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RESEARCH ARTICLE

Septo-columellar reconstruction with radial forearm free flap

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Abstract

Introduction: Columellar subunit reconstruction is described as one the most challenging area in the literature. Radial forearm free flap (RFFF) can easily provide the reconstruction of columella and neighbouring regions with different styles of designs and different types of tissues included if needed.

Methods: Patients who have large composite defects in the septo-columellar region and have been reconstructed with RFFF between 2018-2021 were included in the study. Patients' age, gender, etiology of septocolumellar defect, anatomical deficiencies on nose, flap sizes and designs, cartilage donor site, recipient vessels, flap donor site repair methods, time of hospital stay, and complications were investigated.

Results: Six patients, comprising five males and one female with an average age of 50.8 years, were evaluated. The etiologies were congenital agenesis in one patient, trauma in two patients, and tumors in three patients. Adipofascial radial forearm free flaps (RFFF) were utilized in two patients, with primary closure of the donor sites. To prevent excessive skin thickness in septal mucosal reconstruction, only adipofascial flaps were employed. The facial artery and vein served as the recipient vessels in all cases, with the pedicle tunneled from the nasal region to the submandibular region. The average flap size was 5.08 x 4.66 cm. Septal cartilage was used to create the cartilage framework in two cases, while costal cartilage was used in the remaining cases. The mean operation time was 6.6 hours, the average ICU stay was 16.3 hours, and the mean hospitalization duration was 6.5 days. Complications included scar spread and synechia at the flap donor site in two different patients.

Conclusion: Using the facial artery and vein for recipient vessels makes the new skin scarring away from midface area. RFFF provides an excellent option for optimal septocolumellar reconstruction deriving from a variety of etiologies with the disadvantage of sacrificing a main artery in upper extremity.

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Introduction

It is known that the nose contributes greatly to the cosmetic perception of the face. Reconstruction of any of the subunits of the nose therefore improve the facial cosmetic results. Columellar defects often occur after tumor surgery and traumatic losses, and rarely congenital defects may be present.[1] Different combinations of septal and medial crural cartilage, mucous and columellar skin deficiencies accompanying cartilages can be seen in all etiologies. Skin grafts, composite grafts, washio flap, nasolabial flap, and especially forehead flap and free flaps are the methods that are usually preferred in columellar reconstruction, with or without prefabrication.[2,3]

Columellar subunit reconstruction is described as one the most challenging due to the scarcity of regional flap options and technical difficulties of microsurgical methods.[4] In the free flap option, a long pedicle and a thin, pliable structure are important requirements for reconstruction of the columella. The study aims to assess the efficacy of a novel treatment approach, evaluating different designs of the radial forearm free flap (RFFF) which provide favorable outcomes due to its thinness and flexibility. RFFF can be harvested as an adipofascial flap or fasciocutaneous flap. Primary repair of the RFFF donor site will be easier when the dermal component content taken is as small as possible, but this is dependent on the selection of cases with appropriate defects.

In this study, six cases with columellar defects, due to different etiologies, were treated with a single-session operation, cartilage grafts and adipofascial or dermoadipofascial RFFF.

Methods and Cases

Patients who have large composite defects in the septocolumellar region and have been reconstructed with RFFF between 2017-2020 were included in the study. All procedures performed in study 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. Ethical approval of the study was obtained from the ethics committee of Kocaeli University The Non-Interventional Clinical Research Ethics Committee, dated 14.12.2023 and numbered 2023/413. Patients' age, gender, etiology of septocolumellar defect, surgical history of the region, anatomical deficiencies on nose, flap sizes and designs, cartilage donor site preference, recipient vessels for flaps, flap donor site repair methods, time of hospital stay, and complications were investigated. Surgical techniques of some case examples with different etiologies are described below.

Case 1

A 24-year-old female patient was evaluated for congenital columellar agenesis. On physical examination, columellar skin, medial crural cartilages, agenesis of septal caudal cartilage and mucosa were evaluated. On detailed examination, it was seen that the caudal cartilaginous septum was agenetic, the anterior nasal spine (ANS) was present, bilaterally the lower lateral cartilages terminated on soft triangular fossa, the bilateral medial crural cartilages were agenetic, and the skin covering of this area was rudimentary towards the mucosa. The patient's medical history revealed that she was born at the age of seven gestational months and there was a disorganized, band-like structure in the columellar region at birth. This structure disappeared spontaneously, while being followed in the neonatal Intensive Care Unit (ICU). A history of necrosis due to Continuous Positive Airway Pressure compression was suspected.

