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A Comparative Study Between Classic Derotation Graft and Novel Double V Cutting Folded Derotation Graft

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Abstract

Background To introduce an innovative refinement, the "double V cutting folded derotation graft" (DVCFD graft), which is a method for nasal tip lengthening in aesthetic rhinoplasty with strong holding force and efficient cartilage use.

Methods A retrospective study was conducted from January 2018 to July 2019 with 101 patients, including 11 males and 90 females with an average age of 36.87 ± 10.12 years, at Chang Gung Memorial Hospital; the patients received classic derotation grafts (n = 49, 17 of them were one layer and 32 of them were two layers) and DVCFD grafts (n = 52) for cosmetic tip plasty. The tip projection, columella labial angle and nasolabial angle were measured through clinical photography at three different times (T0: pre-operation, T1: two weeks post-operation and T2: five months post-operation). The differences between the original derotation graft and the DVCFD graft were identified using paired-t and independent-t tests.

Results The final relapse ratios of the classic derotation graft and DVCFD graft were 36.78% versus 36.92% for tip projection, 40.65% versus 38.58% for columella labial angle and 45.00% versus 47.76% for nasal labial angle, respectively. The P values of the independent-t tests were 0.991, 0.564 and 0.439, respectively.

Conclusions Both the classic derotation graft and DVCFD graft possess similar stability in tip plasty. The novel modification of the DVCFD graft has more efficient cartilage usage and is a feasible and safe surgical option for patients with limited harvestable cartilage for tip lengthening.

Level of evidence III 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 Short nose · Conchal cartilage · Derotation graft

Introduction

The noses of Asian individuals are characterized by a weak cartilaginous framework and a thick-skinned soft tissue envelope [1–18]. In addition, autologous cartilage is usually in short supply relative to the amount required to strengthen the nasal tip-supporting structures [1–11]. An aesthetically short nose, characterized by a short nasal length, over-rotation of the nasal tip and obtuse nasolabial angle [12, 13], is very common in Asians. The key points of surgical correction of a short nose are adequate releasing of the lower lateral cartilage and dorsal skin flap, repositioning of the alar cartilage caudally, and stable fixation of the lengthened cartilage [1–6, 13]. Among several techniques for the correction of a short nose or the fixation of lengthened alar cartilage, the septal extension graft, as first described by Byrd et al., has been the most widely used and

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can provide maximal tip projection and rotational controllability [1–18]. Nevertheless, it is almost always difficult to obtain a sufficient amount of septal cartilage from the noses of Asians because the septal cartilage in Asian populations is usually small and weak and sometimes has already been harvested in a previous surgery, which makes an effective septal extension graft difficult. In addition, nasal tip rigidity that leads to an unnatural appearance and facial animation is another drawback of the septal extension graft [1, 3, 4, 6].

Dr. Paik proposed a derotation graft in 2012 to overcome these shortcomings; the derotation graft involves a piece of elastic cartilage graft being harvested from the ear and fixed between the alar cartilage and caudal septum to maintain the tip at a new caudal position and act as a cushion buffer to achieve a less stiff nasal tip with sufficient nasal tip elongation [1, 3, 4]. However, in our practice, sometimes we need more than one layer of cartilage to achieve enough stability, which ultimately does not reduce cartilage usage. Therefore, we tried to modify the classic derotation graft to be more efficient while achieving the same or even better stability in tip rotation and stability.

Materials and Methods

This retrospective study was performed at Chang Gung Memorial Hospital after obtaining approval from the Institutional Review Board (IRB No. 202000194B0). During the period from January 2018 to July 2019, 101 consecutive patients who received rhinoplasty and nasal tip plasty purely due to cosmetic reasons were identified and enrolled. There were 11 males and 90 females, with an average age of 36.87 ± 10.12 years. All the medical charts, operational records and clinical photographs were reviewed. All surgeries were performed by a single experienced surgeon, Dr. Y.C. Hsiao. Early in the study period, forty-nine patients received the classic derotation graft as proposed by Dr. Paik. Seventeen of them had one-layer classic derotation grafts, and thirty-two of them had two-layer classic derotation grafts. Later, after some modifications, another 52 patients underwent our modified DVCFD graft for nasal tip plasty.

