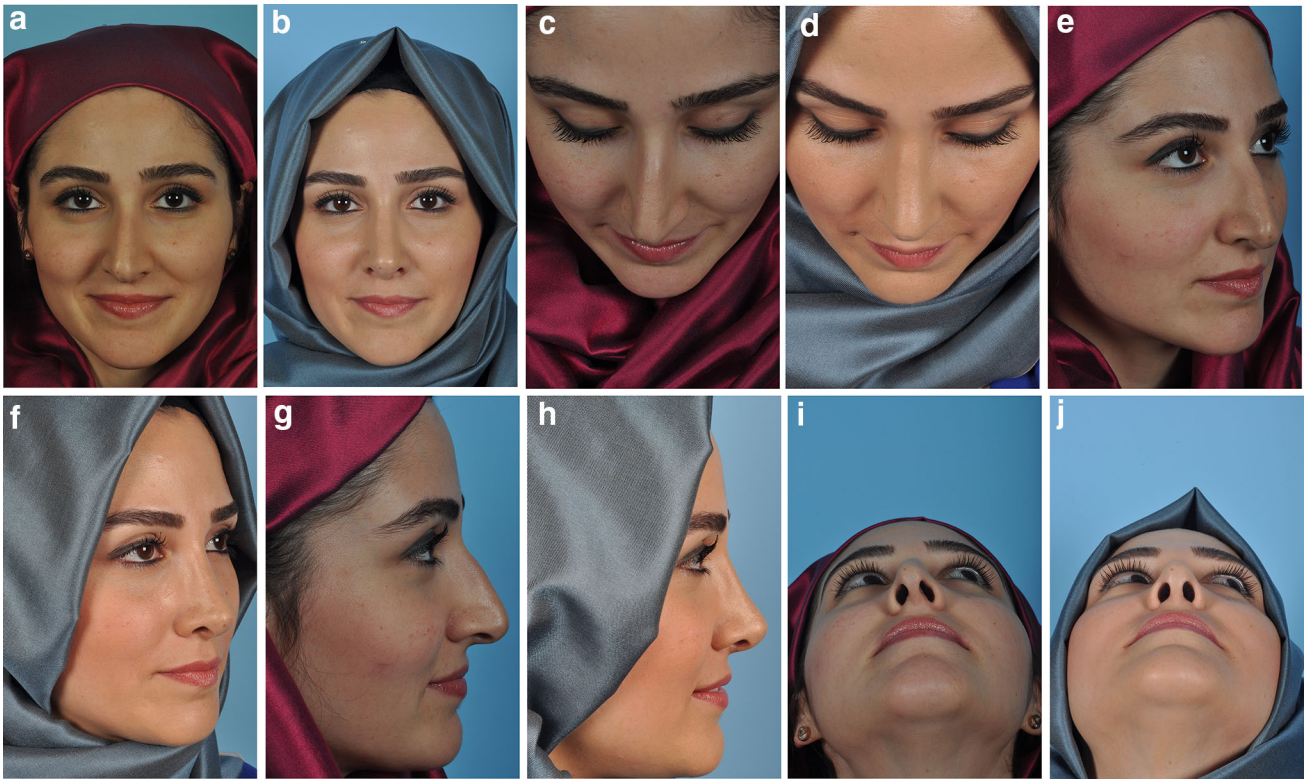


Fig. 9 A 22-year-old woman with a deviated and long nose. Note the bifid nasal dome, asymmetric length, and concavity of the lateral crura. **a**, **c**, **e**, **g**, and **i** are preoperative; **b**, **d**, **f**, **h**, and **j** are 4-year postoperative views. After performing the VAF technique, the desired projection, rotation, and nasal tip shape were achieved. The lateral crural length was arranged, and concavity was corrected as desired

The ideal technique must provide functionality, while it solves the aesthetic problem. It is also important to provide stamina with integrity, and feasibility with other modifications to achieve the realization of multiple results that remain properly stable over time.

