



Use of auricular versus costal cartilaginous grafts for secondary rhinoplasty procedures: comparison of long-term outcomes

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Received: 16 August 2022 / Accepted: 2 December 2022 / Published online: 28 December 2022
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Abstract

Background Secondary rhinoplasty is a much more complex operation than primary rhinoplasty, because previously operated and fibrotic tissue is involved. The predictability of results, both aesthetic and functional, is thus inherently lower, demanding greater attention and safety. Even more intricate are those instances in which cartilaginous septum is absent, either in part or almost entirely. This comparative analysis targeted long-term outcomes of secondary rhinoseptoplasties using either auricular or rib cartilage as grafts.

Methods All patients selected for study met the following criteria: (a) required secondary rhinoplasty for functional and/or cosmetic problems, (b) voids of septal cartilage, (c) follow-up of ~2 years, (d) availability of standard pre- and postoperative photos, (e) fair command of the Italian language, and (f) signed participatory consent. Each subject was randomly assigned to group 1 (costal cartilage graft for secondary rhinoplasty) or group 2 (auricular cartilage graft for secondary rhinoplasty). In follow-up, patients completed the Italian version of the FACE-Q rhinoplasty module. Anthropometric measurements were also acquired in AutoCAD for MAC. We determined angles of deviation pre- and postoperatively for comparison and analysed patient satisfaction levels by group using the chi-squared test for unpaired data. Two plastic surgeons reviewed all postoperative photographs of study subjects, rating them on a scale of 1–5.

Results A total of 135 patients undergoing primary rhinoplasties between January 2008 and September 2019 in our Department of Plastic Surgery and meeting all inclusion criteria qualified for study. Mean patient age was 48.5 years, and mean follow-up time was 3 years. Pre- and postoperative FACE-Q values in group 1 differed significantly ($p < 0.05$). Anthropometric measurements revealed significant differences ($p < 0.05$) in pre- and postoperative angles of septal deviation determined for group 1 vs group 2. In long-term follow-up, group 1 maintained an angle close to 180° ($p < 0.015$), and results in group 1 (vs group 2) remained stable ($p < 0.05$). Members of group 2 underwent more secondary procedures by comparison ($p < 0.05$). Ultimately, the two reviewers determined that outcomes in group 1 (vs group 2) proved more satisfactory ($p < 0.05$).

Conclusions This effort is the first to compare grafting of auricular and costal cartilage in secondary rhinoplasty procedures. Implants from the 5th rib are preferential to ensure satisfactory long-term outcomes and durable, natural aesthetics in patients lacking septal cartilage.

Level of evidence: Level V, Therapeutic.

Keywords Patient satisfaction · Quality of life · Nose · Rhinoplasty · Secondary rhinoplasty · Rib cartilage

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Introduction

Rhinoplasty is one of the most coveted interventions in cosmetic facial surgery and falls within the domain of several surgical specialties, particularly plastic surgery, maxillofacial surgery, and otolaryngology [1, 2]. It is also a procedure in which constant training is critical to ensure predictable and safe results [3–5]. Secondary rhinoplasty is a much more complex operation than primary rhinoplasty, because previously operated and fibrotic tissue is involved. The predictability of results, both aesthetic and functional, is thus

inherently lower, demanding greater attention and safety. Even more intricate are those instances in which cartilaginous septum (the chief grafting site in rhinoplasty and a pivotal support structure for the nasal pyramid) is absent, either in part or almost entirely.

Primary causes for absence of septal cartilage are prior aggressive surgery, use of vasoconstrictors (such as cocaine), and malformations (such as cleft lip and palate). Such conditions call for in-depth planning of nasal pyramid restructuring and an obliging source of cartilage, one that enables functional/aesthetic results as durable and predictable as possible. Auricular concha has customarily provided the necessary cartilage, given its ease of access and the obscurity of resultant scars (posterior auricular, as in otoplasties). Unfortunately, it is patently clear that cartilage has memory that acts to preserve the original curvatures. Consequently, our group has increasingly gravitated to costal cartilage over the years [6].

