

Aesthetic and Functional Evaluation of Total Nasal Reconstructions

Luigi Angelo Vaira^{1,3} · Olindo Massarelli¹ · Giovanna Deiana¹ · Silvio Mario Meloni² · Giovanni Dell'aversana Orabona³ · Pasquale Piombino⁴ · Giacomo De Riu¹

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Abstract The loss of a portion or the totality of the nose has great relevance on the perception of the beauty of a face and can result in a catastrophic quality of life impairment. Several surgical techniques are currently available for the reconstruction of the nasal pyramid. However, there are very few nasal reconstruction quality evaluation protocols that allow the surgeon to choose objectively the best technique for each kind of defects. Six total nasal reconstruction performed in University of Sassari Maxillofacial Unit were evaluated with a protocol that investigate objectively and subjectively the surgical aesthetic and functional outcome. Sensitivity recovery on the reconstructive flaps was also assessed. Patients reported a satisfactory nasal reconstruction both functionally and aesthetically. Sensitivity recovery on the forehead flap was always present even after pedicle resection or in case of traumatic section of the infraorbital nerve. The use of a three layer reconstruction has proved a viable technique both aesthetically and functionally. In particular the use of the forehead flap to reconstruct the outer layer of the nose allows to carry a tissue with very similar characteristics to

the original with a recovery of the sensitivity almost complete.

Keywords Nasal reconstruction · Nasal reconstruction evaluation · Forehead flap · Aesthetic nasal evaluation · Functional nasal evaluation

Introduction

The delicate and complex three-dimensional structure of the nose has an important impact in determining facial eurhythmia. In Antiquity the nose was considered as “the organ of reputation” and it was amputated as a form of punishment, with the certainty that this would irreparably compromise the social life of the convicted [1, 2].

The loss of a portion or the totality of the nose, as a result of trauma or tumors excision, has great relevance on the perception of the beauty of a face and can result in a catastrophic limitation of social life due to private and public implications of the arhinia. In addition to the effects that these defects can have on the nasal function with significant impairment of patients' quality of life (Fig. 1).

During recent centuries, the aim of nasal reconstruction has evolved from a simple “defect filling” to a restoration of the three-dimensional structure of the nose in order to achieve the better aesthetic and functional quality, as near as possible to the original.

Therefore, the challenge for the reconstructive surgeon is to model a portion of different tissues in order to recreate cutaneous and mucosal linings and osteo-cartilaginous support, which can restore appearance and function of a normal nose.

The large amount of reconstructive techniques that exists in literature requires the implementation and use of

✉ Luigi Angelo Vaira
luigi.vaira@gmail.com

¹ Operative Unit of Maxillo-Facial Surgery, University of Sassari Hospital, Viale San Pietro 43B, 07100 Sassari, Italy

² Dental School, University of Sassari Hospital, Viale San Pietro 43B, 07100 Sassari, Italy

³ Operative Unit of Maxillo-Facial Surgery, University of Naples “Federico II” Hospital, Via Pansini 5, 80131 Naples, Italy

⁴ ENT Operative Unit, Second University of Naples Hospital, Via Pansini 5, 80131 Naples, Italy

Fig. 1 Ahrinia following tumor resection



outcome assessment instruments that allow the surgeon to choose the best technique for each different type of defect. Even now, only a few authors have proposed evaluation protocols that are standardized and repeatable [3, 4].

We propose a new evaluation protocol that provides these characteristics, assessing aesthetic and functional outcome of total nasal reconstruction performed in our center in the last years.

Materials and Methods

Between February 2012 and December 2015, at the Maxillo-Facial Surgery Unit of the Sassari University Hospital, 67 patients underwent various degree of nasal reconstructive surgery. Only 6 of these patients presented total defects of the nasal pyramid. A framework summary of the characteristics of this sample is reported in Table 1.

Operative Technique

In all cases a three step nasal reconstruction, as previously described by Burget [5–7] was performed. During the first surgical time, a chondro-mucosal septal flap, when the septum is still present, pedicled antero-inferiorly on the septal branch of the superior labial artery, was transposed anteriorly to reconstruct the anterior part of the septum providing a mucosal source for the subsequent reconstruction of the inner layer. Furthermore a chondrocostal graft was harvested and splitted in two: a part of it was pocketed inside the two mucosal layers of the septal flap to

give thickness to the dorsum while the second portion was left subcutaneously in the donor site to be used subsequently.

