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REVIEW

Literature scans: cartilage grafts in nasal tip rhinoplasty

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Abstract

In the last years, surgical strategies in rhinoplasty were deeply modified with a gradual shifting from a reductive rhinoplasty, with aggressive intervention and trimming of the cartilages, to a more conservative and then "additive" rhinoplasty. We aimed to report the different types of autologous cartilage graft and the specific indications for each one. The authors reviewed 201 papers published in the last 10 years in the international literature database PUBMED and EMBASE deciding to isolate only those articles providing either retrospective or prospective data pertaining to outcomes, descriptions, and complications of the cartilage grafts use in nasal tip's rhinoplasty. Of the 201 articles, 96 were initially selected. Of these, 38 met the predetermined criteria for inclusion. Nasal septum, concha, and the ribs are the main sources for autografts to be used in rhinoplasty. Septal cartilage is easy to harvest, it is versatile, could be useful for many types of grafts, and it has a low percentage of resorption, extrusion, and warping. Cartilage from the auricular concha can be used to correct both the internal and external nasal valve collapse with satisfactory results. Costal chondral grafts are usually used for structural support when septal cartilage is not available. It is possible to divide autologous grafts into two main categories: structural grafts (columellar strut, septal extension, and the alar batten grafts) and contour improving grafts (onlay tip, shield, cap, and the alar rim grafts) useful for the structural support to the tip and smoothing and hiding irregularities.

Level of Evidence: Not ratable.

Keywords Nose · Tip · Cartilage · Graft · Reconstruction · Rhinoplasty

Introduction

Rhinoplasty is one of the most important procedures in cosmetic surgery, and it relays on a deep knowledge of anatomy and the relationship intercurring in between the different anatomical structure of the nose. In particular, it is of pivotal importance to consider how the cartilaginous structure plays a central role in determining the final shape of the nose, and then how to intervene on it in order to obtain the desired results.

In the last two decades, surgical strategies in rhinoplasty were deeply modified with a gradual shifting from a reductive rhinoplasty, with aggressive intervention and trimming of the cartilages, to a more conservative and then "additive" rhinoplasty.

In this change, the use of grafts raised gradually to a more central role becoming, nowadays, in many cases, irreplaceable.

An excessive resection of the nasal cartilaginous structure can lead, moreover, to severe functional problems. The septal quadrangular cartilage and the osseous framework, when resected in an inappropriate way, lose their efficacy in maintaining a structural support to the dorsum being responsible for defects ranging from an inappropriate dorsal height up to a saddle nose deformity.

The tip is, as well, an important aesthetical subunit of the nose and plays a central role in both cosmetic and functional aspects of rhinoplasty. It has strict and specific relationships between the cartilaginous structure and both its esthetic appearance and its functional role [1].

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Many patients can present a bulbous or boxy tip and are candidates to tip reduction.

On the other way, a deficiency in the cartilaginous component on the tip can determine, as well, low projection and a short nose. An overaggressive trimming of the alar and of the triangular cartilages could easily determine an internal and/or external nasal valve due to a collapse of the framework, lacking its support.

Furthermore, an unprecise or asymmetric resection, particularly in the thin-skinned patients, can be revealed by irregularities in the contour.

Therefore, grafts became in secondary and tertiary rhinoplasties even more important than in the primary ones. They are a powerful tool in order to restore deformities subsequent to surgery and to correct functional issues, like a nasal valve.

Many kinds of materials were used as grafts, either autologous, homologous, or alloplastic.

Autologous grafts have several advantages. They are fully biocompatible, they give long-lasting results [2], they have low resorption [3] and extrusion rate [4], and they have good resistance to infection. They have, as well, some drawbacks. The most important is the morbidity on behalf of donor site [5].

Of course, cartilage, for its easy availability, elasticity, and wide possibility in molding, is the most performing tissue for grafting. It can be easily harvested either directly from the septum, or from the auricular cartilage, or from the ribs. Cartilages harvested from different donor sites have different features and can fit better in specified conditions or types of graft.