Surgical Technique

All operations were performed under general anesthesia. Overall, the DVCFD graft procedure was basically the same as that of the classic derotation graft [1, 3, 4]. Our modification was designed to provide stronger holding force and reduce cartilage usage. Open rhinoplasty was performed for all cases, and bilateral lower lateral cartilage (LLC) was adequately released from the surrounding retaining structures, such as the scroll and hinge area, according to the degree of the contractile forces and the amount of the tip rotation that was needed. Usually, only one side of the conchal cartilage, either from the cavum, cymba or both, was harvested through a posterior approach. A piece of elliptical-shaped cartilage was defined and cut. Then, a V-shaped cutting, 1 mm–2 mm in length, was carved out on both the upper and lower poles of this novel derotation graft. Second, a weakening sulcus on the midline of the dorsum was created with a no. 15 blade to facilitate the folding. Care was taken not to cut through the cartilage. Then, the freely mobilized LLC was approximated medially and advanced to the desired position to effectively lengthen and rotate the nose and was fixed with lateral crura-spanning sutures and interdomal or transdomal sutures first. The double V cutting derotation graft was then folded and straddled onto the supratip area as an interpositional graft between the caudal portion of the upper lateral cartilage (ULC) and the cephalic portions of the lower lateral cartilage and fixed with the septum, lower lateral and upper lateral cartilage with several either horizontal or vertical mattress sutures with 5-O PDS. The two ends of the V-shaped cutting could be adjusted to facilitate suture according to the individual angle of the lower and upper lateral cartilage. The folded cartilage with anchoring mattress sutures and the saddle-like effect over the supratip provided strong stability and secured the released cartilage into a more caudal position (Figs. 1 and 2). In addition, another elliptical cartilage, 1.5 cm–2 cm in length, was incised medially to half. The two halves of the cartilage were sutured onto themselves with the concave part inside.