The strength, shape, and position of the lower lateral cartilages, along with soft tissue connections, are important elements affecting the appearance of the nasal tip and the functioning of the external nasal valves. The lateral crura are important for the lateral support and rigidity of the nose, and variations in their anatomy can directly affect tip support and rotation [4, 29].

The VAF technique allows us to perform two procedures together: the lateral crus and dome modifications. And by controlling the lower lateral cartilage, we get the result of a smooth, strong, and flexible dome region that is natural and also desired one. We also control the divergence of each side of the dome. By using VAF, we double the strength of the thin lateral crura and also flatten the concavity, and it is not solely an aesthetic improvement achieved via camouflage grafting. In addition, the desired tip position and rotation, as well as the nose length, determine how much folding will be done.

With the form of new lateral crura, structural strength is increased, in addition to the better function from removal of the weakness of the nasal side wall caused by concavity, especially when a relatively thin and wide lateral crura were present.

With turn-in flap technique for modification of the lateral crura, it has been suggested that it is necessary to leave approximately 7 mm on both sides in women and 8 mm in men [5]. This method requires that the lateral crura have enough width for an unfolded part and a folded part. Therefore, in revision cases where the cephalic resection had already been done, this technique often could not be applied because no remaining excess cartilage existed. When the lateral crus does not have enough width, we cannot make a turn-in flap. However, if the patient has a long lateral crus, we can use excess cartilage for vertical folding after planning of the tip plasty.

Some suturing techniques have also described that are reversible and preserve cartilage integrity; however, as Gruber et al. and Neu et al. point out, there is the possibility that concavity cannot be resolved all the time with only sutures [25, 30].

Modification of the tip cartilage is done for several purposes, such as altering the projection and rotation of the tip, and the improvement of its definition, reduction of tip fullness, and forming of a supratip break all constitute the creation of a proper relationship between ala and columella

Fig. 10 A 33-year-old woman with deviated nose and asymmetric nasal tip. **a**, **c**, **e** are preoperative, **b**, **d**, **f** are postoperative views. Note the asymmetric length and concavity of the lateral crura. After performing the VAF technique, the desired projection, rotation, and nasal tip shape were achieved. The lateral crural length was arranged, and concavity was corrected as desired

[31]. A wide range of techniques have been used for these purposes, including cephalic resection of lateral crura, reshaping and repositioning of the cartilages, vertical transection and overlapping of lateral crura, vertical alar resection, and placement of tip grafts.

In addition to its alar contributions to becoming a tip modification technique, we can prefer VAF over dome division or vertical alar resection in other cases as well. For example, shortening of the lateral crus leads to a change in projection and an increase in rotation. And augmentation, with grafts or struts, can alter the length of this upper leg of the tripod, which also affects the position of the tip [4, 31, 32].

Furthermore, this technique can be combined with cephalic lateral crus resection and various suturing and grafting techniques. VAF forms double-layer lateral crura with an exact strength, and integrity is partially preserved at the tip region. Tip sutures and the double-layer part of the lateral crura increase the durability here, where the dome loses its integrity when we make an incision. Thus, this technique can provide us a smooth transition for the tip area that is lost when we perform a dome division.

Another advantage is that VAF uses autologous cartilage in its original region. No donor site morbidity occurs, so we can use excess cartilage as grafts for other purposes and sites. In addition, a new shape is given to the lateral crus, while the entire lateral crus is inside the nose; it is not

