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The Application of a New Framework Construction Technique in Autologous Costal Cartilage Rhinoplasty

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Background: In this study, the clinical efficacy of a new framework construction technique for costal cartilage rhinoplasty was investigated.
Methods: From January 2020 to February 2022, patients who underwent rhinoplasty in the department of plastic and reconstructive surgery of Zhejiang Provincial People's Hospital were enrolled. The sixth costal cartilage was made into the nasal columellar support graft (strut), the nasal tip graft integrated scaffold, and the septal extension grafts. The strut and septal extension grafts were sutured to construct the framework. Adobe Photoshop 6.0 was used to measure a series of aesthetic indices preoperatively and at 9 months postoperatively, including the nasal length, tip projection, nasofrontal angle, columellar/lobular angle, and nasolabial angle. The visual analog scale score and rhinoplasty outcome evaluation score were used to assess patient satisfaction. A paired *t* test was used for data analysis, and a *P* value of less than 0.05 was considered to indicate statistical significance.
Results: A total of 65 patients aged 19–43 years (average age 26.0 y) were enrolled. No short-term complications occurred. All patients were followed up for 9–23 months. There were statistically significant differences in all measurements ($P < 0.05$), which suggested that the aesthetic defects of the nose were corrected and that no obvious deflection or rotation of the nasal tip occurred. The visual analog scale score and rhinoplasty outcome evaluation score indicated a significant improvement in patient satisfaction ($P < 0.05$).
Conclusions: This new framework construction technique for costal cartilage rhinoplasty can reduce the risk of framework deflection and nasal tip rotation and provide a satisfactory nasal columellar shape. *(Plast Reconstr Surg Glob Open 2024; 12:e6357; doi: 10.1097/GOX.0000000000006357; Published online 18 December 2024.)*

INTRODUCTION

Common nasal deformities in East Asian patients often include a low radix, a bulbous underprojected nasal tip, and/or a short nose. Rhinoplasty is currently one of the most popular aesthetic operations in China. Several kinds of materials are widely used in rhinoplasty, including costal cartilage, auricular cartilage, nasal septum cartilage, and prostheses.[1,2] Compared with auricular cartilage, costal cartilage has many advantages, such as sufficient sources, ample volume, robust strength, lower late absorption rate, and better stability.[3–6] Compared with those in homograft costal cartilage, autologous costal cartilage cells are larger and have better histological characteristics and lower long-term absorption rates due to their higher collagen and polysaccharose contents.[7] On the other hand, there are some common complications (pneumothorax, scarring, and pain) because of the harvest of costal cartilage. At present, costal cartilage should be the preferred material because of the above advantages. However, autologous costal cartilage rhinoplasty has several obvious problems, such as poor stability and defective shape of the nasal columella, a greater possibility of upward and downward rotation of the nasal tip, and even nasal contracture.[8,9] Therefore, the author used a new framework construction technique for costal cartilage rhinoplasty that has been widely used in clinical practice and has achieved good surgical outcomes.

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Related Digital Media are available in the full-text version of the article on www.PRSGlobalOpen.com.

PATIENTS AND METHODS

Patients

In this study, patients who underwent costal cartilage rhinoplasty using new framework construction technology at the department of plastic surgery and reconstructive surgery of Zhejiang Provincial People's Hospital from June 2020 to July 2022 were included. The inclusion criteria for patients were as follows: (1) had a saddle nose; (2) had costal cartilage constructed by our new technique for rhinoplasty; (3) had a follow-up time of more than 6 months; (4) had no mental illness or speech or hearing impairment; and (5) provided complete clinical data and informed consent for this study. The exclusion criteria were as follows: (1) severe calcification of costal cartilage and (2) sinus or nasal infection or other serious infectious diseases.

Overall, 65 patients were enrolled, including 4 men and 61 women, with an average age of 26.0 (19–43) years. All the patients in this study signed informed consent forms, and the study was approved by the ethics committee of Zhejiang Provincial People's Hospital (No. 2022-361).