This retrospective analysis of reconstructed nasal pyramids was intended to show that costal cartilage is the best choice for secondary rhinoplasty grafting, offering stable, safe, and predictable correction of functional and cosmetic problems.

Materials and methods

All study candidates met the following criteria: (a) secondary rhinoplasty performed for functional and/or cosmetic concerns, (b) partial or subtotal septal voids, (c) postoperative follow-up ~ 2 years in duration, (d) standard pre- and postoperative photographic documentation, (e) good command of the Italian language, and (f) signed participatory consent. Informed consent by each patient included permission for photographic publication. All subjects underwent maxillofacial computed tomography (CT) in advance of surgical procedures. Cottle's classification [7] served to evaluate levels of obstruction. In each of our patients, obstruction was confined to area 2 (valve area) or area 4 (anterior turbinate area). The following were grounds for patient exclusion: (a) primary rhinoplasty, (b) intact septal cartilage, (c) follow-up < 2 years, (d) complications from secondary rhinoplasty, (e) invalid pre- or postoperative photographic images, and (f) inability to complete the FACE-Q questionnaire [8]. Data gathering for analysis focused on patient age, sex, duration of follow-up, specific surgical procedure, nature of cartilage used, graft type, means of incision, and level of patient satisfaction. All procedures were performed by the same surgical team, adhering to ethical standards of institutional and/or national research committees and the amended 1964 Declaration of Helsinki or comparable ethical standards.

This study was comparative by design, stratifying patients according to graft utilised for secondary rhinoplasty, either 5th costal cartilage (Fig. 1) (group 1) or cartilage from auricular concha (group 2). Cartilage was obtained from