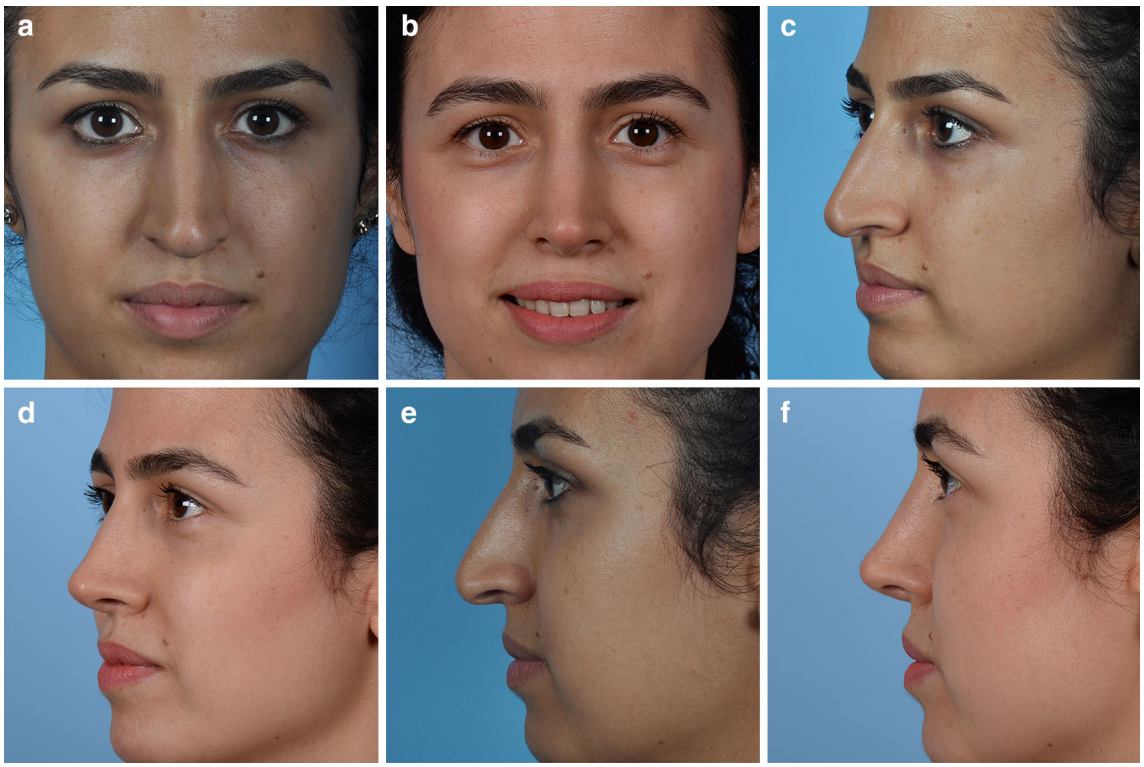


Fig. 11 A 24-year-old woman with a long nose and long and concave lateral crura. **a**, **c**, **e** are preoperative, **b**, **d**, **f** are postoperative images. With the VAF technique, the desired rotation of the tip, shortening of the nose, and correction of excessive concavity of the lateral crura were achieved

reconstructed extracorporeally, which may help with better viability for the cartilage.

We used VAF in some patients having convex lateral crus. In these patients, the VAF provided strength for the lateral crus; however, the proper plane for the lateral crura can be more easily obtained via VAF when it is used for concave lateral crura.

When we fold the caudal lateral crus after dissection between the cartilage and the underlying skin, part of the vestibular skin underlying the folded cartilage sometimes needs to be excised and sutured after formation of the new dome. However, we did not see any visible buckling of the skin under the lateral crura or dome in any of our patients after surgery.

We had no patients requiring revision operation because of tip or lateral crus problems. VAF is a useful method that helps to make a strong external valve and prevents its collapse, and further, VAF is a multipurpose technique that can be used solitarily instead of combining many other possible techniques.

Re-establishment of the tripod is the goal in tip reconstruction. A successfully reconstructed tripod structure must prevent the alar side walls from collapsing and must have the strength to support the tip while providing an aesthetically pleasing and natural appearance.

Conclusion

VAF is a useful and effective method for modification of lateral crura. With VAF, we can control the rotation and projection of the nasal tip, the length of the lateral crura and the nose, and add durability and symmetric contours. We can correct the excess concavity of lateral crura and obtain better functional and aesthetic results in rhinoplasty.

Funding The authors received no financial support for the research, authorship, and publication of this article.

Compliance with Ethical Standards

Conflict of interest The authors declared no potential conflicts of interest with respect to the research, authorship, and publication of this article.

Ethical Approval Ethics committee approval was obtained for this study, which received decision number 1615 dated December 21, 2018.

Informed Consent Informed consent was obtained from all patients.

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