In cases where no septum was remaining, available to reconstruct the inner lining, a revascularized free flap, such as a fore arm free flap, was transposed to fill the defect inside the piriform aperture, in order to provide a viable bed for the costocondral graft structure of the nose. In these cases, the free flap was folded to contain the grafted cartilaginous L-structure that was placed simultaneously.

After two months the second surgical time was performed. Bilateral naso-labial flaps were used to reconstruct the inner layer of the vestibule. The remaining portion of the chondro-costal graft was retrieved and carved to double the dorsal graft and reconstruct alar and triangular cartilages. This solid structure was finally covered with a forehead flap, tailored on the defect shape, pedicled on the epitrochlear vessels. No major complications were detected and in all the cases the cranial portion of the donor site healed for second intention. All the patients underwent a third surgery, 1–3 months after the second one, to defat the skin of the forehead flap and dissect its pedicle (Fig. 2).

Patients who undergone total nasal reconstruction were assessed, after at least one year after the last surgical step (27 months), to evaluate the quality of the reconstruction.

A subjective self-evaluation test of nasal function and aesthetic satisfaction was done, filling a form with predefined questions. It was asked to the patients to rate the residual nasal function (nasal air flow, snore, olfactory function, mucosal dryness, epistaxis and quality of the

Table 1 Framework summary of patients' characteristics

Patient	Etiology of the defect	Defect extension	Reconstructive technique	Complications	Follow up
1/Female/ 83 years old	Tumor resection	Total	Chondro-mucosal septal flap + chondro-costal flap + bilateral naso-labial flap + forehead flap	None	41
2/Female/ 74 years old	Tumor resection	Total	Chondro-mucosal septal flap + chondro-costal flap + bilateral naso-labial flap + forehead flap	None	32
3/Male/ 43 years old	Gunshot injury	Tip, Columella, Left ala, Left sidewall, Dorsum	Chondro-mucosal septal flap + chondro-costal flap + left naso-labial flap + forehead flap	None	30
3/Female/ 73 years old	Tumor resection	Tip, Columella, Ala bilateral, Left sidewall, Dorsum	Chondro-mucosal septal flap + chondro-costal flap + bilateral naso-labial flap + forehead flap	Alar retraction	23
4/Male/ 69 years old	Tumor resection	Total	Chondro-mucosal septal flap + chondro-costal flap + bilateral naso-labial flap + forehead flap	None	21
6/Male/ 57 years old	Gunshot injury	Tip, Columella, bilateral ala, Right sidewall, Dorsum	Chondro-mucosal septal flap + chondro-costal flap + bilateral naso-labial flap + forehead flap	None	15

Fig. 2 24 months follow-up

speech) and to reveal the degree of satisfaction about the aesthetic outcome of the nasal reconstruction and on the donor sites morbidity. The patients expressed their evaluation on a scale of 5: absolutely (1), mostly (2), enough (3), not much (4), none (5). For the last two questions, regarding general nasal and donor site appearance (forehead and naso-labial groove), patients rated in a scale from

0 (very dissatisfied) to 10 (very satisfied). The self-evaluation form is reported in Table 2.

An objective evaluation was carried out by an independent medical doctor (not involved in these interventions), checking for alar collapse during forced inspiration or nasal whistles during phonation or respiration. All the patients undergone anterior rhinoscopy looking for mucosal dryness,

Table 2 Subjective assessment of nasal reconstruction outcome

Functional evaluation	Absolutely	Mostly	Enough	Not much	None					
Nasal air-flow decreased after surgery?										
Do you snore more than before surgery?										
Olfaction has worsened after surgery?										
Do you think that nasal mucosa is more drier after surgery?										
Nasal bleeding occurs more often after surgery										
The quality of your voice has worsened after surgery?										
Aesthetic evaluation	1	2	3	4	5	6	7	8	9	10
How do you rate the appearance of your nose?										
How do you rate the appearance of your forehead?										
How do you rate the appearance of your naso-labial groove?										