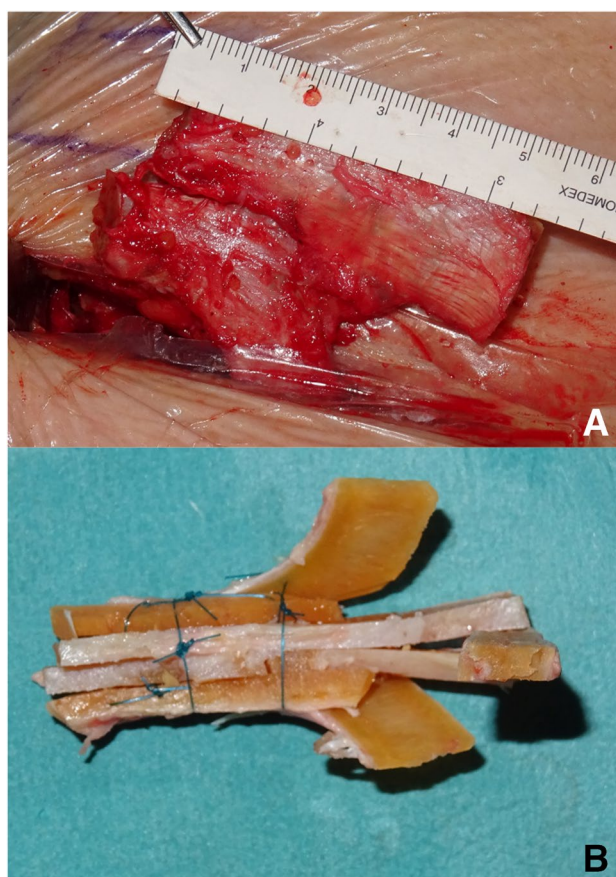
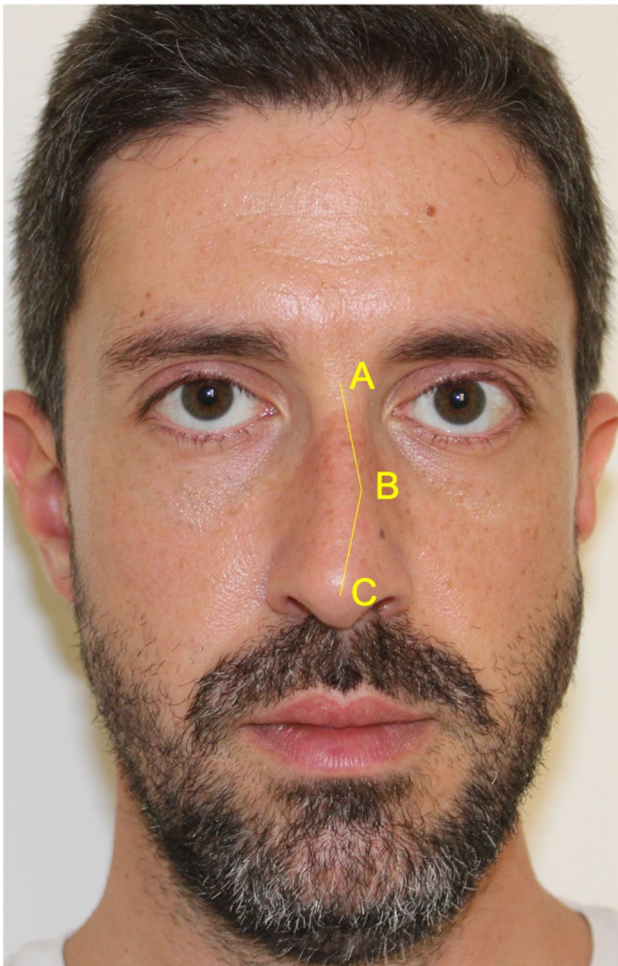
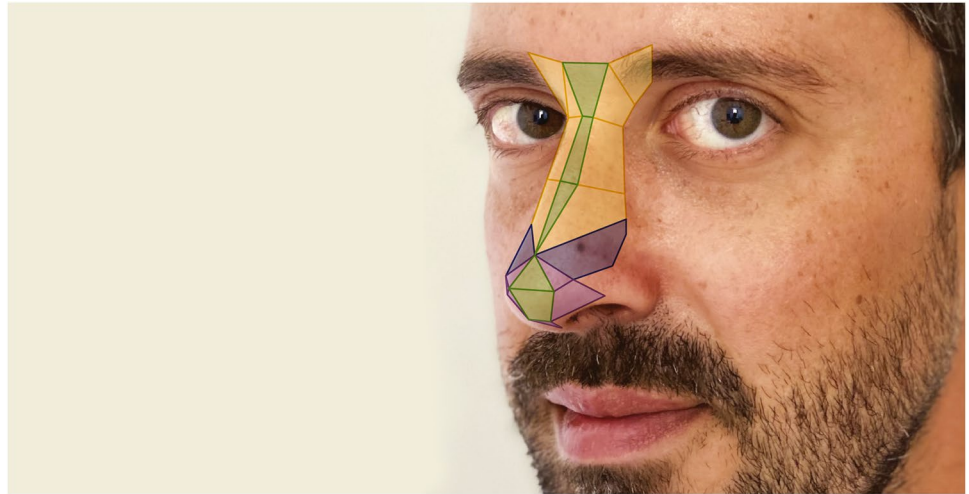


Fig. 1 Fifth rib cartilage (A) and total reconstruction of structural cartilage nasal pyramid (B)

donor sites in the course of secondary rhinoplasty, the goal being sound cosmetic and functional outcomes. The same two-surgeon team performed all procedures, positioning respective grafts within septal pockets after efforts made to straighten them and restructure nasal pyramids. Every patient completed the Italian version of the FACE-Q rhinoplasty module, administered via email ~ 2 years postoperatively. We used Cakir's theory (Fig. 2) [9] of polygons to schematise the aesthetic subunits of the nose in the pre-operative checklist as in Fig. 1. Anthropometric measurements were generated in AutoCAD (<https://www.autodesk.com/products/autocad/overview>) for MAC (Autodesk Inc, San Rafael, CA, USA) from frontal photos taken prior to surgery and at final follow-up visit. One line was drawn from pretarsal fold (A) to maximum projection of dorsal deviation (B) and another from point B to nasal tip (C), depicting the angle of deviation (Fig. 3). Nasal tip projection was measured in profile view using Goode's method, again relying on AutoCAD for angle calculations. All collected data were stored in an EXCEL file.