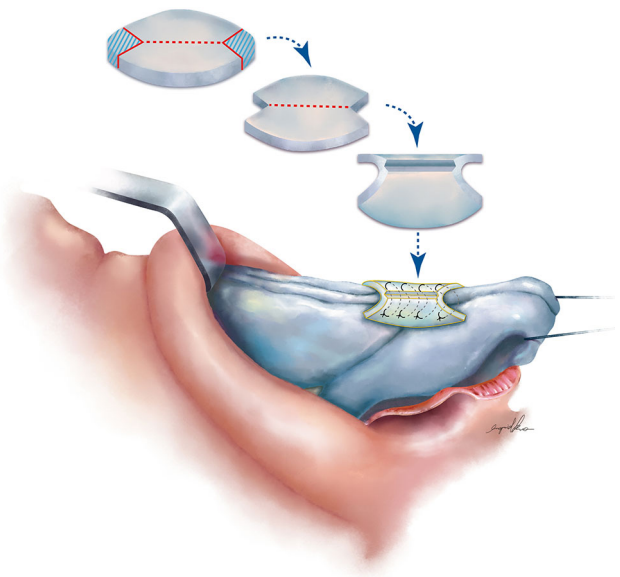

Fig. 1 Schematic depiction of the double V cutting technique

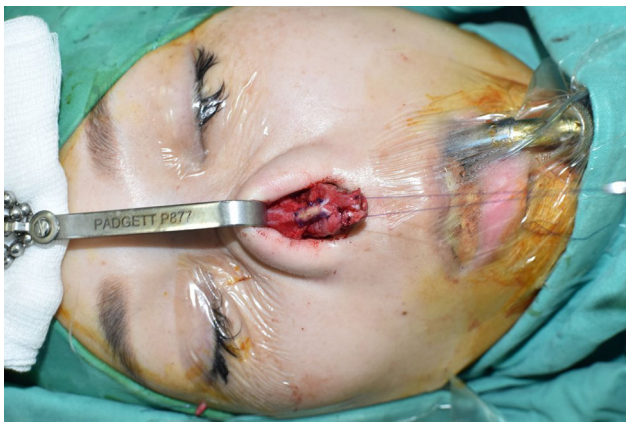

Fig. 2 DVCFD graft intraoperatively

A floating-type columellar strut fashioned from this double layer conchal cartilage was secured between the medial crus of the lower lateral cartilage with transfixed sutures for support of the tip projection (Video 1).

In classic derotation graft, it was placed in the same position between the caudal portion of the ULC and the cephalic portions of the LLC. If one layer is not strong enough to hold the tip position, another layer of derotation graft would be added on the original derotation graft to strengthen the force [1]. A floating-type columellar strut made of two layers of conchal cartilage was also inserted between the medial crus of the LLC.

Outcome Evaluation

For the comparison of the classic derotation graft and the DVCFD graft, three time points were established for evaluations: preoperative (Time 0, T0), immediately postoperative (Time 1, T1; 2 weeks after the operation) and postoperative (Time 2, T2; average of 13 months after the operation). Photographs were taken using the same patient positioning, camera setting and lighting conditions at every visit by a professional medical photographer. The nasal tip projection, columellar labial angle and nasal labial angle were measured through the clinical photographic images by ImageJ® software (National Institutes of Health, Bethesda, MD). The nasal tip projection was indirectly measured and calculated as the pixel count ratio between the pupil to the alar groove distance and the shortest distance from the tip defining point to the alar plane, as previously proposed [2] (Fig. 3).

Each measurement of the nasal tip projection, columellar labial angle and nasolabial angle was performed 5 times by the same observer, and the extreme values at both ends were excluded. The remaining values were averaged and used as the final measurement data. The differences between the classic derotation graft and DVCFD graft among the values obtained preoperatively (T0), immediately postoperatively (T1) and an average of 5 months postoperatively (T2) was identified using paired-*t* and independent-*t* tests. The statistical analyses were all performed using SPSS package version 19.0 for windows. Values of $p < 0.05$ were considered statistically significant.

For subjective outcome assessment, we utilized a questionnaire (Appendix A) that measured the degree of satisfaction of the nasal appearance and aesthetic outcome. We performed the questionnaire by telephone interview by the same investigator (research assistant, Chien MH). The patients assigned a score from 1 to 5, where higher scores indicated greater satisfaction. Preoperative and postoperative average scores were calculated, respectively.

Results

The average follow-up period was 13 months (range 12–28 months) for all patients. For the 49 patients who received classic derotation grafts and the 52 patients who received DVCFD grafts, there were no significant differences among the preoperative nasal tip projection, columellar labial angle and nasolabial angle (Table 1). Before the operation, the tip projection was 43.93% ± 4.61% for the patients with classic derotation grafts and 45.12% ± 5.34% for the patients with DVCFD grafts. Immediately postoperation, the nasal tip projection was 52.44% ± 4.93% for the patients with classic derotation grafts and 53.11% ± 5.29% for the patients with DVCFD grafts. After an average period of approximately 5 months postoperatively, the nasal tip projection was 49.31% ± 5.21% for the patients with classic derotation grafts and 50.16% ± 5.13% for the patients with DVCFD grafts. The average differences between time 0 and time 1, time 1 and time 2 and time 0 and time 2 were 8.51%, 3.13%, and 5.28%, respectively, for the patients with classic derotation grafts and 7.99%, 2.95% and 5.04% for the patients with DVCFD grafts, respectively. The differences between three different time points among the patients with the two types of grafts were all significantly different (p values all < 0.001). From time 1 to time 2, 63.22% and 63.08% of changes were maintained in the classic grafts and DVCFD grafts, respectively. In other words, the average relapse ratio was 36.78% for the patients with classic derotation grafts and 36.92% for the patients with DVCFD grafts, which were not significantly different ($p = 0.991$) (Table 2).