Standard images of the rhinoplasty of all patients were taken, and the images were processed using the ImageJ software version 1.80 (National Institutes of Health) as a measurement tool. The software was used to measure previously defined nasal markers,[10] including the nasal length, tip projection, nasofrontal angle, columellar/lobular angle, and nasolabial angle. As there are no established references for these measurements, the tip projection/nasal length index and lobular/columellar length index were used as indicators of the elevation of the nasal tip and the elongation of the nasal length. All data measurements were made by the same person, and the length and angle measurements were accurate to 0.01 cm and to an angle of 0.1, respectively. Each variable was measured 3 times, and the average value was used in the analysis. SPSS 20.0 software was used to analyze the pre- versus postoperative data via paired *t* tests.

During the follow-up period, hematoma, infection, bleeding, swelling, bruising, and other short-term complications were recorded. Long-term complications, including nasal tip skewing, upturning or downturning, cartilage absorption, subcutaneous movement of cartilage, deformation, and bending, were recorded. All patients were asked to complete a postoperative satisfaction survey consisting of a visual analog scale score for the aesthetic outcome[11] and a rhinoplasty outcome evaluation.[12,13]

Surgical Technique

Preparation of Cartilage Framework Components

All patients were operated on by the same senior plastic surgeon while they were under general anesthesia. The sixth costal cartilage was harvested, and the full thickness of the middle part of the costal cartilage was sculpted into the strut and septal extension graft (SEG). The thickness of the strut was 2.5–3.0 mm; the height was 3 cm (including 0.6 cm for the mushroom cap tip); the width was 0.6 cm; and the tail split vertically was 2 cm (1 cm from the top of the mushroom cap tip). The SEG was close to a right-angled trapezoid. The thickness of the SEG was 2.5 mm; the long side was 2.2 cm; the short side was 1.8 cm; and the width was 0.6 cm. The right triangle area of approximately 3 × 3 mm was left unsplit at the caudal end. The height and width of the cap tip graft of the mushroom head were both 0.6 cm, and the curved surface was adjusted in real time according to the shape of the skin covered during the operation until the ideal appearance was achieved (Fig. 1A) (**See figure**, **Supplemental Digital Content 1,** which shows the different angle views of

Takeaways

Question: Is there any new technique of framework construction to solve the poor stability in costal cartilage rhinoplasty?

Findings: The new technique of framework construction in costal cartilage rhinoplasty can reduce the risk of framework deflection and nasal tip rotation and provide a satisfactory nasal columellar shape.

Meaning: We introduced a new framework construction technique in autologous costal cartilage rhinoplasty that has been widely used in clinical practice and has achieved good surgical outcomes.