In theory, dorsal angles should be 180°. This is precisely what we achieved in each patient at the close of secondary

Fig. 2 The polygons theory**Fig. 3** Dorsal angle deviation. One line was drawn from pretarsal fold (A) to maximum projection of dorsal deviation (B) and another from point B to nasal tip (C), depicting the angle of deviation

rhinoplasty. By evaluating angles of deviation, we were able to gauge graft performance (auricular vs costal) in reaching a stable aesthetic and functional reconstruction of nasal pyramid. We compared pre- and postoperative levels of patient satisfaction with nasal appearance by group, using the chi-squared test for unpaired data. Two plastic surgeons reviewed all postoperative photos of study subjects, rating images on a scale of 1–5. Data analysis was driven by SPSS software (v25.00 for Windows; SPSS Inc, Armonk, NY, USA), with significance set at $p < 0.05$. Values were expressed as numbers and percentages (categorical data) or means and standard deviations (quantitative data). Fisher's exact test was applied to compare categorical data of the two groups.

FACE-Q rhinoplasty module

The 2016 pre- and postoperative FACE-Q rhinoplasty module [10] is a rigorously developed, nasal surgery-specific reporting instrument for patient outcomes proven by Rasch measurement theory analysis. The latter has prompted refinement of a 10-item Satisfaction with Nose Scale and a 5-item Satisfaction with Nostrils Scale. Person separation indices and Cronbach α values were 0.91 and 0.96, respectively, for Satisfaction with Nose and 0.89 and 0.96, respectively, for Satisfaction with Nostrils. All items showed ordered thresholds and good item fits. This module may be used to incorporate patient perspectives in outcome assessments conducted for clinical practice, research, and quality improvement.

Results

A total of 135 patients (men, 101; women, 34) undergoing primary rhinoplasties between January 2008 and April 2019 in our Department of Plastic Surgery and having met all

inclusion criteria were enrolled for study (Table 1), divided into 2 groups: group one 71 patients, group two 64 patients. Demographic data and surgical details are shown in Table 2. Mean patient age was 48.5 years, and mean follow-up time was 3 years (range, 2–8 years). All patients underwent secondary rhinoplasties to correct nasal deviation, collapse, or deformity, with C-shaped, S-shape, saddle distortion, or hypoprojection. All showed preoperative nasal obstruction of varying severity. Anthropometric measurements revealed significant differences ($p < 0.05$) between pre- and postoperative angles of anterior dorsal deviation in group 1 (Figs. 4 and 5) vs group 2 (Table 3). In long-term follow-up, group 1 maintained an angle close to 180° . Differences in pre- and postoperative FACE-Q values for group 1 were significant ($p < 0.05$) (Table 4), and results for group 1 (vs group 2) remained stable during long-term follow-up ($p < 0.05$). Members of group 2 also underwent more secondary procedures by comparison ($p < 0.05$) (Table 2). The two reviewers enlisted determined that outcomes in group 1 proved more satisfactory than those of group 2 ($p < 0.05$) (Table 5).

Discussion

The purpose of this study was to assess secondary rhinoplasty procedures, steering all plastic surgeons, maxillofacial surgeons, and otolaryngologists who perform such revisions towards the most suitable approach. It is obvious that auricular cartilage has several advantages, such as ease of removal and the potential for scar concealment (in posterior auricular region). For years, this site has actually served as the main donor source in patients with deficient septal cartilage.

Table 2 Population data

	Number (<i>N</i> = 135)
Age	
Mean (years old)	48.5
Gender	
Male	101
Female	34
Follow-up	
Mean (years)	3
Dorsal deviation type	
C-shape	12
S-shape	13
Saddle dorsum	90
Hypoprojection	20
Type of access	
Open	132
Closed	3
Number of patients	
Group 1	70
Group 2	60
Secondary procedures	
Group 1	0
Group 2	34
Level of obstruction (Cottle's classification)	
Area 1	0
Area 2	88
Area 3	76
Area 4	89
Area 5	0

