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Microsurgical Reconstruction of the Nose: The Aesthetic Approach to Total Defects

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TITLE PAGE

MICROSURGICAL RECONSTRUCTION OF THE NOSE: THE AESTHETIC APPROACH TO TOTAL DEFECTS

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MICROSURGICAL RECONSTRUCTION OF THE NOSE: THE AESTHETIC APPROACH TO TOTAL DEFECTS

RUNNING TITLE

TIMING AND AESTHETIC IN MICROSURGICAL NOSE RECONSTRUCTION

KEY WORDS

Total nose defects, microsurgical lining reconstruction, expanded forehead flap

ABSTRACT

BACKGROUND

Reconstruction of complex defects involving nose and close facial units represents an aesthetic and functional challenge. Restoring satisfactory nasal shape, combining aesthetic, nasal function and patent airways is mandatory. In this paper we describe our approach to total nose defects and we report our 20 year experience in microvascular nose reconstruction.

Clinical cases are shown to illustrate different surgical techniques and the evolution of our approach.

METHODS

Nasal reconstruction procedures were performed on 21 patients between 2000 and 2020 using the radial forearm flap (RFF) or antero-lateral thigh flap (ALT). Reported reconstructions included total/subtotal nasal defects, caused by cancer resections. Reconstruction is completed by expanded forehead flap for skin coverage and cartilage grafts to restore nasal framework and to shape nasal tip. Ancillary procedures were needed in some cases to optimize aesthetic outcomes.

RESULTS

Twenty-one patients completed the multistaged nasal reconstruction. The RFF flap was used in 56% of the cases (n=11), while the ALT flap was used in 44% (n=10) of our case series. No difference has been detected in the number of reconstructive stages required to achieve the final result comparing RFF and ALT reconstruction (3.3 vs 3.1 reconstructive steps). Ancillary procedures were performed in 7 patients.

CONCLUSION

Microvascular tissue transfer plays a key role in full-thickness nasal defects restoration. Both the radial forearm flap and antero-lateral thigh are effective and reliable options in lining reconstruction, although with different indications. Expanded forehead flap, combined to free cartilage graft, is our gold standard to provide external skin coverage to rebuild the nasal framework.

According to our current approach, accurate pre-operative planning, supported by modern technologic tools, multi-staged reconstruction and ancillary procedures are useful to accomplish satisfactory functional and aesthetic outcomes.

INTRODUCTION

Reconstruction of complex and wide defects involving nose and close facial units represents an aesthetic and functional challenge.

The nose represents one of the most complex structure in the face for its tridimensional architecture,

skin colour, texture, thickness and projection and for its essential functional role (1) (2).
The nose plays a central role in the face appearance and its involvement in wide excisions has a negative impact on patients' social functioning, quality of life, physical health, and satisfaction with their look.
Restoring a satisfactory nasal shape, combining aesthetic, nasal function and patent airways is mandatory in nasal reconstruction. The reconstruction of total defects must replace the multilayered structure of the nose, consisting of the external skin coverage, skeletal support and internal nasal lining. To repair a small nasal defect, the combination of multiple local skin flaps, skin graft, cartilage graft and mucosal flaps have been traditionally described, providing excellent thickness, color and texture match (3). However, in complex cases for large defects, as in total nasal loss, involving adjacent facial units like the lip and the cheek, in irradiated field or in case of unavailable local tissues, conventional methods may not be sufficient. Vascularized free tissue transfer is required-(2)-(3) when traditional alternatives are not possible to provide adequate coverage or lining reconstruction. Free flaps are the first choice to restore nasal lining in total or subtotal nose defects. This procedure is the most important and challenging part of nasal reconstruction, as its contraction can lead to nasal collapse and airway obstruction, compromising the result of the entire reconstruction (1) (2) (3) (4). In selected cases, as serious injuries, wide resections or facial burns, free-flap transfer as nasal covering are strictly indicated, because of the considerable color mismatch (5). Distant tissue has the main advantage of being plentiful and free of the insult that facial trauma or radiation can cause; on the other hand, free flaps are bulky compared to the thin nasal mucosa, requiring multiple contouring procedures. Further disadvantages are represented by a significant color and texture mismatch with the facial skin (2).
Several free flaps have been described for nasal lining reconstruction: radial forearm flap (RFF), antero-lateral thigh flap (ALT), ulnar forearm flap, dorsalis pedis and first dorsal metacarpal (1) (5) (6). In this paper, we present our 20-year experience in complex nasal reconstruction with microsurgical technique. We focused our attention on the evolution of our approach during the time, to improve functional and aesthetic outcomes in full-thickness total/subtotal or heminasal defects. Our modern approach consists of restoring not only the aesthetic subunits of the nose, but close facial units also, rather than just covering the defect according to a multistaged procedures (7) (8) . However, although a reconstructive algorithm is useful, especially for less skilled surgeons, a satisfactory nasal reconstruction remains very challenging and requires experience and creativity.