As for the columellar labial angle and nasolabial angle, the preoperative mean columellar labial angle was 101.12 ± 5.32 degrees and 99.89 ± 5.23 degrees for the patients with classic derotation grafts and DVCFD grafts, respectively. The nasolabial angle was 116.24 ± 5.93 degrees and

Fig. 3 Measurements of clinical photography. Nasal tip projection (red line) was calculated by measuring each pixel count ratio between the pupil to the alar groove distance and the shortest distance from the tip-defining point to the alar plane. The columellar labial angle (green line) and nasal labial angle (black line) were also measured for outcome analysis. (Left) T0: pre-operation baseline. (Middle) T1: two weeks post-operation. (Right) T2: five months post-operation

Table 1 Basic analysis

	Classic derotation graft (n = 49)		DVCFD graft (n = 52)		P
	Mean	± SD	Mean	± SD	
Age	36.43	± 10.84	37.15	± 10.67	0.671
Nasal tip projection	43.93%	± 4.61%	45.12%	± 5.34%	0.566
Columella labial angle	101.12	± 5.32	99.89	± 5.23	0.091
Nasal labial angle	116.24	± 5.93	114.69	± 6.61	0.068

Table 2 Relapse ratio of the nasal tip projection

	Nasal tip projection(%)			Average differences			Average relapse ratio
	T0	T1	T2	T1–T0	T2–T1	T2–T0	[1-(|T2–T0|)/(|T1–T0|)]
Classic derotation graft	43.93 ± 4.61	52.44 ± 4.93	49.31 ± 5.21	8.51%	3.13%	5.38%	36.78%
DVCFD graft	45.12 ± 5.34	53.11 ± 5.29	50.16 ± 5.13	7.99%	2.95%	5.04%	36.92%
P							
Classic derotation graft							
Versus T1	<.001*						
Versus T2		<.001*					
Versus T0			<.001*				
DVCFD graft							
Versus T1	<.001*						Classic versus DVCFD
Versus T2		<.001*					P = 0.991 +
Versus T0			<.001*				

* Statistical significance of paired-t test

+ Independent-t test was used for relapse ratio comparing between classic derotation graft and double V cutting folded derotation (DVCFD) graft

114.69 ± 6.61 degrees, respectively. Immediately postoperatively, the mean columellar labial angle was 92.15 ± 6.19 degrees and 90.87 ± 6.84 degrees for patients with classic derotation grafts and DVCFD grafts, respectively. The nasolabial angle was 107.64 ± 6.49 degrees and 106.63 ± 6.93 degrees, respectively. Five months postoperatively, the mean columellar labial angle was 96.01 ± 6.92 degrees and 94.35 ± 5.93 degrees for patients with classic derotation grafts and DVCFD grafts, respectively. The nasolabial angle was 111.51 ± 7.19 degrees and 110.48 ± 6.92 degrees, respectively. There were significant differences among the columellar labial angle and

nasolabial angle between all time points. For the columellar labial angle, the average relapse ratio between time 1 and time 2 was 40.65% for the patients with classic derotation grafts and 38.58% for the patients with DVCFD grafts. The nasolabial angle was 45.00% and 47.76%, respectively. Additionally, there was no statistically significant difference between the two different graft methods (p = 0.564 for columellar labial angle, p = 0.439 for nasolabial angle) (Tables 3 and 4).