Examination showed that there was no narrowing or any alar fluctuation in the vestibular opening due to adequate support of the existing part of the septum and the upper lateral cartilages. The nasal dorsum remained stable from radix to nasal tip. There was a complex defect of approximately 2.5 x 5 cm on the sagittal plane, because of agenesis of the caudal septal and columellar areas. For the characteristics of all patients see Supplemental Table-1.

Table 1:
Information concerning appearance and anatomical assessment at presentation, flap features, and follow-up data for patients. (AF: Adipofascial, DAF: Dermoadipofascial)

case	1	2	3	4	5	6
age	24	54	36	62	60	69
sex	F	M	M	M	M	M
aetiology	Congenital	Trauma	Trauma	Tumor	Tumor	Tumor
Medial Crural Cartilage	-	-	-	-	-	-
Caudal Septal Cartilage	-	-	-	-	-	-
Anterior Nasal Spine	-	-	-	+	+	+
Surgical History	-	+	+	-	+	-
Flap Design	AF	AF+DAF	AF	AF+DAF	AF+DAF	AF+DAF
Flap Size (cm)	5 X 3	5 X 6	5 X 5	4 X 5	5 X 4	6.5 X 5
Cartilage Donor Site	Septum	Septum	Costal	Costal	Costal	Costal
Recipient Vessels (Artery/ Vein)	Facial	Facial	Facial	Facial	Facial	Facial
Donor Site Complication	Linear Skar spread on donor site	STSG -	Linear Synechia L- Strut failure	STSG -	STSG -	STSG -
Hospitalisation (day)	6	6	6	8	6	7

Ulnar artery dominance was observed in the left upper extremity after doing The Allen test. Flow directions, flow velocities and flow forms were evaluated bilaterally with Color Doppler Ultrasonography. The RFFF was harvested as an adipofascial flap. Preparation of the nasal area began when rudimentary skin tissues were dissected from the mucosa border and the nasal tip region. These were saved as two viable skin flaps to be used for columellar skin reconstruction at the end of the adipofascial flap adaptation. Septal cartilage grafts were used for constructing the L-strut, and using polydioxanone sutures, the cefalic septal cartilage and maxillary periosteum were used as anchor points. The base of the apertura piriformis was accessed through the mucosa at the base of the right alar base and subcutaneous dissection was performed towards the right mandible corpus. After exposing the facial artery and vein with a right submandibular horizontal skin incision, a tunnel was created for the pedicle by subcutaneous dissection. The RFFF was planned and harvested with a minimum pedicle length of 15 cm and without any skin component. Pedicle tunneling was carefully performed, avoiding any rotation or buckling. Subsequently, 3-0 polyglactin suspension sutures were passed separately to the most cephalic mucosal part where the flap would be reconstructed. Flap adaptation was started using these sutures and the other parts were repaired with 4-0 polyglactin. Adipofascial tissue was also fixed to the septal cartilage in the midline supratip region, and new-transseptal, 5-0, rapid polyglactin sutures were placed to close the dead space between two half parts of the flap following folding. Right facial artery and vein end-to-end micro-anastomoses to the RFFF were performed with 9-0 nylon. For the columellar skin reconstruction of the adipofascial flap, rudimentary skin flaps were mutually repaired. The operation was terminated by placing intranasal packs, under-flap penrose drains, and hemovac drains in the flap donor site and splint on the forearm.

In the peroperative period, even the presence of a pulse in the columellar region was clearly observed. However, in order for mucolysis and skin epithelization to occur spontaneously from rudimentary flaps, no split thickness skin graft (STSG) was used, and nasal pads soaked in pomade were changed daily for the first postoperative week. During this 7-day hospitalization period, the patient was followed closely. No healing problem or any other complications occurred. (Case1 is shown in Figure-1)