METHODS

Patients with total thickness nose defects after tumor resection, underwent complex nasal reconstruction with microsurgical free flap, between January 2000 and January 2020 at the Bologna University Hospital (Policlinico di Sant'Orsola) were included. Partial thickness nose defects and patients underwent local or regional flaps without microsurgical techniques were excluded from the present case series. Data collected included demographics information (patient age and gender), clinical and pathological data (histology and extension of the tumor, surgical resection, lymph node involvement and lymph node dissection, radiation therapy), data concerning the reconstructive timing (immediate or delayed, number of reconstructive stages performed) and the reconstructive procedures. Further, clinical outcomes, including recurrences and complications, were included. Rhinectomy were classified in conservative (when limited to the nose) or in wide excision (when the resection was extended to adjacent facial subunit, as upper lip, paranasal region, maxilla or cheek). Nasal defects were also divided in total rhinectomy, subtotal rhinectomy and hemirinectomy.

Microvascular reconstruction of nasal defects is always a multistaged procedure, in which all the three layers of the nose must be restored. In the analyzed period our approach was based on the use of a microvascular free flap for the nasal lining, cartilage grafts for framework support and a forehead flap for skin coverage. In detail, ~~our approach consists of~~(si ripete da 3 righe sopra) three were the options of choice: 1) Fasciocutaneous Radial Forearm flap with cartilage rib graft and expanded Forehead flap, 2) Anterolateral thigh flap with cartilage rib graft and expanded Forehead flap, 3) Osteocutaneous Radial Forearm flap with expanded Forehead flap.

SURGICAL TECHNIQUE

Total nasal reconstruction can be performed at the same time of the oncological resection, whereas in case of conservative rhinectomy, can be delayed for six to nine months for oncological surveillance. Complex reconstruction for wide resections, extended to other face subunits, should be, at least in part, reconstructed at the first stage.

CONSERVATIVE RHINECTOMY

Conservative rhinectomy were treated during the first operative stage, inserting a forehead tissue expander. We strongly support the use of pre-expanded forehead flap to obtain a thinner coverage flap, reducing the need of multiple flap shaping debulking and refinements. Further, pre-expanded donor site provides an aesthetically satisfactory forehead scar.

The second stage, approximately 6 months later, consists of the reconstruction of the nasal lining with a microsurgical free flap, the harvesting of a cartilage rib graft to restore the dorsal support and the transposition of the pre-expanded full-thickness forehead flap for external coverage. -Primary dorsal graft is positioned at the same time as the free flap insetting, to provide support to the flap and avoid tissue retraction during wound healing.
To stabilize the nasal framework, the cartilage graft is fixed in a cantilever fashion to the frontal or nasal bone. We prefer~~e~~ a cantilever rib cartilage dorsal graft, instead of L-strut, to reduce the columellar bulking and to obtain a more natural appearance Alternatively, an osteocutaneous free flap (eg. Osteocutaneous Radial Forearm flap) can be used to restore "en bloc" the nasal lining and the skeletal support.