During the follow-up, several complications were found (Table 5). For the total of 9 patients that required revision surgery, 5 patients (10.2%) were in the classic derotation group (1 for alar widening, 2 for septal deviation, 1 for tip irregularity and 1 for dorsum irregularity), and 4 patients (7.7%) were noted in the DVCFD graft group (1 for septal deviation, 2 for tip irregularity and 1 for dorsum irregularity). Few infections were found during the follow-up period, including for three patients (6.1%) in the classic derotation group (2 for *Staphylococcus aureus* and 1 for *Streptococcus pyogenes*) and 4 patients (7.7%) in the DVCFD graft group (2 for *S. aureus* and 2 with cultures showing no growth). Erythematous changes over the nasal tip/dorsum were also reported, including 4 (8.2%) in the classic derotation group and 5 (9.6%) in the DVCFD graft group. These minor complications were all treated conservatively and improved.

For the subjective outcome evaluation, the average satisfaction score was 2.02 before operation and 3.95 after operation in classic derotation graft group and 2.12 before operation and 4.23 postoperatively in DVCFD graft group.

Case Report

A 23-year-old woman underwent open rhinoplasty for a short nose (Fig. 4a, b, c). A DVCFD graft with a floating columellar strut was utilized for tip rotation and lengthening. A cap graft and shield graft were also made with septal cartilage and conchal cartilage. Postoperative follow-up at 24 months showed a good and stable outcome (Fig. 4d, e, f).

Discussion

A short nose is difficult to correct because the underlying framework is limited in its ability to withstand the opposing contractile forces from the nasal skin envelope [1–18]. The septal extension graft is a powerful method to control and maintain the lengthened cartilaginous tip structure and can produce a strong tip-supporting effect [1–18]. However, we usually have to leave a 10-mm L-shaped strut in order to not attenuate the normal support of the nasal septum [5], so the quantity or strength of harvestable septal cartilage is often inadequate for complete septal extension. Due to the depleted donor supply of septal cartilage and some complications of artificial material in tip plasty, a recent trend to control tip projection and rotation has been the use of conchal cartilage grafts in Asians [5]. The derotation graft proposed by Dr. Paik showed that, with LLC repositioning and ear cartilage grafting, the nasal tip can be positioned in accordance with the patient's anatomic limits [1, 3, 4]. Additionally, the entire nasal tip and

Table 3 Relapse ratio of the columella labial angle

	Columella labial angle			Average differences			Average relapse ratio
	T0	T1	T2	T1–T0	T2–T1	T2–T0	[1-(|T2–T0|)/(|T1–T0|)]
Classic derotation graft	101.12 ± 5.32	92.51 ± 6.19	96.01 ± 6.92	8.61	3.50	5.11	40.65%
DVCFD graft	99.89 ± 5.23	90.87 ± 6.84	94.35 ± 5.93	9.02	3.48	5.54	38.58%
P							
Classic derotation graft							
Versus T1	<.001*						
Versus T2		.002*					
Versus T0			<.001*				
DVCFD graft							
Versus T1	<.001*						Classic versus DVCFD
Versus T2		.004*					P = 0.564 +
Versus T0			<.001*				

* Statistical significance of paired-*t* test

+ Independent-*t* test was used for relapse ratio comparing between classic derotation graft and double V cutting folded derotation (DVCFD) graft

Table 4 Relapse ratio of the nasal labial angle

	Nasal labial angle			Average differences			Average relapse ratio
	T0	T1	T2	T1–T0	T2–T1	T2–T0	1-(|T2–T0|)/(|T1–T0|)
Classic derotation graft	116.24 ± 5.93	107.64 ± 6.49	111.51 ± 7.19	8.60	3.87	4.73	45.00%
DVCFD graft	114.69 ± 6.61	106.63 ± 6.93	110.48 ± 6.92	8.06	3.85	4.21	47.76%
P							
Classic derotation graft							
Versus T1	<.001*						
Versus T2		.005*					
Versus T0			<.001*				
DVCFD graft							
Versus T1	<.001*						Classic versus DVCFD
Versus T2		.043*					*P* = 0.439 +
Versus T0			<.001*				

* Statistical significance of paired-*t* test

+ Independent-*t* test was used for relapse ratio comparing between classic derotation graft and double V cutting folded derotation (DVCFD) graft