Especially for the tip correction cartilage graft is a versatile and useful instrument in surgeons' hands.

In this paper, the authors reviewed the international literature about cartilage grafts in tip remodeling in rhinoplasty, with advantages or problematic of the different types of graft and the specific indications for each one.

Materials and methods

The authors performed a research in the international literature database PUBMED (https://www.ncbi.nlm.nih.gov/pubmed) and EMBASE (https://www.embase.com) with different keywords (nose, tip, cartilage, graft, reconstruction, rhinoplasty) (Diagram 1).

Two hundred one papers published in the last 10 years were reviewed. The authors decide to isolate only those articles providing either retrospective or prospective data pertaining to outcomes, descriptions, and complications of the cartilage grafts used in nasal tip's rhinoplasty.

Thirty-eight papers, cited in the texts, were analyzed and selected using Prisma Flow [6] (www.prisma-statement.org) (Diagram 2).

Results

Of the 201 articles returned from the initial search, 96 were initially selected on the basis of the abstract review. Of these, 38 met the predetermined criteria for inclusion. Seventy-seven percent of studies focused on surgical description of the technique, showing acceptable results with generally low levels of complications with the use of various types of cartilage grafts.

Complications and reviews were reported in 33 % of studies, with a multitude of approaches, presenting mostly satisfactory results.

Nasal septum, concha, and the ribs are the main sources for autografts to be used in rhinoplasty. Septal cartilage has many positive aspects. It is easy to harvest, the donor site is already in the surgical field, requiring only a little extra effort to get it, it is versatile, and could be useful for many types of grafts, and it has a low percentage of resorption, extrusion, and warping.

Cartilage from the auricular concha can be used to correct both the internal and external nasal valve collapse with satisfactory results.

Costal chondral grafts are usually used for structural support when septal cartilage is not available.

Crushed cartilage, minced cartilage, and diced cartilage can be used in the noses with thinner soft tissues obtaining good results.

Discussion

The cartilaginous framework of the nasal tip is determined by the two alar cartilages and by the columellar portion of the quadrangular cartilage of the septum.

First of all, it is important to assess clinically the defect that should be corrected.

Any rotation, elongation, or deficit of the tip should be evaluated and documented with preoperative photos.

Different authors tried to correlate the surface anatomy to the internal structure in order to get a more precise preoperative planning.

The tripod concept proposed by Anderson et al. [7] It is probably familiar to every surgeon dealing with rhinoplasties in the last 30 years. He proposed to consider the tip structure as a tripod; the length of each of its legs, and the relationship between them and the skull underneath, are the major determinants of the tip shape and rotation.

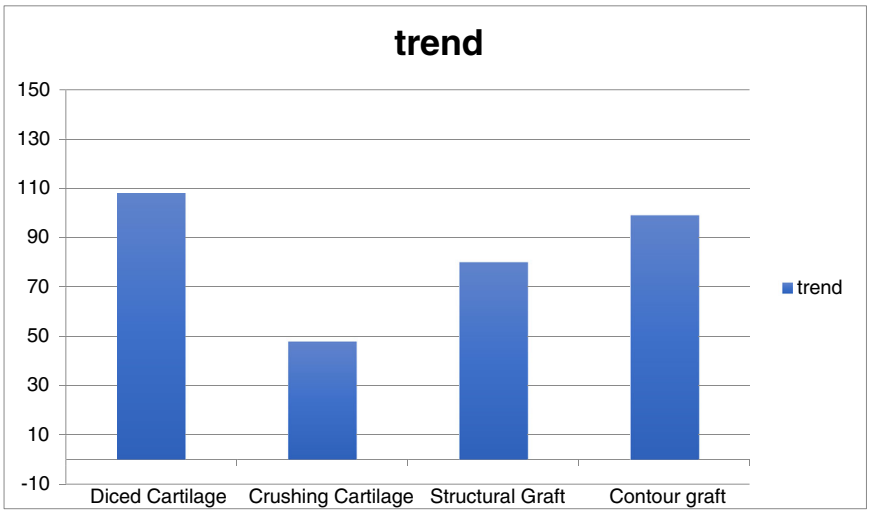

Diagram 1 Number of papers indexed in PubMed.gov on rhinoplasty grafting. Trend in nasal surgery