EXTENDED RHINECTOMY

In case of total or subtotal nose defects, extended to adjacent facial units, a planned and accurate multisteps approach is mandatory.
During the first operative stage, a forehead tissue expander is inserted and a free flap, supported by a dorsal cartilage graft, is used to restore the nasal lining. The second time, approximately 3 months later, consists of the shaping of the free flap and ~~in~~ the transposition of the forehead skin flap to restore the nasal cover providing optimal color and texture match. Alternatively, a wide rhinectomy defect can be reduced in a first stage with local flaps to restore the missing adjacent facial units (eg. a nasolabial flap to reconstruct the upper lip, as we performed in the case n° 2). This strategy can convert a wide defect in a conservative rhinectomy which can be approached as previously described.
Fasciocutaneous Radial Forearm Flap (RFF), Osteocutaneous Radial Forearm flap (oRFF), and Anterolateral Thigh flap (ALT) were the free flaps used in our case series. According to literature (1) (8), RFF is our first choice in nasal lining reconstruction. ALT flap can be used in wide excision, involving adjacent facial units, where the radial forearm flap lacks of sufficient volume to restore an extensive defect. End-to-end anastomosis were performed to the superior thyroid artery or the facial artery, and the internal jugular vein and the common facial vein.
The third operative stage, 4 months later, consists of the forehead pedicle section, the debulking of the proximal third of the forehead flap and the tailoring of the alar crease by direct incisions. A further surgical refinement (fourth step), four months later, is planned to reduce nasal obstruction by defatting the nostril rims and the columella, providing a patent nasal airway. This procedure is a critical step to remove excessive tissues inward or outward of the external nares and to simulate natural airway structures.

At this time, secondary cartilage grafts and repositioning of the nasal alae can be performed, if needed. Ideally, the nasal reconstruction is completed in four stages, but further revisions may often be required to achieve an aesthetically pleasing result.

THE EVOLUTION OF THE PERSONAL APPROACH TO THE TOTAL NASAL RECONSTRUCTION: AESTHETIC CONSIDERATIONS:

Based on 20-years experience, consistent improvement in surgical skills and applicable technologies have been achieved and our approach to total nasal reconstruction has undergone significant changes. Accurate preoperative planning using a template is mandatory. The use of a template to determine the exact dimension, border and position of the nose subunits helps to achieve a greater accuracy, especially in total nasal defect in which the contralateral side cannot be used as a model. From the traditional paper templates, thanks to the developments in new technologies, nowadays we apply the CAD CAM (*computer aided design and computer aided manufacturing*) models in complex nasal reconstruction planning. This modern tool is based on preoperative CT images and a software able to manufacture, through a 3D printer, a tridimensional custom-made template (9) (10) which can be used during the flap planning and the insetting. CAD CAM technology allows to reproduce the preoperative personal nasal shape and to restore the patient's normal face appearance (Case n° 4) instead of a standardized nasal structure. We started to apply CAD CAM technologies in nose reconstruction in 2018 and the satisfactory results of this preliminary report will require further experience to be confirmed in the future.

During the time, our reconstructive approach evolved from an anatomical perspective to restore nasal structure involved in oncological resections, to a more aesthetic view, to assess the nose in the overall face complexity. Multiple refinements are planned, as necessary, to achieve an aesthetic result which meets the expectations of both the surgeon and the patient; refinements should be customized for each individual case, according to surgeon experience and creativity and patient compliance. Secondary cartilage grafts (*alar batten, tip graft and columellar strut*) are placed in a delayed time, when the microvascular lining and the skin coverage are stabilized and just enough to ensure support to the alae and the nostril and to keep patent airways. Secondary cartilage and combinations of them (multiple shaped: shield, diamond, folded and customized tailored grafts) are also used as ancillary procedures to define and project nasal tip, in order to increase naso-labial angle and to optimize aesthetic appearance. Combination of multiple graft is needed to accentuate nasal tip under thicker skin. (7) (8).

To achieve more harmony among the different components of the face, we focus our treatment on close facial subunits too. In selected cases, we perform lipofilling of the paranasal and zygomatic

area, upper lip definition and reshaping, hair bearing reconstruction of the upper lip in male patients.

The operative sequence of the surgical procedures needed **(FIG. 1)** is customized for each patient, with certain steps deleted or modified as indicated by each clinical condition.

The following fundamental principles **(Table n° 1)** are adopted in our current approach to total nasal reconstruction.