Table 1 PICOS criteria

Parameters	Inclusion criteria	Exclusion criteria
Patient, population, or problem	Patients with absence of the septal cartilage candidate to secondary rhinoplasty for functional and/or cosmetic problems	Patient with psychiatric disorder, with abuse of alcohol or drug, follow-up < 2 years, complications following secondary rhinoplasty, presence of septal cartilage, invalid pre- or postoperative photographic images, inability to answer the FACE-Q instrument
Intervention, prognostic factor, or exposure	Patients with almost 2 years follow-up had both standard pre- and postoperative photographic images, with absence of septal cartilage, had a good understanding of the Italian language, and had signed a consent form for inclusion in the study	
Comparison or intervention	Group 1: secondary rhinoplasty using rib cartilage Group 2: secondary rhinoplasty using auricular cartilage	
Outcome you would like to measure or achieve	Structural nasal pyramid in patient with absence of septal cartilage	
Study design	Comparative study	



Fig. 4 Forty-four-year-old man with dorsal and hypoprojection of the dorsum, valves collapse, functional and cosmetic problems, and absence of the septal cartilage because of use of cocaine. Preop-

erative photos: A–D. Postoperative photos after nasal reconstruction with 5th costal cartilage with 5 years follow-up: E–H

Unfortunately, auricular cartilage is not only quite thin, but it is also curved and therefore less inclined to reconstructive stability over time. The present study is the first clinical analysis to underscore this weakness and encourage other reconstructive options for nasal septum, leaving its utility for alar revisions (similar thickness and shape) unchallenged.

In the literature, there are several histologic studies comparing costal and auricular cartilage. Buckwalter et al. [11] have confirmed that chondrocytes provide the macromolecular framework for a tissue matrix composed of collagens, proteoglycans, and non-collagenous proteins. Collagen types II, IX, and XI create a fibrillary meshwork instilling tissue form, tensile stiffness, and strength. Other shapes are thereby not readily imposed, and the original curvature tends to prevail. Buyuklu and colleagues [12] have also compared auricular and costal cartilage after crushing, demonstrating that auricular chondrocytes largely retain viability and afford better structural preservation. To our knowledge, there are no published studies exploring histologic aspects of auricular and costal cartilage or any differences in structure, memory, or adaptation once manipulated. Perhaps this will follow at some point in time and deliver guidance on their use.

Some sources have argued that auricular cartilage is the best solution for secondary rhinoplasties, regardless of

surgical indications. After review of 197 secondary or tertiary rhinoplasties, Pascali et al. [13] have concluded that grafted auricular cartilage is the preferred means of correcting aesthetic and functional residuals from ineffective primary or secondary procedures. Our research group is not swayed by this study, given the less tenable results presented herein. Auricular cartilage does not ensure stable reconstruction of some aesthetic nasal subunits (more central) and will not remain straight over time, owing to its initial shape and thickness. This is especially true if major structural revisions must be performed in the total or subtotal absence of septum.

The same research group [14] (Gentile and Cervelli) cited above has reported a case of secondary reconstruction using the 11th rib. We are not in agreement with this strategy either, because the 11th rib is more sharply curved than the 5th rib (typically accessed to reconstruct nasal pyramid, particularly septum). In fact, this is the only case involving the 11th rib to appear in the literature. Lee et al. [15] have similarly endorsed (based on 22 cases) auricular cartilage as a versatile source of grafting material in primary and secondary rhinoplasties. Aside from the small number of cases entailed, the authors did not investigate an alternate donor site for comparison. Ultimately, many studies conducted in recent years have established the importance of