Diced Cartilage	108 Papers
Crushing Cartilage	48 Papers
Structural Graft	80 Papers
Contour graft	99 Papers

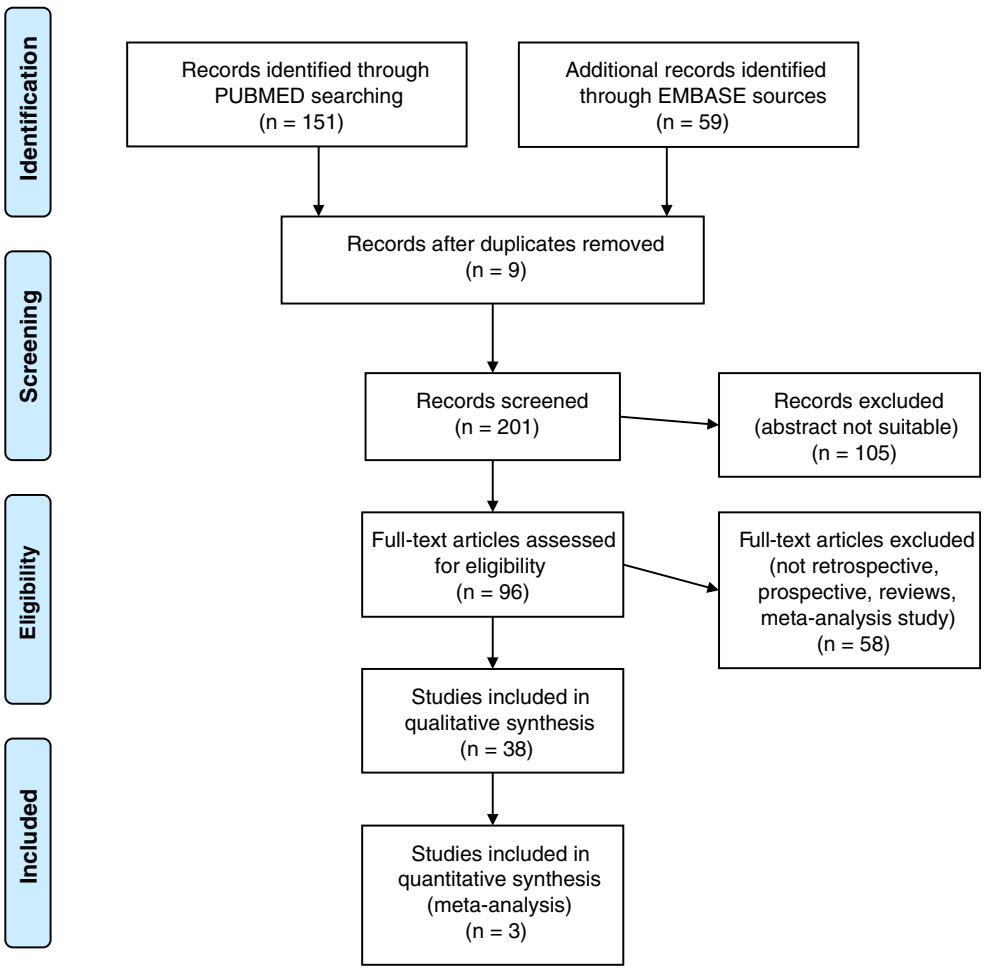

Diagram 2 Articles selected (retrospective, prospective meta-analysis) according to PRISMA 2009 Flow Diagram

In 2014, Çakır et al. [8] defined the nasal tip as a polygonal structure where each aesthetical subunit could be drawn as a polygon. The shape of the tip, according to the authors, could be schematized into a diamond. Each facet of the diamond is a tip aesthetical sub-unit and the angles in between the edges of the various polygons are the tip defining lines.