Table 5 Complications

	Classic derotation graft (*n* = 49)	DVCFD graft (*n* = 52)
Revision surgery		
Ala reduction	1 (2.0%)	0
Septal deviation	2 (4.1%)	1 (1.9%)
Tip irregularity	1 (2.0%)	2 (3.8%)
Dorsum irregularity	1 (2.0%)	1 (1.9%)
Infection		
Staphylococcus aureus	2 (4.1%)	2 (3.8%)
Streptococcus pyogenes	1 (2.0%)	0
No growth	0	2 (3.8%)
Erythematous change	4 (8.2%)	5 (9.6%)

columella can be lengthened, while the tip maintains its mobility [1, 3, 4].

Among the control group with classic derotation grafts in our study, 17 of them had one layer and 32 of them were two layers, which means that sometimes a one-layer graft was still too weak to support the caudally shifted dome and an additional layer or more cartilage material was necessary to achieve adequate tip rotation and stability. This is the reason why we presented the modified method to improve the efficiency and effectiveness of the ear cartilage graft in tip rotation.

Compared to the classic derotation graft, our modified DVCFD graft had several advantages. (1) It required the same or a lesser amount of cartilage to attain similar tip rotation. (2) With the V-cutting design over both the upper and lower portions of the derotation graft, the spreading of the two arms could be better adjusted to different shapes and angles of the upper lateral cartilage and lower lateral cartilage person to person, which facilitated the fixation sutures and provided smoother edges. (3) The folding fashion of the cartilage and the mattress suture in the septum provided rigid fixation and more strength for holding the tip position and rotation (Video 2). The relapse ratio was smaller in the DVCFD group than in the classic derotation group, although the relapse rate and long-term stability showed no statistically significant difference with the traditional method. (4) The folded fashion of the graft on the supratip seldom resulted in graft show or required shaving the graft. Moreover, it had benefits as the classic method with a mobile and elastic tip [1, 3, 4], the potential for preservation of septal support, and the ability to serve as a bridge or augmentation to the gap over the supratip area in certain patients with supratip depression.

As Dr. Paik previously mentioned, a derotation graft usually lowers tip projection, and it is difficult to correct a short septum by using a derotation graft alone [1]. We