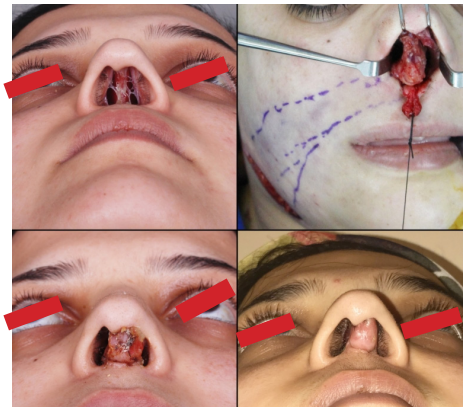

Figure 1 : A 24-year-old female patient with congenital columellar agenesis, with absence of columellar skin, medial crural cartilages, septal caudal cartilage and mucosa (Above left). Suspension of the rudimentary skin flaps with the silk suture and the tunnel in which the RFFF flap was passed from the nasolabial area to the right submandibular area is shown (Above right). Post-operative appearance of the area on the seventh day (below left) and at six months (below right).

Case 3

A 36-year-old male patient had a nasal deformity due to explosion injury, for which he had previously undergone nasal reconstruction with a pre-expanded forehead flap in another center. There was a depressed scar line from the nasal dorsum to the right lower lateral cartilage, 60% of the lower septal area was absent, there was a septal fistula of approximately 3 x 4 cm, the medial crural cartilages were absent, the skin in the columellar area was irregular, inadequate and also folded towards the nasal cavity because of the absence of cartilage support.

After similar preparations, an L-strut was created with costochondral cartilage grafts and the pedicle of the RFFF was tunneled and anastomosed to the left facial artery and vein. Suspension sutures were placed caudally beginning from the cephalic region. The mucosa on the cephalic part of the presented columellar skin flap was shaved and a rough surface was created for healthy contact with the RFFF. At the end of the operation, fixation was completed with caudal trans-septal sutures before dressing closures, drains and nasal pads were applied. (Case 3 is shown in Figure-2)

Figure 2:
A 36-year-old male patient with a nasal deformity due to an explosion injury. There was an absence of cartilaginous septal area and there was a septal fistula of approximately 3x4 cm size, the medial crural cartilages were absent, the skin in the columellar area was irregular, inadequate and also folded towards the nasal cavity because of absence of cartilage support (Above). Basal and oblique views are seen at the third post-operative month (Below).

Case 6

A 69-year-old male patient was evaluated due to a nasal mucosal mass exhibiting bilateral growth for a period of four years. A mucosal mass in septo-columellar area, which was larger on the left than the right, and that caused erythema of the left nostril base was observed. The patient's investigational biopsy was reported as a well-differentiated squamous cell carcinoma (SCC). No pathological lymph node was detected in the neck, either with palpation or with superficial ultrasonography. As the tumor was considered a high-risk SCC, left modified radical supraomohyoid lymph node dissection was performed after wide resection under general anesthesia. The cartilaginous roof was reconstructed with costochondral cartilage grafts as the L-strut, and the cephalic septal cartilage was fixed inferiorly to the ANS and superiorly to cephalic septal cartilage. Left facial artery and vein were used as recipient veins. The defect was reconstructed with partial skin islands and partial adipofascial RFFF taken from the left upper extremity. The upper-cephalic margin of the flap was defined with a transdermal bolster suture extending to the nasal dorsum. Figure 3 and 4 shows the steps of patient surgical procedure and Figure 5 shows the scheme of surgery stages. STSG was used for repair of the flap donor site.

Figure 3:
A 69-year-old male patient presented with a well-differentiated, squamous cell carcinoma of the septocolumellar area with no evidence of lymphadenopathy by palpation or radiologically (Above). After wide resection of the mass and supraomohyoid, modified radical neck lymphadenectomy, the septocolumellar area was reconstructed with costochondral grafts and dermoadipofascial RFFF. The right and left sided oblique views are seen on the seventh postoperative day (Below).