RESULTS

A retrospective review of single-centre consecutive 21 patients underwent to nose reconstruction with microsurgical technique between 1990 and 2020 has been reported.

Nose defects included total rhinectomy (52,4% - *n*=11), subtotal rhinectomy (33,3% - *n*=7) and hemirhinectomy (14,3% - *n*=3). There were 11 females (52,4%) and 10 male patients (47,6%). Patient age ranged from 52 to 86 years, (average 70,6 years). Nasal defects had resulted from skin cancer excision in all the patients (100%): SCC in 76% (*n*=16) and BCC in 24% (*n*=5) of the cases. Table n° 2 reported data collection.

In 18 cases (86%) the first reconstructive stage was performed at the same time of the oncological resection (immediate first reconstructive step), consisting of tissue expander placement only in 7 cases and in free flap transfer in 11 cases. In the other 14% of the cases (*n*=3), the first reconstructive stage has been delayed for a period of about 9 months. The average (SD) number of reconstructive surgical steps was 3.8 (±1.3) in total nasal reconstruction, without considering further surgeries in case of recurrence or complications. In case of subtotal defects and hemirhinectomy the average (SD) number of operations needed to achieve the final result was respectively 2.6 (±1.3) and 2.3 (±1.2). The average (DS) interval period from the ~~the~~ first reconstructive stage to the last one, was 18 (±13.2) months in total nasal reconstruction, 7 months in subtotal nasal reconstruction (±7.4) and 10 months (±9.4) in heminasal defects.

Twenty-three free flaps were used in 21 consecutive patients. In one case, a forearm free flap was used in a second stage to reconstruct the columella. In one patient, a further free flap (ALT) was used in a second time for upper lip and palate reconstruction. The Radial forearm flap was used in 56% of the cases (*n*=11), in particular, a fasciocutaneous RFF in 64% (*n*=7) and osteocutaneous RFF in 36% (*n*=4). The anterolateral thigh flap was used in 44% (*n*=10) of our case series. The ALT flap was chosen as a reconstructive option in the 60% of wide rhinectomies, where RFF can lacks of sufficient volume to cover extensive face defects involving upper lip or cheek. The RFF was used in the 64% of the cases for conservative rhinectomies; in particular the osteocutaneous RFF was used in 100% of the cases for conservative defects. According to our experience, no

difference has been detected in the number of reconstructive stages needed to achieve the final result comparing RFF and ALT reconstruction (respectively 3.3 and 3.1 reconstructive steps). This interesting clinical data assesses the ALT flap to be an effective and reliable reconstructive option for lining in large nasal defects.

Ancillary procedures to achieve harmony among the different components of the face were performed in 7 patients: lipofilling of the paranasal and zygomatic area (*n*=2), hair-bearing upper lip reconstruction (*n*=2), and nasal tip definition by using multiple cartilage grafts (*n*=4).

Complications are summarized in Table 4. Early events~~,~~ include total and partial flap loss, hematoma or flap congestion, requiring reintervention. We reported one total flap loss (4.7%), which has been removed and replaced 30 days later, with a second RFF. Two cases of partial flap loss (9.5%) were found, resolved with local flap or skin graft. For three patients (14,3%), taking-back to the operating room in the first operative day was needed to drain a hematoma. Three patients (14,3%) developed a cutaneous fistula, treated with toilette and primary closure or local flap during the further refinements. In one patient (4.7%), a complete nostril obliteration with airway impairment occurred, partially resolved after two further operations to perform ~~of~~ nostril debulking, positioning of secondary cartilage grafts and alae reshaping. Cartilage graft infection and graft resorption occurred in one patient (4.7%) after the radiotherapy and required immediate graft removal, toilette and replacement with a second dorsal cartilage graft.

No complications in the donor sites were reported. Skin grafted areas healed without complications and no radial fractures were detected after osteocutaneous radial forearm flap harvest.

Regarding long term follow up, Recurrences were found in the 35% of the patients (*n*=7). Average disease-free survivor was 29.6 months. Among patients who developed a recurrence, the 70 % (*n*=5) were undergone lymph node dissection and the 43% (*n*=3) presented lymph node involvement at the lymphadenectomy.