Table 3 Objective assessment of nasal reconstruction outcome

Functional evaluation	Present	Absent			
Alar collapse					
Nasal whistle					
Mucosal dryness					
Nasal crusts					
Nasal synechiae					
Aesthetic evaluation	Very poor	Poor	Moderate	Good	Excellent
Color matching					
Hair growth					
Flap thickness					
Nostrils size					
Alar thickness					
Alar retraction					
General appearance					

crusts, ulcers and synechiae. An aesthetic assessment of the reconstruction was also carried out by the same investigator, with a score from 1 (very poor) to 5 (excellent), according to skin color matching, hair growth, thickness and size of the nostrils, alar thickness and retraction, general appearance of the nose. This form is reported in Table 3.

It was finally assessed the sensitivity, both on the forehead and on the naso-labial flap, in its various forms (tactile, discriminative, thermal and pain). Tactile sensitivity was evaluated asking the patient if he felt the light touch of a 2.83 Semmes–Weinstein Monofilament. Two-points discrimination was assessed with surgical staples set up at different widths and gently pressed on the skin until the patient didn't feel the two stimuli as separated. A prick test was used to check the presence of pain sensitivity while thermal sensitivity was assessed with a cotton swab soaked in cryogenic solution or hot water. All these tests were executed by a single operator, in a quiet room and the patient was blindfolded.

Results

Subjective Assessment of Functional Outcome

All patients filled the functional outcome assessment form, the results are reported in Table 4. The average overall score was 4.30/5 with mean values of 4.33/5 for the nasal air flow, 4.50/5 for snoring, 3.66/5 for the sense of smell, 3.66/5 for mucosal dryness, 5/5 for epistaxis, and 4.75/5 for the phonation quality.

Subjective Assessment of Aesthetic Outcome

The results of the self-test are reported in Table 4, the average score for the nasal aesthetic outcome was 7.66 for the nose, 6.33 for the forehead and 8.66 for the naso-labial donor site.

Objective Assessment of Functional Outcome

All patients were evaluated by a maxillofacial surgeon, different from the operator who detected the presence of nasal functionality impairments and mucosal alteration with anterior rhinoscopy, the results are reported in Table 5. Alar collapse and nasal whistle, only during forced inspiration, have been detected in 2 of the 6 patients assessed. Mucosal dryness was observed in all the patients. Synechia and crusts, sought with anterior rhinoscopy, were absent in all patients.

Objective Assessment of Aesthetic Outcome

The same investigator rated the aesthetics of reconstruction. The results are reported in Table 5. The average overall score was 4.09/5 with mean values of 4.5/5 for skin color matching, 4.16/5 for hair growth, 4.5/5 for flap

Table 4 Subjective outcomes assessment results

	Patient 1	Patient 2	Patient 3	Patient 4	Patient 5	Patient 6
<i>Subjective assessment of functional outcome</i>						
Nasal air flow	5	5	3	4	5	4
Snore	5	4	4	4	5	5
Olfaction	5	5	1	5	4	2
Mucosal dryness	4	5	3	3	4	3
Epistaxis	5	5	5	5	5	5
Phonation	5	5	4	5	5	4
<i>Subjective assessment of aesthetic outcome</i>						
Nose	10	8	6	8	8	6
Forehead	8	6	7	5	6	6
Naso-labial groove	10	10	7	8	10	7

thickness, 3.66/5 for nostrils size, 3.83/5 for alar thickness, 4/5 for alar retraction and 4/5 for general appearance of the reconstructed nose.

Objective Assessment of the Sensitivity Recovery

Sensitivity recovery was assessed both on the forehead flap and the two naso-labials flaps used to reconstruct the inner lining of the nasal vestibules. Results are reported in Table 6. All the forehead flaps showed a tactile sensitivity recovery with discriminative thresholds near to the native frontal region. In the two cases of traumatic avulsion of the nose, in which the major injury of the central third of the face damaged bilaterally the infraorbital nerves, nasolabial flaps did not show any sensitivity recovery.

Discussion

The nasal reconstruction success can't refrain from considering the satisfaction of patient needs and expectations, which often addresses himself to the surgeon with a disfigurement that is perceived, especially in young people, such a severe deformity to hide from society. For this reason, quality evaluation of a reconstruction must take into account, not only the objective opinion of the surgeon, but also the perception of the reconstructed nose that the patient has. Therefore, the possibility of obtaining standardized data allows to compare the effectiveness of various available surgical techniques and choose the most appropriate for each kind of defect.