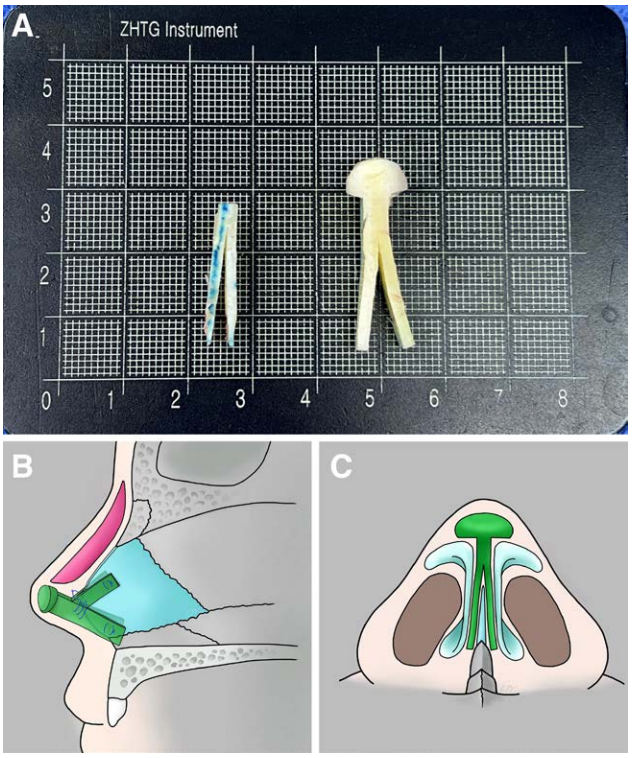

Fig. 1. Preparation of an integrated framework of strut and nasal tip–covered graft and SEG and methods of graft construction during cartilage rhinoplasty. A, Fabrication of the strut, nasal tip–covered graft, and SEG. The strut was split sagittally at the bottom of the strut, and the mushroom-like structure was used as the nasal tip graft. The SEG was split sagittally with a 3 × 3 cm right triangle left. B and C, Schematic diagram of the bottom and side views of the graft constructed intraoperatively.

the strut and SEG, http://links.lww.com/PRSGO/D664.) (**See figure, Supplemental Digital Content 2,** which shows the different angle views of the strut and SEG, http://links.lww.com/PRSGO/D665.) (**See Video 1 [online],** which displays the preparation of the strut and SEG.)

Construction and Implantation of the Cartilage Framework

Local infiltration anesthesia was induced with 2% lidocaine containing 1:100,000 epinephrine.

A bilateral lower lateral cartilage margin incision combined with a nasal columnar incision was made, and the cartilage and nasal soft tissue were sharply separated from the surface of the inferior lateral nasal cartilage. The space was bluntly stretched over the middle nasal arch until it reached the keystone zone. After touching the nasal bone with scissors, the periosteum of the nasal bone was cut along the nasal bone. The periosteum was dissected with a stripper. A hook was used to pull the nasal skin flap toward the head, and the space of the inferior lateral cartilage was separated to observe whether the bilateral inferior lateral cartilage was released thoroughly. The soft tissue between the membranous septum and medial crura was incised and the mucoperichondrium of the septum was dissected. The anterior nasal spine was carefully dissected laterally to expose the maxillary surface to a range of approximately 0.3 cm for the placement of the strut.

The strut was inserted to achieve appropriate nasal tip projection and septal support and was firmly fixed to the nasal septum. (**See Video 2 [online],** which displays the stabilization of the strut to the anterior nasal spine and the stabilization of the lower lateral cartilage to the strut.) The SEG was straddled on the nasal septum, and the uncut part of the SEG was located in the tail of the nasal septum. The strut and SEG were fixed with 5-0 polydioxanone suture (PDS). The first needle was inserted from the SEG at the depth of the caudal end of the SEG approximately 0.5 cm from the contact surface between the SEG and strut, and the second needle was inserted in the same plane at the strut on the same side. After 3 cycles, the last needle was passed through the SEG and was knotted and secured on the shallow side of the SEG to ensure reliable SEG and strut fixation (Fig. 1B, C). (**See figure, Supplemental Digital Content 3,** which shows how the integrated framework of the strut and nasal tip–covered graft was fixed on the caudal side of the septum cartilage, and the bottom was connected to the anterior nasal spine, http://links.lww.com/PRSGO/D666.) (**See figure, Supplemental Digital Content 4,** which shows how the SEG was fixed with the integrated framework of the strut and nasal tip–covered graft, and the split part was fixed with the septal cartilage, http://links.lww.com/PRSGO/D667.) (**See Video 3 [online],** which displays the placement and fixation of the strut and SEG.)

The skin flap was turned down to cover the mushroom-like structure, and the mushroom-like structure was trimmed to the appropriate shape depending on the shape of the nasal columella, columellar lobule angle, and nasal tip. The top of the mushroom-like structure was covered with 1–2 layers of perichondrium and fixed with 5-0 PDS if the surgeon predicted that the skin would thin later.

Insertion of Nasal Dorsal Prosthesis

The nasal dorsal prosthesis was sculpted as needed, with a drop of approximately 0.4 cm at the end of the prosthesis to form a proper supratip area. Approximately 0.5 cm of the tail of the nasal dorsal prosthesis was fixed with 1 suture to the lateral end of the inferior lateral nasal soft bone and the junction of the fornix using 5-0 PDS. (**See Video 4 [online],** which displays the placement and stabilization of the nasal dorsal prosthesis.) The skin incision was closed with 6-0 Prolene sutures, and the endonasal incision was closed with 6-0 Vicryl sutures. Thermoplastic nasal splints were routinely used to stabilize the dorsal onlay graft at the midline.