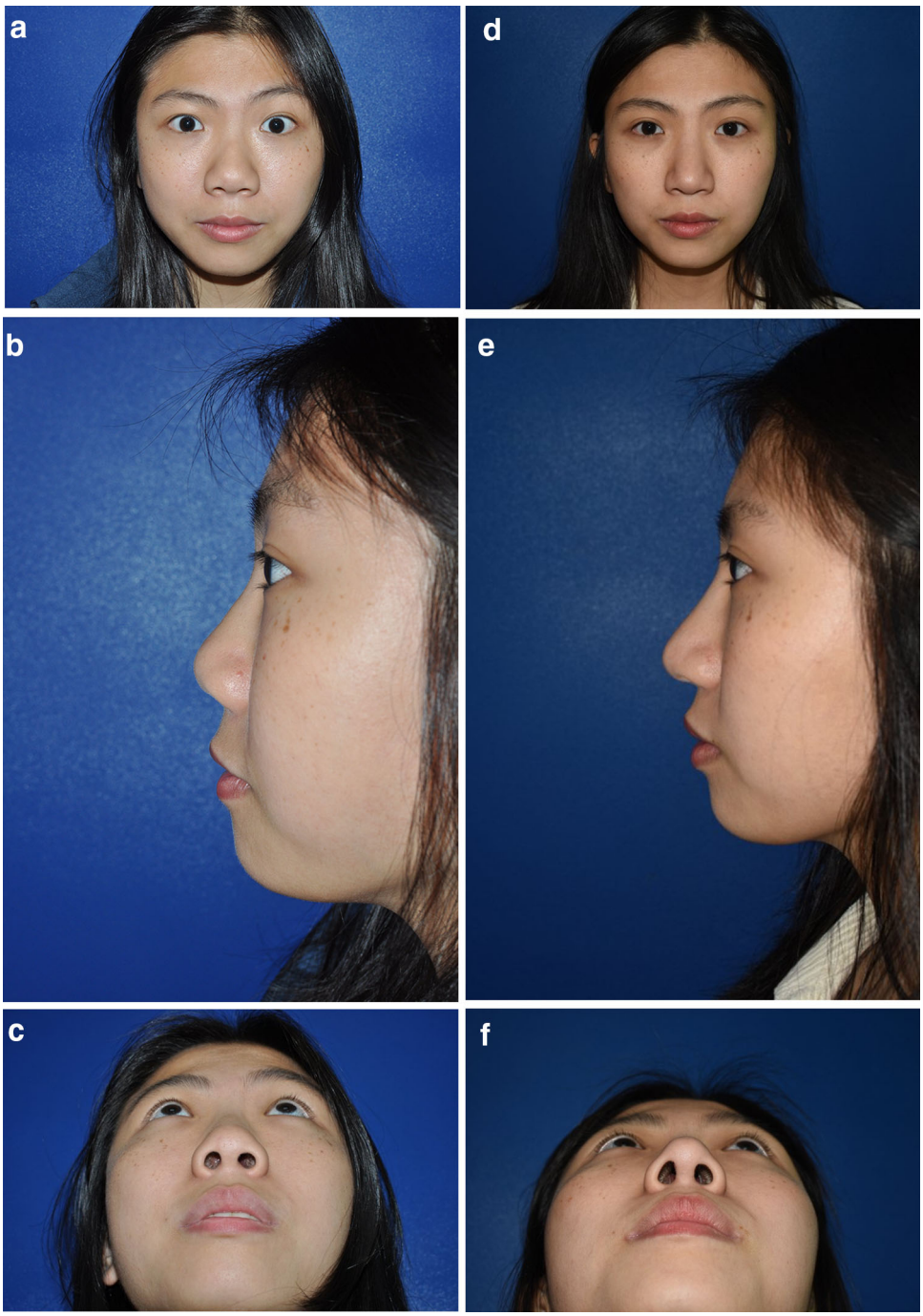

Fig. 4 **a–c** A 23-year-old woman underwent open rhinoplasty for a short nose. A DVCFD graft with a floating columellar strut was utilized for tip rotation and lengthening. **d–f** Postoperative follow-up at 24 months showed a good and stable outcome

utilized a columellar strut made of a double layer of conchal cartilage to enforce tip support and prevent drooping of the tip. Our results were quite similar to the finding of Suh et al. that the septal extension graft and double layer conchal cartilage graft are similar in terms of tip stability [2]. Although the strut is relatively floating and not fixed to the anterior nasal spine, the stability is still optimal and can prevent postoperative nasal tip rigidity and somehow also improve columellar retraction. Benavides et al. reported that suturing the caudal septal extension graft with absorbable material without fixing it to the nasal spine region is a reliable variation to the conventional method, which uses permanent sutures to fix the graft to the nasal spine region [17]. Both showed similar complication, reoperation and tip de-projection rates [17]. In addition, the floating component of the strut graft allowed the tip to be pushed down when external force was applied [1, 2]. Taking advantage of the fact that conchal cartilage has intrinsic strength similar to that of the nasal cartilage [2], the combination of the DVCFD graft with floating

columellar strut could preserve much of the natural physiology of the original nasal tip and allow the tip to move as naturally as possible, since the nasal tip is normally mobile and flexible [1–6]. In Asian society, some degree of cephalic rotation when passive force is applied at the tip is an index of whether rhinoplasty had been performed. Some people care about this index because they do not want others to know that they have undergone a rhinoplasty procedure. They prefer a natural look and natural nasal mobility.