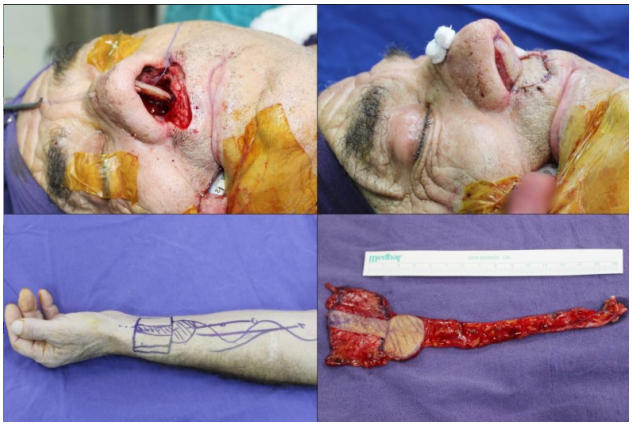

Figure 4 :
After reconstruction of the cartilage framework using costal cartilage grafts, the framework was fixed to both the ANS and the cephalic part of the septal cartilage. The polyglactin suspension and bolster sutures were prepared for suspending both the framework and the surrounding adipofascial parts of the RFFF (Above). The dermo-adipofascial RFFF planning on the donor extremity (Below right) and its appearance after harvesting (Below left).

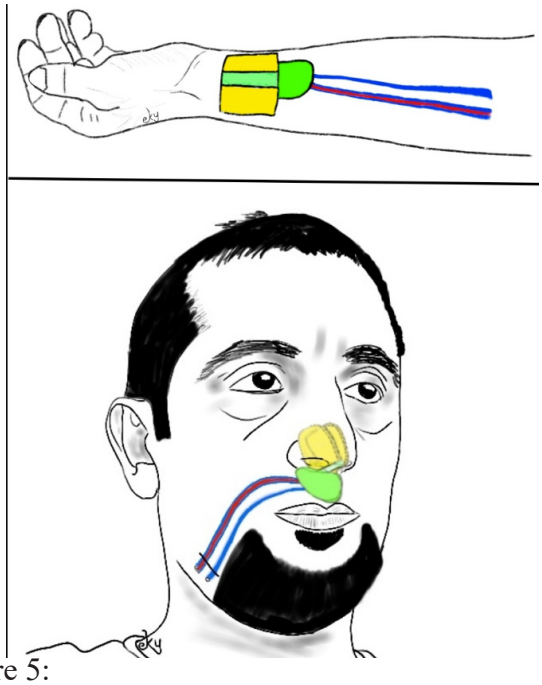

Figure 5:
The flap design made on the forearm is seen before the RFFF was harvested.
Yellow quadrangular areas are deepitelized to form the septal mucosa bilaterally. (Above) After adapting the flap and tunneling the pedicle to the submandibular region subcutaneously is seen. The fact that the recipient vessels are in an area far from the face provides an advantage in terms of scarring.(Below)

Results

All patients were male except one case. The average age of the patients was 50,8 years old. In two patients, RFFF design was planned using adipofascial flaps and donor sites were repaired primarily, while in the other patients, a STSG was used for donor site repair, since partial skin tissue was included in the flap for any skin reconstruction. In all cases facial arteries and veins were used as recipient vessels and the RFFF pedicle was tunneled subcutaneously. Thus new scar formation was prevented in the middle of the face. Concomitant veins of the radial artery were used as the donor vein in all patients. Average flap size was 5.08 x 4.66 cm. Sufficient septal cartilage was present in two cases to create the L-strut with cartilage grafts, while in the other cases this was not possible, and the sixth costochondral areas were used. While the maxillary anterior region was used in three cases to support the L-strut graft caudally, in the remaining cases the ANS could be used.

In two patients, the operation was performed while preserving the columellar rudimentary skin tissue, while reconstruction was completed with a columellar skin island from the RFFF in four patients. Left-sided, type 3, modified radical supraomohyoid neck dissection was performed for case-6 with septocolumellar SCC. The average operation time was 6.6 hours. After the operation, all patients were followed in the ICU, due to the length of operation time. The average duration of stay in the ICU was 16.3 hours.

In all cases STSGs were not placed on the adipofascial flaps used for septal mucosal reconstruction. Healing was expected as a result of secondary follow-up, through mucolysis. For this, daily pomade tampon changes and other moisturising creams were applied to prevent synechia and fascial drying. Average hospitalization time was 6.5 days. On follow-up after discharge, no problem was encountered in the formation of mucolysis. However, in Case 3 subtotal obstruction and synechia occurred in the right nasal passage and the patient was re-operated due to difficulty in breathing.

There were no problems about healing or any other complication in the late follow-up for any patient except the scar spread on RFFF donor site in Case-1. In Case 6, histopathological examination of the neck dissection tissues showed that all lymph nodes were reactive. Thus this patient required medical multidisciplinary oncological follow-up and no recurrence was encountered in the 15th month post-operatively.