Postoperative Care

The endonasal incision was cleaned with normal saline once daily during the first week postoperatively to ensure that no dried blood adhered to the wound, and the sutures were removed on postoperative day 7. A thermoplastic external splint was worn at all times for 10 days postoperatively. For patients in whom the graft appeared to be unstable or subjected to uneven forces, it was recommended that they wear a silicon endonasal supporting tube for 1–3 months, ideally at all times throughout the day or for approximately 12 h/d. The silicon endonasal supporting tube had the appropriate hardness and elasticity to effectively reshape the nostril and maintain symmetry. (**See figure, Supplemental Digital Content 5,** which displays the silicon endonasal supporting tube, http://links.lww.com/PRSGO/D668.) Due to the need for implants, we used preoperative antibiotics to prevent infection. It is generally used once before surgery and is stopped 24 hours after surgery.

RESULTS

Sixty-five patients, including 4 men and 61 women, consented to participate in the present study. The follow-up duration ranged from 9 to 23 (mean follow-up, 16.5) months.

The nasal length, tip projection, nasofrontal angle, columellar/lobular angle, and nasolabial angle were significantly corrected postoperatively (Table 1, $P < 0.001$). No severe short-term complications or obvious long-term complications were observed. All patients were satisfied with the final nose shape. Postoperatively, patients had a significant improvement in visual analog scale score and the mean rhinoplasty outcome evaluation test score (Table 1, $P < 0.001$). Preoperative and postoperative images of 3 typical patients are displayed in Figures 2 and 3 and Supplemental Digital Contents 6–8. (**See figure, Supplemental Digital Content 6,** which displays a 27-year-old female patient who underwent rhinoplasty with the new framework construction technique. A–D, Preoperative views. E–H, Postoperative views 14 months after surgery; unpleasant nasal feature defects substantially improved, http://links.lww.com/PRSGO/D669.) (**See figure, Supplemental Digital Content 7,** which displays a 24-year-old female patient who underwent rhinoplasty with the new framework construction technique. A–D, Preoperative views. E–H, Postoperative views 15 months after surgery; unpleasant nasal feature

Table 1. Pre- and Postoperative Measurements Comparison of 65 Cases of Rhinoplasty With New Framework Construction Technique

	Preoperation	Postoperation	*t*	*P*
NFA	140.9 ± 5.0	136.1 ± 3.8	20.30	<0.001
NLA	87.3 ± 5.5	94.4 ± 3.6	−20.21	<0.001
NTA	86.1 ± 6.2	80.1 ± 4.9	18.67	<0.001
CLA	48.9 ± 4.5	43.6 ± 2.4	12.67	<0.001
TP/NL	0.48 ± 0.04	0.54 ± 0.04	−13.20	<0.001
L/C	1.74 ± 0.21	1.20 ± 0.17	18.73	<0.001
VAS score	6.1 ± 0.5	7.6 ± 0.5	−18.92	<0.001
ROE score	10.5 ± 1.2	21.3 ± 2.0	−60.24	<0.001

CLA, columellar/lobular angle; L/C, lobular length/columellar length index; NFA, nasofrontal angle; NLA, nasolabial; NTA, nasal tip angle; ROE, rhinoplasty outcome evaluation; TP/NL, tip projection/nasal length index; VAS, visual analog scale.