Four patients (57%), who developed recurrences, were undergone adj~~i~~uvant therapy (chemotherapy or radiotherapy).

CLINICAL CASES

Case 1: Total wide rhinectomy reconstructed with the Anterolateral thigh flap and a cartilage graft

A 52- years old woman presented with an extensive SCC of the nose, appeared 7 months before (Fig. 2 A-B). The preperative CT showed a massive solid formation with a full-thickness involvement of the anterior portion of the nose, extended in the left nasal fossa to the ipsilateral inferior turbinate and the septum (Fig. 2 C). The patient underwent a wide surgical excision with

total rhinectomy with circumferential osteotomy of the nasal process of the maxilla, nasal spine and of the nasal bones (Fig. 2 D). A selective bilateral neck dissection (levels I-II-III) was performed The large defect, involving the upper lip and the paranasal area, was covered in an immediate fashion with an ALT flap, shaped to recreate the nasal lining and restore the nasal platform (Fig. 2 E). The flap pedicle was tunneled under the cheek and anastomosed to the facial vessels. A cartilage rib graft was harvested to recreate the dorsal support, fixed with a plate and screws in a cantilever fashion to the frontal bone. Simultaneously a tissue expander was placed in the forehead for the subsequent stage. At the next operation, 6 months later, the ALT flap was partially elevated and rotated to a circle, to restore the nasal vault, and excess of skin and subcutaneous tissue was discarded. The septal partition was not restored to avoid intranasal bulk and airway obstruction. Based on a template, a forehead flap was designed over the expanded skin, and after the removal of the tissue expander, a full-thickness paramedian forehead flap was transposesd for nasal cover. The frontal donor site was repaired with a primary closure and healed with an excellent aesthetic result. Three months later, an intermediate operation was performed, with intact supratroclear pedicle, thinning the forehead flap in the mid vault and contouring the alae. After three months, in the fourth operation, the pedicle was divided and the nostril margins thinned and the airways debulked. A fifth operation, defined the alar creases by direct incision and secondary cartilage grafts, the yellowish ALT skin in the upper lip was removed and replaced by a skin graft with a better color match (Fig. 2 F). The nasal repair was completed in 6 procedures over a period of 33 months. The result of the nasal reconstruction was aesthetically and functionally satisfying and both the patient and the surgeon judged the cosmetic appearance to be normal and pleasant. After a follow-up period of 24 months from the last surgery, the result is stable and the patient didn't develop complications, as infections, contracture, bone reabsorption, or disease recurrences (Fig. 2 G-H).

Case 2: Total wide rhinectomy reconstructed with Radial Forearm Flap and a cartilage graft

A 74- years old patient presented with extensive Sclerodermiform BCC, with a full-thickness involvement of the anterior portion of the nose and the upper lip, extended bilaterally to the cheeks (Fig. 3 A). The patient underwent a wide surgical excision with total rhinectomy with circumferential osteotomy of the nasal process of the maxilla, nasal spine and of the nasal bones (Fig. 3 B). A selective bilateral neck dissection (levels I-II-III) was performed. The large nose defect, involving full-thickness the upper lip and the paranasal area, was partially reduced with the rotation of bilateral nasolabial flaps, the right one rotated internally to restore the intraoral side of the upper lip and the left one rotated externally to reconstruct the cutaneous component of the upper lip. Simultaneously a tissue expander was placed in the forehead for the subsequent stage (Fig. 3 C).

In the second time, six months later, the initially large defect was converted in a conservative rhinectomy defect, the paranasal region and the upper lip is completely healed and the nose can be reconstructed on a stable platform. The internal lining was restored with a fasciocutaneous RFF, the dorsal support framework was recreated with a cartilage rib graft, fixed with a plate and screws in a cantilever fashion to the frontal bone. Based on a template, a forehead flap was designed over the expanded skin, and after the removal of the tissue expander, a full-thickness paramedian forehead flap was transferred for nasal cover. The frontal donor site was repaired with a primary closure and healed with a good aesthetic result (Fig. 3 D).
The patient underwent three more operative stages to reach the final result: despite the aesthetically satisfying result after the pedicle division and a first nostril refinement, a complete nostril obliteration was present and it was partially resolved after two further operations of nostril debulking, positioning a secondary cartilage grafts and alae and columella reshaping. Fig shows the final result (Fig. 3 E-F-G).