Discussion

One of the most challenging areas in nasal reconstruction is the columellar area.[5] It has a wide range of repair options, from with skin grafts to free flap repair.[6] Both the STSG and full thickness skin grafts techniques, which have been reported to have success rates approaching 90%, are good options for superficial defects because of the lack of volume and consisting of the contraction and depression on the late period.[7,8] Skin with adipose tissue composite grafts can be useful in terms of volume if there is no need for any new cartilage support in the defective area.[6] In case of combined skin and cartilage defects, auricular chondrocutaneous composite grafts are usable. Chang et al, performed columella reconstruction with auricular chondrocutaneous composite grafts in fourteen children aged 5-13 years, and achieved 100% success in grafts with a maximum size of 1.5 x 0.8 cm.[9] In a study by Son et al, the nasal defects of seventeen adult patients were reconstructed with composite grafts, with a maximum size of 1.0 x 1.9 cm. One of the grafts necrosed and this was attributed to smoking.[10]

As the defect deepens and increases in size radially, solely composite graft options become inadequate and local flap options with or without cartilage graft are required. Single or two-stage operations can be performed with alar rim flap, nasal sill flap and vestibule flap.[11,12] There is also a mucosal flip-over method that can be carried out gradually, with or without prefabrication, from the upper lip mucosa.[13,14] Nasolabial,[15] nasofascial[16] and melolabial[17] island flaps are also useful flaps but all these flaps are generally only sufficient for columellar reconstruction; the cannot contribute to septal area reconstuctions due to their size and they may need the support of the caudal septal chondromucosal area after flap transfer.

The landmark flap in nasal reconstruction is the paramedian forehead flap. This flap is flexible enough to be used for subtotal reconstruction of the nose with two or three staged operations.[18] In cases where a wide flap is required, the donor site scar can be left linear with the pre-expanded forehead flap.[19] In addition, prelamination options, such as mucosal, osseos or cartilagineous reconstruction highlight the utility of the paramedian forehead flap.[20] However, when there is a low hairline, difficulties may arise in the reconstruction of the columellar region. Thus the use of a paramedian forehead flap alone is not usually sufficient for isolated septocolumellar reconstruction. Although oblique designed forehead flaps are available, hair-bearing forehead flap transfers often occur in classical forehead flap applications, because of the long distance of the columellar area to the flap rotation arc point.

Local flap options provide excellent texture and color match without the difficulties and morbidities of microsurgical techniques. There are instances in which free flap surgery becomes an imperative option. The reasons for free flap option for nasal reconstruction include total nasal defects, defects involving nasal linings and defects which involve the upper lip or cheek.[21] A free flap option needs to possess some key characteristics including being pliable and thin. It should also be covered by thin skin if the plan is to harvest a fasciocutaneous flap. These characteristics help to create the required contours around the nasal framework or to provide adequate lining without obstructing the nasal airway.

Since the recipient vascular structures are usually selected from the facial and angular arteries, it would be more appropriate to choose a long pedicle with a large diameter. Choosing the recipient area as close to the nose as is practicable means minimal free flap donor site morbidity but may cause other problems such as appropriateness of recipient vascular structures, the need for a super-microsurgical procedure and thus surgical experience.[22] In addition, there may be permanent scarring in the central area of the face, for example a scarring of the nasolabial sulcus. It has been shown that it is possible to access these recipient vessels using an intraoral approach which eleminates this scar risk.[23]

The free flap options commonly used in the literature are the dorsalis pedis flap,[24] the first dorsal metacarpal flap[25] and the radial forearm flap.[26] The first dorsal metacarpal flap has an artery with a diameter of 0.5-1.0 mm and can be planned as a double skin island flap. The dorsalis pedis flap has a relatively larger arterial diameter and a longer pedicle than the first metacarpal flap. The donor sites of both flaps are often repaired with skin grafts, but it is harder to hide the scar on the hand. The dorsalis pedis flap vessels may be badly affected if the patient suffers from atherosclerosis and so might be a risky choice in elderly patients. While these two flaps can reconstruct the columella, it is thought that they do not have sufficient dimension for large septal mucosal reconstruction. The pedicle of both flaps is not long enough to anastomose the facial artery and vein. For this reason, the angular artery should be used as the recipient artery or vein grafts should be used both for artery and vein anastomoses when employing these flaps.