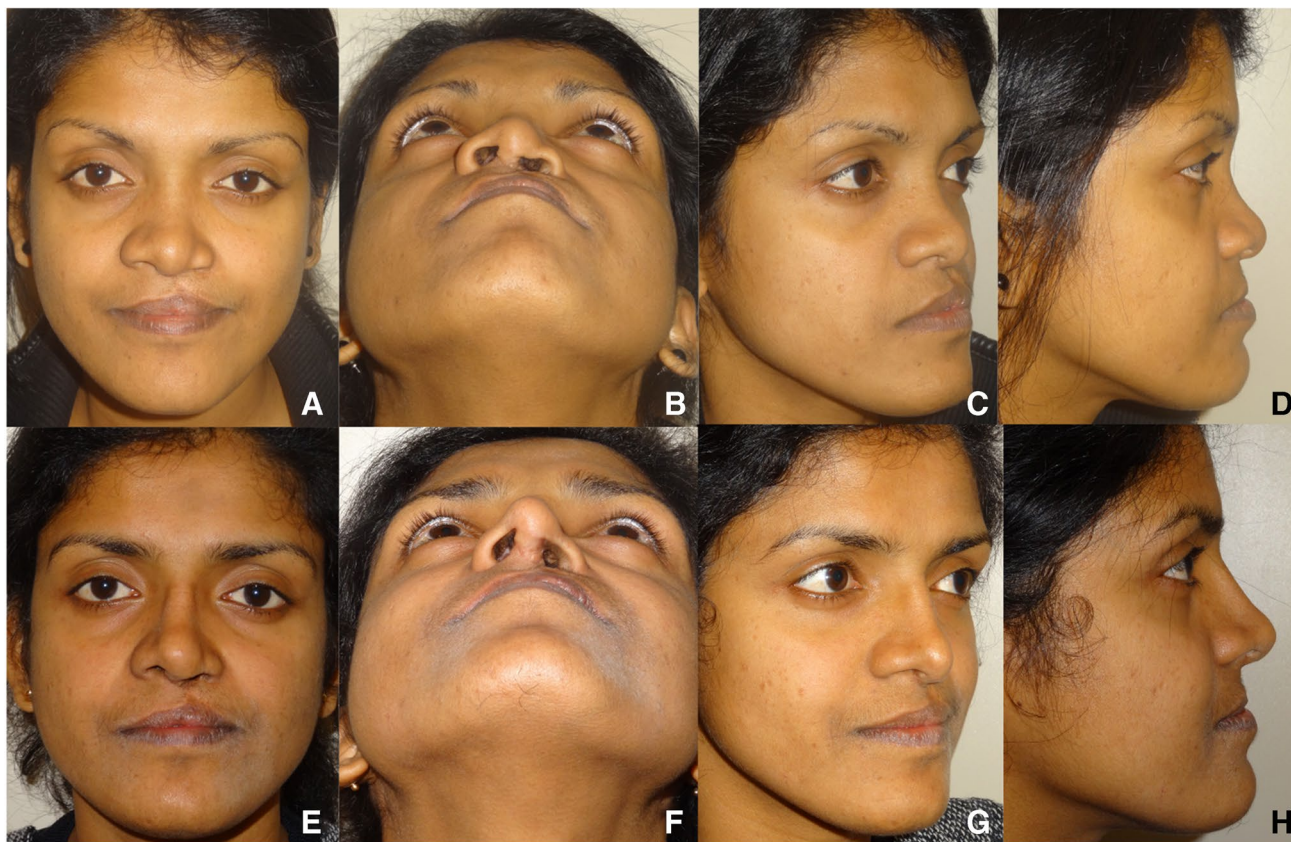


Fig. 5 Twenty-nine-year-old woman with previous correction of cleft lip and palate and previous rhinoseptoplasty, with saddle and deviated dorsum, with functional and cosmetic problems. Preoperative photos:

A–D. Postoperative photos after nasal reconstruction with 5th costal cartilage with 5 years follow-up: E–H

Table 3 Objective outcome measurements

Groups (N= 135)	Preop-erative angle (mean ± SD)	Postoperative angle (mean ± SD)	P
Group 1 (N=71)	165.5 ± 1.0	175.5 ± 1.0	< 0.05†
Group 2 (N=64)	166.0 ± 1.0	172.2 ± 1.0	> 0.05

†Statistically significant

costal cartilage [16–22], showing its versatility and long-term stability in even extreme scenarios of nasal pyramid reconstruction. Finally, tissue constraints must always be borne in mind. Unlike auricular sites, there is simply ample availability of costal cartilage. Probably the future of surgical interventions in which rib cartilage will be used will be to exploit frozen cartilage taken from a cadaver, despite a cost [23, 24].