A good comprehension of the surface anatomy allows a better preoperative planning and opens the way for a better understanding about when to resect or when to modify the existing cartilages, and when to add new ones.

Then, cartilage grafting, should not be viewed as something apart from the other cartilage molding techniques, but as something that should be integrated into a comprehensive evaluation of the tip.

On this behalf, each cartilage donor site is best suitable for some elements of the nose tip and is a second choice in others.

The surgical approach to the tip can be "open" or "closed." They should not be considered as opposite one to the other but as complementary and useful in different situations [9].

In our experience, when dealing with cartilage grafting, the open-tip approach is preferred.

Gentile et al. [10] published a comprehensive review about the advantages of this approach when a graft is included in the preoperative planning. A direct visualization of anatomy in its whole allows a better decision-making process about which kind of graft suits best and which is the best way to harmonize the graft with the dome-defining sutures and the cartilage trimming.

A full anatomical view plays a fundamental role especially in secondary rhinoplasties when the nose structure is already altered by previous interventions [10].

Moreover, an open-tip approach allows the surgeon to fix the grafts in an easier and stronger way in order to maximize the contact with the recipient bed and to reduce the chance of graft resorption.

Each structure of the nasal tip has different characteristics in terms of shape, curvature, and elasticity of the cartilage.

On this behalf each cartilage donor site is best suitable for some elements of the nose tip and is a second choice for others [11].

Nasal septum, concha, and the ribs are the main sources for autografts to be used in rhinoplasty. Each of these donor sites has its own favorable and unfavorable aspects, which should be taken into account in order to harvest the best graft for our purpose and to minimize the donor site morbidity.

Septal cartilage has many positive aspects. It is easy to harvest, the donor site is already in the surgical field, requiring only a little extra effort to get it, it is versatile, and could be useful for many types of grafts, and it has a low percentage of resorption, extrusion, and warping [12]. In our center, it is used in about 40% of the cosmetic rhinoplasties [13].

The main drawbacks of this technique are mainly due to the limited amount of cartilage available. In order to maintain the stability of both the dorsum and the tip, it is important to maintain an L strut of 10 mm [14] to avoid the tip collapse. Moreover, in secondary cases, the septal cartilage is usually already taken and used or discarded during the septoplasty procedure.

Cartilage from the auricular concha can be easily harvested in local anesthesia and is usually always present. It is the first choice when it is required as a contour improving graft or when the graft does not play any structural role. Furthermore, Bottini et al. used the conchal cartilage to correct both the internal and external nasal valve collapse with satisfactory results [15].

Auricular cartilage is effective in substituting the action of lower lateral and alar cartilages as an internal or external nasal valve, because it is classified as a histological type 4 cartilage with mixed hyaline and elastic components, and its elasticity allows the graft to follow in the right way the respiratory movements [16].

The natural convexity of the auricular cartilage is the main feature that designates it as the first choice as onlay grafts to smoothen the nasal tip contour [17].

Moreover, conchal cartilage has proven its usefulness when septal cartilage is not available, like in secondary and tertiary rhinoplasties.

Pascali et al. [4] demonstrated that auricular cartilage could be carved and used also as a structural graft in revision rhinoplasties. On the other hand, the carving process could be difficult due to the fragility of this kind of cartilage [18]. Its brittle nature and its lack of rigidity are the main disadvantages of this type of cartilage.

Costal chondral grafts are usually used for structural support when septal cartilage is not available [19]. Usually, it is harvested from the fifth, sixth, or seventh rib, and it could be harvested usually simultaneously with the rhinoplasty [20]. Gentile et al. described also the 11th cartilage as an optimal donor site [21].