The lower lateral cartilage is connected superiorly to the upper lateral cartilage by fibrous connective tissue at the scroll and held laterally at the hinge region [5, 6]. We believe that releasing the LLC adequately from surrounding retaining components for a tension-free caudal rotation is critical in tip rotation because the fixation will not always be stable if the initial release is not precise and will relapse easily. We routinely released the lower lateral cartilage to the caudal portion of the upper lateral cartilage. For more severe cases, wide dissection extended to the scroll and hinge area, medial crura (or even membranous septum and nasal mucosa) and underlying vestibular skin was performed to gain more mobility. The freely mobilized LLC was approximated medially and advanced to the desired location to effectively lengthen and rotate the nose. With sufficient releasing and stable fixation, even moderate to severe contracture or short noses could be improved without the need for the use of rigid cartilage materials, such as the septum or rib.

In secondary rhinoplasty or revision cases, adequately freeing the retaining forces is especially significant [6, 13]. In addition, the importance of the release of the soft tissue skin envelope for adequate nasal lengthening cannot be overemphasized [6, 13]. It is paramount to create support that will counteract the contractile forces of the soft tissue skin envelope. However, in this group of patients, the cartilage structure was somehow changed or destroyed. The septum had sometimes already been harvested and more of the remaining L-shaped strut was considered to be left behind in terms of stability. Without adequate cartilage support, the vectors of contracture from the soft tissue skin envelope will continue unopposed and make the tip rotate cephalically [6, 13]. Our technique is a safe, effective and reliable alternative to address either a short nose or perform primary or secondary rhinoplasty. With our method, the mobility of the nasal tip is maintained while providing enough structural support. There is a low incidence of complications, and we were able to remarkably reduce the use of rib cartilage and consequently avoid chest scarring and the deterioration of nasal tip stiffness.

Postoperative relapse was identified with mild decreased tip projection or cephalic rotation of the nasal tip from time 1 to time 2, which might be due to the effect of gravity, gradual loss of cartilage support, decreased swelling or soft tissue contracture. The weakening of the cartilaginous support and the contractile forces imposed by the healing soft tissue skin envelope may result in this phenomenon, which is an unavoidable process during the wound healing period, regardless of the technique. Enhancing graft stability is important for better long-term outcomes and minimizing relapse or complications, and even more efficient application of these methods is needed for East Asians given the paucity of cartilage resources [10], especially in revision cases and the need for strong structural support. In our novel method, the relapse ratio was 36.92% in nasal tip projection and 38.58% and 47.76% in columellar labial angle and nasal labial angle, respectively, without a significant difference when compared with the classic method. However, the changes in the three parameters between every time point, including T0 and T2, were all significant in both groups, which showed that the rotation effect was predictable and consistent.

There are some limitations of our technique. For patients who already have supratip fullness, the derotation graft may not have benefits. Our DVCFD graft can cause more supratip fullness than the classic method. For revision cases or individuals whose bilateral ears have already been harvested, the derotation graft may no longer be available, and a rib cartilage graft is probably the remaining autologous choice for tip lengthening in this situation. Another concern is the medialization of the nasal cartilage. In certain cases, the application of a spreader type derotation graft can avoid excessive medialization of the LLC. However, this comparative study showed value, as it compared the tendency and relapse ratio of tip projection and amount of tip rotation during the postoperative period between the classic derotation graft and our novel DVCFD graft, which provides a safe and effective alternative in the management of the challenging issue of correction of a short nose.

Conclusions

The combination of double V cutting folded derotation graft and floating columellar strut is a feasible surgical option for tip lengthening in patients with limited harvestable septal cartilage. The novel modification of the DVCFD graft showed a similar outcome and stability as the classic derotation graft, with more efficient cartilage usage.

Compliance with Ethical Standards

Conflict of interest None

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of

the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Institutional Review Board (IRB No. 202000194B0) approval was obtained.

Informed Consent For this type of retrospective study, informed consent is not required.

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