Case 3: Conservative rhinectomy reconstructed with a osteocutaneous radial forearm flap
A 69 years old patient, presented with a SCC recurrence, involving the dorsal nose and the tip (Fig. 4 A). The patient underwent a conservative rhinectomy and the reconstruction was delayed for oncological surveillance. Nine months later, at the first reconstructive stage a tissue expander was inserted in the forehead for the subsequent stage (Fig. 4 B). At the second operative step, four months later, the internal lining and the skeletal support were restored with an osteocutaneous radial forearm flap (Fig. 4 C-D). The radial bone was fixed to the frontal bones in a cantilever design with a plate and screws (Fig. 4 E-F). The skin cover was repaired with the transposition of the expanded forehead flap. The patients underwent two more operative stages: at the third surgery, the forehead pedicle was divided and the proximal part of the flap was thinned; at the fourth surgery, the distal part of the nose was reshaped, debulking the nostrils and the columella. The final result was achieved after 11 months from the first reconstructive stage (Fig. 4 G-H).

Case 4: Conservative rhinectomy reconstructed reconstructed with Radial Forearm Flap and a cartilage graft with CAD- CAM
A 76- years old patient presented with a SCC involving full-thickness the tip, the columella and the nasal floor. The patient underwent a conservative total rhinectomy, without neck dissection. During the same operation, a tissue expander was placed in the forehead and a skin graft was placed to reduce the defect of the nasal floor (Fig. 5 A). The second reconstructive stage was planned with the aid of the CAD CAM technology (Fig. 5 B). Based on preoperative CT images, a tridimensional

custom-made template was used during the RFF flap design and flap insetting, in order to simplify this reconstructive stage and reproduce as much as possible the preoperative nasal shape. Thus, the internal lining was restored with a fasciocutaneous RFF, the dorsal support framework was recreated with a cartilage rib graft, fixed with a plate and screws in a cantilever fashion to the frontal bone. The skin coverage was repaired with the transposition of the expanded forehead flap (Fig. 5 D). The third reconstructive stage, 4 months later, consisted of the pedicle division and forehead flap thinning (Fig. 5 E). The final result was achieved with three operative stages after a 9-months period from the first reconstructive step.

DISCUSSION

Total nose reconstruction is a very old procedure described by Gaspare Tagliacozzi in 1597 in "De Curtorum Chirurgia per Insitionem". Tagliacozzi's idea to reconstruct the nose, by using distant available tissues, had a great impact on the evolution of modern approaches to reconstruct complex nasal defects.

The reconstruction of total nasal defects is always a multistaged procedure, in which all the three layers of the nose must be restored. The necessity to rebuild the skin coverage, the support and the lining was stated by Gillies already in 1920, (11) as a fundamental dogma in nose reconstruction. Although reconstructive techniques have evolved a lot during the years, the achievement of a satisfactory nasal shaping (projection, skin quality and adequate color match, anatomical contouring), and functional aspects, remains a challenge.

In this case series, our current approach demands the use a microvascular free flap to reconstruct the internal lining, providing a large surface area of vascularized and healthy tissue. Microsurgical procedure is needed to nourish and protect a non-vascularized cartilage graft, which ensures the support, prevents the soft tissue retraction and keeps patent airways.

Ideal free flaps in lining reconstruction must be thin and pliable enough to allow the skin cover contouring and not obstructing the airways. Free flaps must also be well-vascularized to prevent contracture and distortion of the external cover (3).

Ramji et al., in a recent review found only few reports of microvascular lining reconstruction described in literature, with a total of 65 cases (12). Afterwards, Salibian et al. published their 17-year experience in microvascular reconstruction of the nose with 47 patients (8). In this paper, we present our 19-year experience in 21 consecutive patients, with full-thickness total/subtotal or heminasal defects, underwent complex nasal reconstruction with microsurgical procedure. In the considered period, we used three different microsurgical techniques, depending on the features of the single case:

1) Fasciocutaneous Radial Forearm flap combined to free cartilage rib graft and expanded Forehead flap;
2) Anterolateral Thigh Flap with free cartilage rib graft and expanded Forehead flap;
3) Osteocutaneous Radial Forearm flap, with expanded Forehead flap.