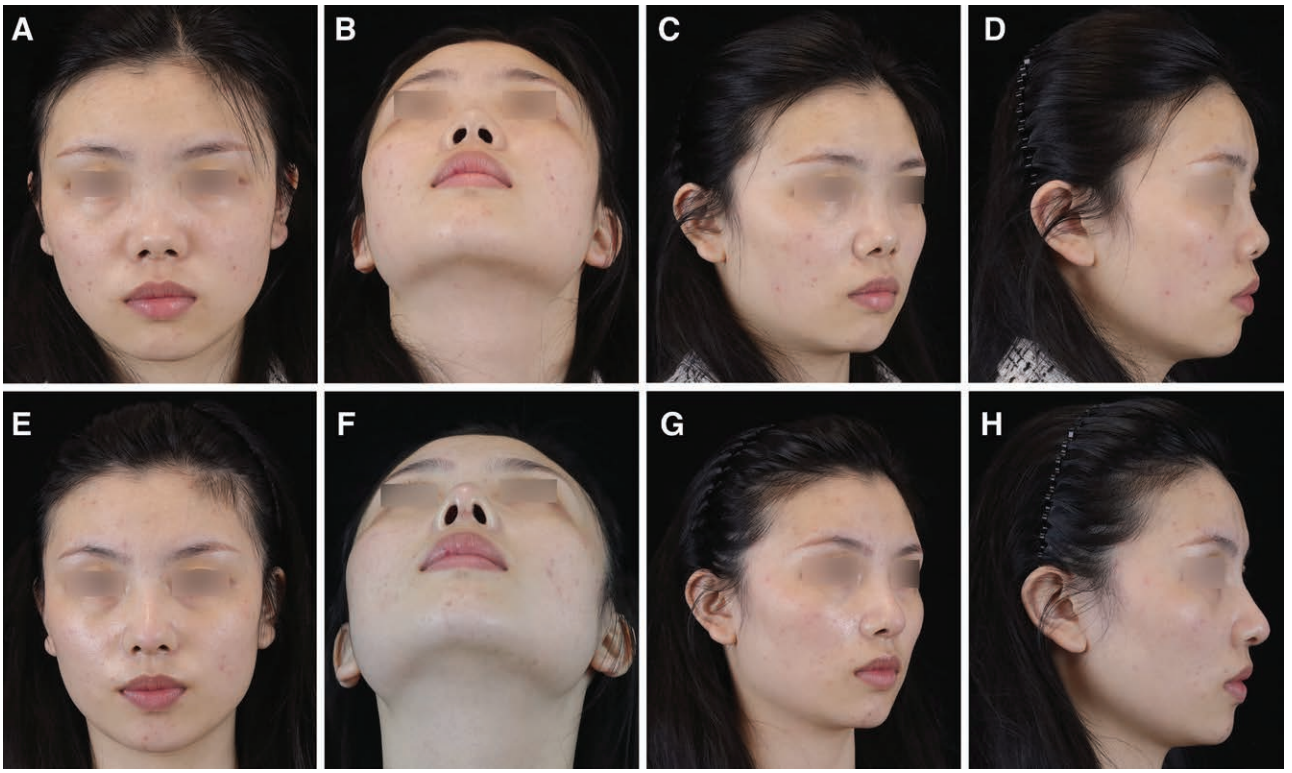

Fig. 2. A 33-year-old female patient who underwent rhinoplasty with the new framework construction technique. A–D, Preoperative views. E–H, Postoperative views 12 months after surgery; unpleasant nasal feature defects were significantly improved.

defects were significantly improved, **http://links.lww.com/PRSGO/D670**.) (**See figure, Supplemental Digital Content 8,** which displays a 28-year-old female patient who underwent rhinoplasty with the new framework construction technique. A–D, Preoperative views. E–H, Postoperative views 18 months after surgery; unpleasant nasal feature defects substantially improved, **http://links.lww.com/PRSGO/D671**.)