The anthropometric study we carried out, evaluating angles of deviation, allowed us to verify the overall straightness achieved over time. This was primarily due to use of the 5th rib to reconstruct or support septum via

Table 4 FACE-Q satisfaction with the nose postoperative module

FACE-Q satisfaction with the nose postoperative module	Group 1 (71)	Group 2 (64)	P 1–2
The width of nose	65 (91%)	44 (69%)	< 0.05†
The length of nose	67 (94%)	43 (67%)	< 0.05†
The bridge of nose	68 (96%)	32 (50%)	< 0.05†
The nose and face	68 (96%)	31(48)	< 0.05†
The nose looks straight	68 (96%)	33 (52%)	< 0.05†
The size of the nose	66 (93%)	42 (66%)	< 0.05†
The shape of the nose in profile	68 (96%)	40 (63%)	< 0.05†
The nose in photos	67 (94%)	38 (59%)	< 0.05†
The tip of the nose	69 (97%)	38 (59%)	< 0.05†
The nose from every angle	67 (94%)	38 (59%)	< 0.05†

*Raw score ≥ 3

†Statistically significant

spreader and extension grafts. On the other hand, septal cartilage drifted from 180° in procedures involving auricular grafts, failing to maintain inner straightness

Table 5 Surgeons reviewers VAS Scale

VAS Scale	Group 1 (71)	Group 2 (34)	<i>P</i> 1–2
a. Global cosmetic outcome (mean)	4.6	3.3	<0.05†
b. Scarring (mean)	5	5	1
c. Profile view (mean)	5	3.3	<0.05†
d. Frontal view (mean)	4.6	3.2	<0.05†
e. Basal view (mean)	4.6	3.7	0.05†
f. Feminine/masculine shape (mean)	4.6	4.2	0.1

†Statistically significant

From 0 to 5 points

and stability after at least 2 years of follow-up. We considered the 2-year mark a minimum duration for assessing durability. In our study subjects, spreader grafts to straighten septum anteriorly and provide better aesthetics or septal extension grafts to achieve caudal elongation of septum were largely applied, most notably in cases of previously removed posterior septum, columellar strut grafting, required stabilisation of nasal pyramid, or augmented projection of nasal tip. A distinct disadvantage of donor rib cartilage is the chest scar (3–4 cm), more visible in hairless men. In women, the scar is immediately concealed within the inframammary sulcus. For this study, we selected only patients needing septal reconstruction, excluding those with intact nasal septa or revisions of alar cartilage alone (for example).

Limitations of our investigation include its single-centre, comparative, and non-prospective design and a lack of post-operative instrumental studies for the entire patient sampling. At present, however, it remains the only effort comparing two grafting sites in a sizeable number of patients. Corroborative research on the utility 5th rib cartilage in aesthetic and functional nasal revisions will hopefully materialise going forward.

Conclusions

Our data demonstrate that grafting of costal cartilage reduces the risk of further revision procedures, renders outcomes more predictable and safe, and confers aesthetic/functional stability, despite the inherent perils of secondary rhinoplasty.

In our experience, the 5th rib cartilage is preferred for reconstructing the nasal pyramid. Our department no longer harvests auricular cartilage for this purpose. Ours is ostensibly the first comparative study to demonstrate superiority of costal cartilage grafts in patients facing secondary rhinoplasties. We consider it the optimal approach in this setting, ensuring satisfactory long-term outcomes and durable, natural aesthetics.

Author contribution All authors contributed to the study conception and design.

Funding The authors declare that no funds, grants, or other support were received during the preparation of this manuscript.

Declarations

Ethical approval This study was performed in line with the principles of the Declaration of Helsinki. Due to the retrospective nature of this study, approval from the ethics committee was not required.

Consent to participate Informed consent was obtained from all individual participants included in the study.

Consent for publication The authors affirm that human research participants provided informed consent for sharing their data and publication of their images.

Competing interests Mauro Barone, Annalisa Cogliandro, and Paolo Persichetti declare no competing interests.

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