The RFF is the most common used free flap in lining reconstruction, Rami et al. found that the RFF was the first choice in the 51% of microvascular lining reconstruction (12). The forearm, indeed, is a thin and well vascularized flap, with a long and safe vascular pedicle, despite the considerable donor site morbidity. The ALT flap is the second most frequently used free flap for lining reconstruction, described in the 17% of the cases (12).In our case series, lining reconstructions using ALT flap was comparable to RFF flap in term of number of treated patients, feasibility, surgical stages, functional and aesthetic outcomes and complications.

In detail, RFF was the flap of choice in the 56% of the cases, whereas an ALT flap was used in the 44% of the patients, mostly in wide and deep defects involving facial units adjacent to the nose such as the upper lip or cheek. The osteocutaneous forearm flap, frequently used in our first approach has been later replaced by fasciocutaneous radial forearm flap and free rib cartilage graft. The fasciocutaneous tissue, independent from cartilage or bone support, provides a greater freedom in flap shaping and graft insetting, allowing to achieve a more aesthetically satisfactory results with a safe tailoring.

Despite the ALT flap is commonly considered a thick flap, not suitable to restore a thin structure like the nasal mucosa, it can be raised as a superthin flap or with a suprafascial dissection in order to reduce its thickness. Thanks to these feasible tricks and to the aesthetic refinements we previously described, we achieve optimal functional and aesthetic results in microvascular lining reconstruction with the ALT flap, with a significantly lower donor site morbidity compared to the RFF. Moreover, in our case series, the use of ALT flap did not increase the number of operative stages for further contouring procedures, compared to the RFF, confirming that both flaps are effective and reliable option in lining reconstruction, although with different indications.

The high rate of ALT flap found in our series, in our opinion, may be due to high number of head and neck cancers, directed to our referral center, where extensive rhinectomy and subsequent large defects of the midface are not uncommon issues.

According to literature, the Forehead flap is commonly considered the primary choice for the external coverage of the nose, providing adequate color and texture matched skin (2). In our experience, the pre-expansion of the forehead flap allows to obtain excellent aesthetic results and a fast healing in donor site closure, and provides a thinner forehead flap ideal to restore skin

coverage, needing less secondary aggressive trimming. Further, skin and capsule expansion provides a better vascular supply of the forehead flap.

From this retrospective analysis, we can affirm that the combined approach to complex nasal defects with a microsurgical procedure (free flap) and traditional technique (cartilage graft and expanded forehead flap), is a valid and effective option. However, although a reconstructive algorithm is useful, especially for less skilled surgeons, a satisfactory nasal reconstruction requires sophisticated techniques, expertise and technical skills. In fact, complications in microvascular lining reconstruction are not an uncommon event, reported to be as high as 28% (12) which can arise during each operative stage, jeopardizing the whole reconstruction. The function restoration is a primary goal in lining reconstruction and can be compromised during the healing process, when fistulae, graft resorption and scar retraction can occur (2) .

According to our experience, it is important to emphasize that total nose reconstruction is not a straightforward procedure and an overall approach is useful to accomplish satisfactory functional and aesthetic outcomes.

CONCLUSIONS

The reconstruction of a composite nasal defect is still challenging and requires experience, surgical skills and creativity. Nasal lining restoration plays a key role in full-thickness nasal defects and microsurgical strategies consisting of radial forearm flap or antero-lateral thigh flap, represent reliable options in complex cases. Nasal reconstruction is completed by expanded forehead flap for skin coverage and cartilage grafts to restore nasal framework and to shape nasal tip. According to our current approach, accurate pre-operative planning, supported by modern technologic tools, multi-staged reconstruction and ancillary procedures are useful to accomplish satisfactory functional and aesthetic outcomes.