DISCUSSION

Saddle nose deformities, including low and flat radix, short nose, short columella, and hypertrophy of the ala, are common in Asian patients and generally need to be corrected by complex rhinoplasty.[1,2] Due to the constitution differences between Asian patients and White patients, Asian patients are more prone to scar hyperplasia and contracture. Skin tension, secondary rhinoplasty, the use of a silicone prosthesis, and infection are all risk factors for contracture. Therefore, the construction of the support structure and the filling of the nasal dorsum are key to the operation. First, in terms of the material of the framework, some studies have shown that the cartilage used in rhinoplasty can be divided into 2 categories: hyaline/supporting cartilage, which includes costal and septal cartilage; and elastic/contouring cartilage, which includes auricular cartilage.[14] Due to the weak development of nasal septum cartilage in Asian people, costal and auricular cartilage are mainly used in rhinoplasty. This classification is consistent with our experience in clinical practice. Compared with auricular cartilage, costal cartilage provides a highly stable

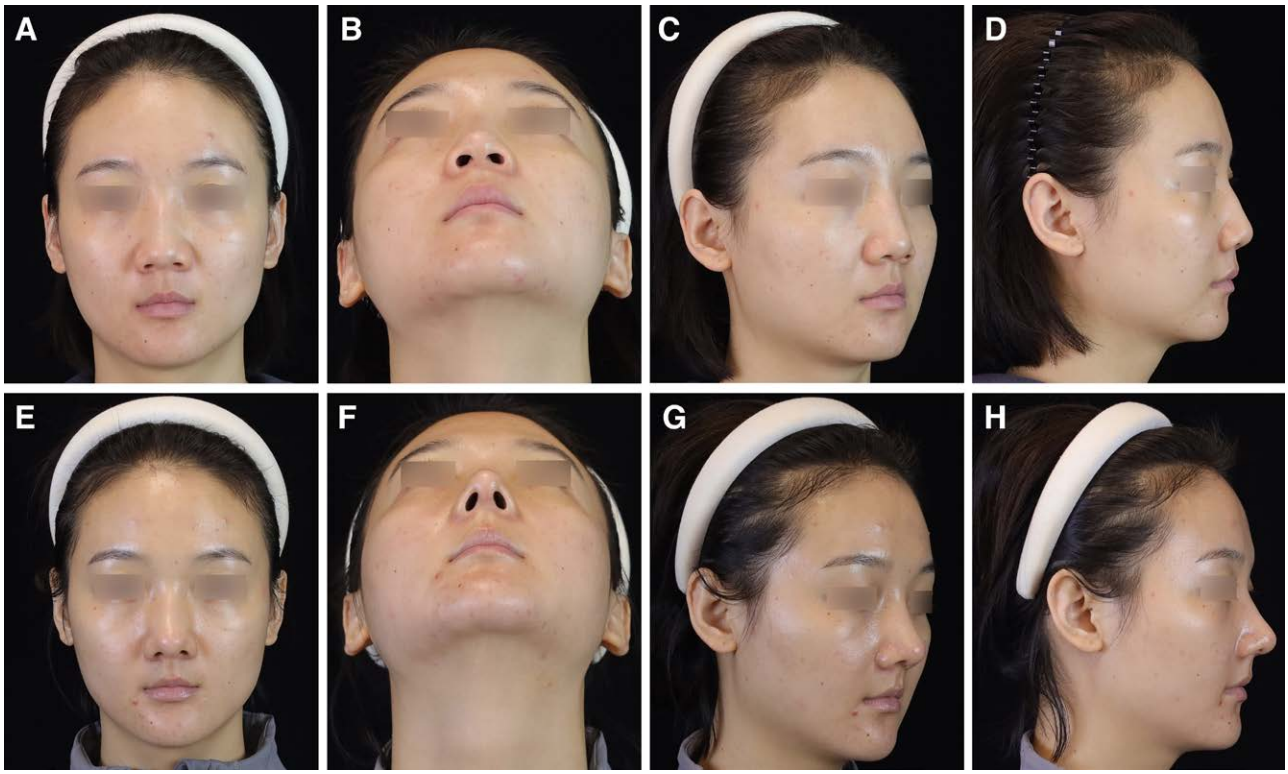

Fig. 3. A 25-year-old female patient who underwent rhinoplasty with the new framework construction technique. A–D, Preoperative views. E–H, Postoperative views 17 months after surgery; unpleasant nasal feature defects substantially improved.

framework, which has a low risk of subsequent deformation contracture and sufficient sources. A comparative analysis of the appearance and histology of auricular cartilage and costal cartilage after transplantation revealed that costal cartilage has greater stability.[15] Second, in terms of framework construction, our new technique can decrease the thickness of the framework while ensuring stability, which results in a better nasal columella shape and stronger resistance to contracture in later stages. For patients with saddle nose deformities, most doctors choose costal cartilage to construct the framework.