Only few authors have developed evaluation protocols of the nasal reconstruction quality. An excellent grading system to evaluate cosmetic surgical results has been presented by Strasser [8]. This system, however, is not specific

for nasal reconstruction and it doesn't take into account patient opinion. A nose-specific questionnaire, specifically designed for rhinoplasty outcome evaluation, was proposed by Alsarraf [9] but it doesn't take care of the objective assessment of the surgeon. To overcome these limitations Moolenburgh [3] proposed the "Nasal Appearance and Function Evaluation Questionnaire (NAFEQ)", a self-compiled form who assess the aesthetic and functional perception that the patient has about his nose. Mureau [4] added to NAFEQ an objective aesthetic and functional evaluation performer by an independent surgeon. We have simplified this protocol eliminating the evaluation of the single nasal subunits and focusing on the general appearance and function of the nose, to assess reconstructions of the entire nasal pyramid. Furthermore, we have associated an objective assessment of sensitivity recovery of the reconstructive flaps. To our knowledge, no previous work evaluate this functional aspect of a reconstructed nose. Skin sensitivity of the nasal pyramid plays a key role in the proprioception of a body part that would otherwise be recognized as not self. In the same way, the inner lining sensitivity of the vestibule is essential to appreciate the air flow, giving the patient the better awareness of his nasal function.

The analysis of our cases has detected no major complications of the flaps or grafts. Particular attention has been paid to the timing of the pedicle section (not less than 3 weeks) and the final thinning of the reconstructive flap was always delayed to a further surgical time.

In nasal alae reconstruction, we always found a minimum degree of shrinkage that in one case necessitated a re-entry, under local anesthesia, for nostrils revision. To reduce the alar collapse and retraction, it is advised the use of cartilage of adequate thickness (>2 mm) and a minimal tension of the inner mucosal flaps.

Table 5 Objective outcomes assessment results

	Patient 1	Patient 2	Patient 3	Patient 4	Patient 5	Patient 6
<i>Objective assessment of functional outcome</i>						
Alar collapse	No	No	No	Yes	No	Yes
Nasal whistle	No	No	No	Yes	No	Yes
Mucosal dryness	Yes	Yes	Yes	Yes	Yes	Yes
Nasal crusts	No	No	No	No	No	No
Nasal synechiae	No	No	No	No	No	No
<i>Objective assessment of aesthetic outcome</i>						
Color matching	4	5	5	5	4	4
Hair growth	5	5	5	2	4	4
Flap thickness	4	4	5	5	4	5
Nostrils size	2	5	3	3	4	5
Alar thickness	3	5	4	3	4	4
Alar retraction	4	5	3	3	4	5
General appearance	4	5	4	3	5	3

Table 6 Sensitivity recovery assessment results (*P* present, *A* absent)

	Patient 1	Patient 2	Patient 3	Patient 4	Patient 5	Patient 6
<i>Objective assessment of the sensitivity recovery on the forehead flap</i>						
Tactile	P	P	P	P	P	P
Two-points discrimination	P (6 mm)	P (10 mm)	A	P (8 mm)	P (8 mm)	A
Pain	P	P	P	P	P	P
Thermal (cold)	P	P	A	P	P	P
Thermal (heat)	P	A	A	P	P	A
<i>Objective assessment of the sensitivity recovery on the naso-labial flaps</i>						
Tactile	P	P	A	P	P	A
Two-points discrimination	P (6 mm)	P (6 mm)	A	P (7 mm)	P (7 mm)	A
Pain	P	P	A	P	P	A
Thermal (cold)	P	P	A	P	P	A
Thermal (heat)	P	P	A	P	P	A

In our series, four patients underwent an isolated nasal reconstruction. Two patients (case 3 and 6) received a rhinopoesis in complex facial reconstruction after self-inflicted gunshot trauma that also caused the loss of soft and hard tissues of jaw, maxilla and nose, obviously affecting the overall aesthetic and functional result.

In the case of neoplastic resection of the external nose, reconstruction is advisably delayed to a second surgical step to get histological confirmation of the oncological radicality and allow a long follow up with easy intranasal checks before proceeding to complex reconstructions. In addition, the delayed reconstruction phase allows the patient the psychological elaboration of the disfigurement

caused by the disease, with better acceptance of nasal reconstruction, which is unlikely suffered as an insult, but rather experienced as a relief.