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Table n° 1

THE EVOLUTION OF THE PERSONAL APPROACH TO THE TOTAL NASAL RECONSTRUCTION: AESTHETIC CONSIDERATIONS

	FUNDAMENTAL PRINCIPLE	AIM	TIMING
1	**ACCURATE PREOPERATIVE PLANNING** *(**3D CAD CAM** reconstructive template)*	▪ reproduce the preoperative individual nasal shape and to restore the patient's normal face appearance	**PRE OPERATIVE AND 1st STEP**
2	**PRE-EXPANDED FOREHEAD FLAP**	▪ Thinner skin coverage ▪ Satisfactory donor site scar	**1st STEP**
3	**MICROSURGICAL LINING** (**RFF***flap* or **ALT***flap*)	▪ fasciocutaneous tissue, independent from cartilage or bone support , provides a greater freedom in flap shaping	**1st STEP**
4	**PRIMARY DORSAL GRAFT** *(**CANTILEVER** rib cartilage dorsal graft)*	▪ Provide nasal framework and projection ▪ Avoid tissue retraction during wound healing ▪ Less columellar bulking	**1st STEP - 2nd STEP**
5	**SECONDARY CARTILAGE GRAFTS** *(Alar batten, tip graft and columelar strut)*	▪ to ensure support to the alae and the nostril and to keep patent airways	**3rd STEP**
6	**MULTIPLE REFINEMENTS** *(Tissue debulking, cartilage graft, nasal tip definition, ancillary procedures)*	▪ Different procedures according to surgeons experience and creativity and patient compliance.	**2nd STEP to LAST STEP**
7	**FOCUS ON CLOSE FACIAL SUBUNITS** *(Lipofilling of the paranasal and zygomatic area, upper lip definition and reshaping, hair bearing reconstruction of the upper lip in male patients)*	▪ To achieve harmony among the different components of the face	**3rd STEP to LAST STEP**

Table 2: Demographic and pathological data

	No (%)
Patients, No	21
Age, mean	70.6
Gender	F=11 M=10
Nose Defects	
Total rhinectomy	*n*=11 (52.4%)
Subtotal rhinectomy	*n*=7 (33.3%)
Hemirhinectomy	*n*=3 (14.3%)
Ethiology	
SCC	*n*=16 (76%)
BCC	*n*=5 (24%)
Lymph node dissection	*n*=10 (48%)
Radiotherapy	*n*=6 (28.5%)

Table n°3: Reconstructive results

Reconstruction	No (%)
Immediate	*n*=18 (86%)
Delayed	*n*=3 (14%)
Free Flaps	
RFF	*n*=11 (56%)
Fasciocutaneous	*n*=7 (64%)
Osteocutaneous	*n*=4 (36%)
ALT	*n*=10 (44%)
Reconstructive mean time	
Total rhinectomy	18 months
Subtotal rhinectomy	7 months
Hemirhinectomy	10 months
Mean reconstructive stages, No	
Total rhinectomy	3.8
Subtotal rhinectomy	2.6
Hemirhinectomy	2.3

Table n°4: Complications

Complication	No (%)
Early	
Total Flap Loss	1(4.7%)
Partial Flap Loss	2(9.5%)
Hematoma	3(14%)
Late	
Fistula	3(14%)
Nostril Obliteration	1(4.7%)
Cartilage graft resorption	1(4.7%)

LEGEND

Fig. 1: Treatment algorithm for total nose defects. (RFF=Radial Forearm Flap)

Table n° 1: The evolution of the personal approach to the total nasal reconstruction: aesthetic considerations

Table n°2: Demographic and pathological data

Table n°3: Reconstructive results

Table n°4: Total wide rhinectomy reconstructed with the Anterolateral thigh flap and a cartilage graft

Fig. 2: Total wide rhinectomy reconstructed with the Anterolateral thigh flap and a cartilage graft

Fig. 3: Total wide rhinectomy reconstructed with Radial Forearm Flap and a cartilage graft

Fig. 4: Conservative rhinectomy reconstructed with a osteocutaneous radial forearm flap

Fig. 5: Conservative rhinectomy reconstructed reconstructed with Radial Forearm Flap and a cartilage graft with CAD- CAM