The costal cartilage rhinoplasty methods are generally divided into 2 categories. Some surgeons cut the cartilage into particles to augment the nose shape,[16–18] which avoids the problems of edge disconnection and late bending deformation caused by the use of large amounts of cartilage.[19] However, there are also problems such as postoperative absorption and insufficient structural stability to support the nose tip.[20–22] The other method is the construction of a framework in which the costal cartilage is whole or cut into strips or sheets, spliced and sutured according to the patient's nasal anatomy and needs; thus, it is fixed on the nasal septum cartilage. This technique is currently widely used in clinical practice. In the past, 1 or 2 pieces of strut combined with 2 or 4 pieces of SEG were used to construct the framework. After fixation, the nasal tip covering the graft was sutured at the nasal tip position. There are problems such as secondary deformities caused by the instability of the framework. In view of this, we used the new technique of constructing the framework to carry out rhinoplasty. The postoperative measurements of 65 patients were significantly improved compared with those before the operation. This method has the following advantages: (1) Because the width of the nasal columella is determined only by the strut, the strut can be made wider than the construction of 2 struts combined with 2 or 4 SEGs. Overall, the width of the nasal columella is narrower than that of the nasal columella in the previous method, which can increase the physiological nasal columellar width and improve the stability of the nasal columella while improving its appearance. (2) The traditional technique of framework construction relies mainly on the force and friction of the suture to support the strut. Using this new technique, the strut and SEG mutually support and strongly resist the rotation of the nose tip. To minimize the influence on the width of the nasal columella and nasal septum, the thickness of the traditional framework was controlled at approximately 0.8 mm. However, the thickness of the SEG used in this new technique was 2.5–3.0 mm, which provides a stronger ability to enhance the long-term anticontracture ability. (3) We combined the strut and hemispherical cap graft into one graft, minimizing the occurrence of tip deviation or asymmetry and reducing the number of suture knots needed. In addition, the key to avoiding tip deviation or asymmetry in the operation is ensuring that the mushroom-shaped costal cartilage graft is stable in the medial position during the process of being fixed to the nasal septum and the process of stabilizing the alar cartilage onto the strut. Some surgeons have reported that similar mushroom-like structures were used for costal cartilage rhinoplasty via closed

incisions, and satisfactory aesthetic and functional results were achieved.[23] The technique involved suture fixation of 1 strut and 2 SEGs, and the nasal columella was wider than the framework of our technique, although the SEG was thinner. This method of framework construction results in the poor shape of the columella and insufficient stability of the framework against the rotation of the nose. Our framework construction technique can solve this problem well.

Using our technique, straight costal cartilage within 3 cm can generally meet the needs of 2 grafts. In addition, all the components of the framework are thicker than those of the traditional method, which reduces the risk of deflection and deformation of the framework. To facilitate shaping of the nasal tip, we prefer to use costal cartilage from the sixth ribs for the construction of the framework.

We do not use costal cartilage for dorsal augmentation because of the long-term risks of deformation and warping due to the inherent density and mechanical differences of its cortical and medullary components. We also avoid using granulated costal cartilage, as it is difficult to shape and resorbs easily. The hardness of prostheses is moderate, so the prostheses are close to the texture of the nose. The length of prostheses varies from 3.5 to 4.2 cm according to the length from the nasal root point to the strut.

However, there are also some problems with our technique. Compared with the conventional nasal tip, the nasal tip is less mobile and firmer postoperatively, making its shape quite different from the natural nasal shape. In addition, the construction of the framework is more technically demanding.

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DISCLOSURES

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PATIENT CONSENT STATEMENT

Patients provided written consent for the use of their images.

ETHICAL APPROVAL

The study was approved by the ethics committee of Zhejiang Provincial People's Hospital (No. 2022-361).

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