The RFFF is frequently used in head and neck reconstruction.[27] There are many advantages of the RFFF including permitting the removal of more than one skin island, and being used as an innervated fasciocutaneous flap with the antebrachial cutaneous nerves.[28] It is possible to harvest the RFFF with the palmaris longus tendon, partial muscle tissues and a bone segment of the radius.[29] This flap also has the option of being harvested adipofascially, meaning that the donor site morbidity can be minimized.[30] One of the most important benefits of the RFFF is its long pedicle and large vascular diameter. This provides a technical advantage in microsurgical applications and increases the number of recipient vascular area options. This study has shown that transferring the recipient area to the submandibular area provided increased cosmetic benefit, as a submandibular scar is preferable to a mid-facial scar for the majority of patients. Care should be taken while performing tunneling and pedicle transfer, because there are risks, such as intimal trauma due to hard manipulation and pedicle rotation or strangulation. In order to reduce these risks, the author uses a temporary suture that holds the adventitia of the distal ends of all pedicle elements together and also marks the semi-surface of the pedicle from beginning to the end of the vascular structures.

In septal reconstruction, local mucosal flaps are the first preference and can be combined with cartilage grafts or acellular dermal matrices.[31] However, free flaps are needed in large defects due to existing mucosal tissue insufficiency. The temporo-parietal fascia (TPF) flap is an ideal flap option for septal reconstruction[32] because of location, minor donor site morbidity, and the desired pliable and thin nature of TPF. However, the anatomic relation to the proximal part of the superficial temporal artery and vein make harvesting the TPF more challenging and the pedicle of the TPF is generally believed to not be as long as the pedicle of an RFFF.

The RFFF has a wide variety of tissue transfer options, including adipofascial, fasciocutaneous and osteocutaneous flaps, with neurosensory innervation if needed. It has a long vascular pedicle from the proximal edge of the skin paddle to the take off point from the brachial artery, just distal to the antecubital fossa. The RFFF is a reconstructive workhorse due to its reliable anatomy, pliability, multiple design options and ease of harvest.[33] The venous drainage system of the RFFF has a pair of concomitant deep veins and the cephalic vein, which is superficial. Cha et al. pointed out that the success rates of the RFFF has derived from its venous system and the concomitant venous drainage system has proven a reliable system in practice.[34] We did not include the cephalic vein while harvesting the RFFF, as we prefer to anastomose only concomitant veins because of the flap design, and have not experienced any venous complication.

Although there scarce evidence in the literature concerning septal mucosal reconstruction, the general consensus appears to be that if the free flap has a thick dermal component, there may be a slight risk of the narrowing of the nasal passages. Fascial or adipofascial flaps may be preferred to prevent this risk. With the contribution of surgical area edema after placement of the adipofascial flaps for septal mucosal reconstruction, the risks of synechiae and stenosis in the late period cannot be ignored. One option to reduce this risk is skin grafting, but in our study we preferred to wait for spontaneous epithelization, promoted with the post-operative use of periodically changed nasal tampons. One patient`s cartilage framework had migrated postero-laterally and mucosal sagging occured in the postoperative period, therefore synechia and "force breathing" on the contralateral side was inevitable.

Donor site morbidity, colour mismatch, loss of the radial artery and cold intolerance in the late period can be considered as the most important disadvantages of the RFFF. In this study, in two patients there was no need for columellar skin reconstruction. Therefore, donor site morbidity risk and rates varied in our patients. In the late period, no patient complained of upper extremity cold intolerance associated with the RFFF donor site.

Conclusion

The RFFF is one of the workhorse flaps for head and neck reconstruction because of its versatility. Although several microsurgical options are usable for septocolumellar reconstruction, use of the RFFF allows for a longer and wider pedicle facilitating the microsurgical procedure. Anastomoses with the facial arteries and veins and careful tunneling of the pedicle meant scarring was restricted to the sub-mandibular area rather than mid-facially. The biggest disadvantage of RFFF is sacrificing a main vessel in upper extremity. In our experience the RFFF provides an excellent option for optimal septo-columellar reconstruction deriving from a variety of etiologies.

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