All analyzed patients have a good nasal flow. In two cases, only during forced inspiration, alar collapse associated with nasal whistle was reported. The anterior rhinoscopy did not reveal synechiae and crusts in any case, while mucosal dryness was detected in all the patients. It is probably related to the reconstruction of the inner mucosa with cutaneous flaps such as the naso-labial.

A maxillofacial surgeon other than the operator has detected the presence of aesthetic and proportion alterations. The overall result of the reconstruction was

satisfactory in all cases (4.09/5) with an excellent color match offered by the forehead flap (4.5/5) and a correct projection of the nasal pyramid. Only one of the patients experienced hair growth on the skin paddle of the flap, but he refused permanent hair removal judging the problem as independently solvable with periodic trichotomy. Thanks to the defatting of the flap on the nasal dorsum, normally covered by a very thin skin, the thickness of the flap was satisfactory in all patients (4.5/5). The alae support and thickness and the size of the nostrils were fully satisfactory in three patients. In one case (case 1) there was a significant reduction in the amplitude of the nasal vestibule, due to the large volume of the naso-labial flap, but the airflow was good without valvular collapse in forced inspiration. In another case (case 4) a nostrils revision was necessary due to an insufficient columellar support.

The subjective evaluation revealed a sufficient air flow in all the patients, increasing of snoring, epistaxis and speech impairment were absent in all the patient. Olfaction was severely impaired in two patients with gunshot injuries that fractured the cribriform plate.

Overall, the patients were fully satisfied with the outcome of the nasal reconstruction (7.66/10). The residual mild aesthetic alterations did not represent a disturbing element in the normal facial eurhythmy, these data are in accordance with those obtained from previous studies [4, 10–12] that, however, included mostly small size defects of the nose. Less satisfaction was recorded regarding the appearance of the donor site scar on the forehead (6.33/10), particularly in male patients where the scar can't be covered by hair. These results are worse than those collected in other studies from patients who have reconstructions, even if smaller, using naso-labial flaps [12, 13]. Even our patients, who underwent inner lining reconstruction with a naso-labial flap, reported as negligible the aesthetic results at this donor site level (8.66/10).

In all patients, sensitivity was evaluated on the skin surface of the flap used for the reconstruction: there are no similar studies in the literature. Nasal pyramid sensitivity is normally provided by infraorbital nerve branches (alae and lateral subunits of the nose) and by the anterior ethmoid nerve (dorsum and nasal tip). The innervation of the forehead, donor site of the reconstructive flap, is ensured by epitrochlear nerve, satellite of the homonymous vessels, and by the supraorbital nerve.

In all the patients, the forehead flap recover tactile and pain sensitivity similar to the original, even after the pedicle section and in patient with infraorbital nerve traumatic damage (case 3 and 6). In these patients, on the contrary, the naso-labial flap used to reconstruct the inner lining remains anesthetized because its innervations is granted by the infraorbital nerve. Asking the patient to report where experience the stimulus, this was interestingly

detected on the nose and not on the forehead. The two-points discrimination threshold, that is a quite good index of the density of innervations, reports values similar to that found on the non-operated part of the forehead.

Conclusions

A careful study of the defect and a correct planning of the three-dimensional reconstruction of the nose are the basis of a satisfactory aesthetic and functional result, for both the surgeon and the patient. The large number of reconstructive options currently available force the surgeon to adopt outcome evaluation protocols that can objectively guide the choice for the best technique of each kind of defect. In our series the use of a three layer reconstruction has proved a viable technique both aesthetically and functionally. In particular the use of the forehead flap to reconstruct the outer layer of the nose allows to carry a tissue with very similar characteristics to the original with a recovery of the sensitivity almost complete. However, donor site morbidity, at least from the patient aesthetic point of view, is not negligible for the scar that leaves on a highly visible area. This problem can be limited using skin expanders that allow a primary closure of the wound after flap transposition [14]. However this problem still appears the only critical of the forehead flap that, not surprisingly, is the reconstructive cornerstone of the major nasal pyramid defects for over 2600 years.

Compliance with Ethical Standards

Conflicts of interest The authors declare that they have no conflict of interest.

Ethical approval This study is approved by University of Sassari Ethical committee.

Informed consent Additional informed consent was obtained from all individual participants for whom identifying information is included in this article.

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