Costal cartilage is abundant in quantity, and it provides a strong structural support.

However, it has several disadvantages. The principal is an unpredictable warping of the cartilage [22]. It can be avoided, most of the times, by carving the cartilage equally on both the external sides, along the longitudinal axis, and using only the central core [23].

Resorption and extrusion rates are low [22]. Donor-site complications are numerous and in some cases of relevant importance, including hypertrophic chest scarring, need for revision surgery, and pneumothorax [5].

As it was previously discussed, each cartilage donor site can provide the right material for different types of graft, which could be used by the surgeon for various defects of the nasal tip, both in primary and in revision rhinoplasty. There are many different types of grafts useful in tip surgery (Table 1), but here the authors want to describe only the most used.

The presenting review divides autologous grafts into two main categories: structural grafts and contour improving grafts.

Among the structural grafts, the most important in tip surgery are the columellar strut, the septal extension graft, and the alar batten graft. On the other side, the most commonly used grafts in refining the tip shape and contour are the onlay tip graft, the shield graft, the cap graft, and the alar rim graft [24].

Columellar strut graft is usually put in place in a pocket dissected in between the medial crura, and it is anchored with sutures to them in order for them to remain stable.

The caudal part of the graft can be fixed or not to the nasal spine in order to gain more stability.

A columellar strut is usually used to increase the support to the tip and to add projection. It is also helpful in defining the columellar-lobular angle. Nasal septal cartilage is usually preferred, but it can be substituted by costal cartilage when lacking.

The septal extension grafts are usually classified into three different types. The type I is a dorsal spreader involving also the interdomal space, going further the anterior septal angle. The type II is two paired batten grafts positioned in the tip-lobule complex and crossing diagonally the caudal-dorsal junction of the two legs of the septal L strut. The type III is directly sutured to the anterior septal angle extending the septum. Cartilage from the septum is the first choice for this kind of graft. However, both rib and auricular cartilage can be exploited as acceptable substitutes.

Table 1 Graft types in nasal tip surgery (adapted from Gunter et al. [24])

Tip	Alar region
Anchor graft	Alar batten graft
Cap graft	Alar contour graft (alar rim graft)
Columellar strut (floating/fixed- floating)	Alar spreader graft (lateral crural spanning graft)
Columellar strut (fixed)	Composite alar rim graft
Extended columellar strut-tip graft (extended shield graft)	Lateral crural onlay graft
Onlay tip graft	Lateral crural strut graft
Shield graft (sheen or infralobular graft)	Lateral crural turnover graft
Sub-domal graft	
Umbrella graft	

Septal extension grafts are particularly useful in stabilizing the caudal septum minimizing tip rotation and adding projection and support to the tip [25].

Alar batten grafts play mainly a functional role. They are usually not visible and are used to repair the collapse of the internal nasal valve during inspiration. This is usually due to an overaggressive trimming of the lateral crura [16]. They can be put in place through an endonasal approach or sutured to the lateral crura when using an open-nose technique. The conchal auricular cartilage fits perfectly for this type of graft.

Only tip graft [26] is usually a place to hide tip irregularities, while its usefulness in improving tip projection is minimal. It is sutured in a transverse fashion over the alar domes. Beveling of the edges is required in order to smoothen the transition between the graft and the domal cartilages. Auricular cartilage is the golden standard.

Shield graft [27] is shield shaped and it is put in place by suturing it to the cephalic part of the medial crura advancing cranially into the tip. The more it is cranially extended, the more it increases the tip projection. Furthermore, it provides better infratip-lobule contour and tip definition. Morselization or beveling of the graft edges is always necessary to reduce graft visibility.

The cap graft [28] is a small graft placed in the interdomal space in order to fill in the clefts that could be visible in the tip of thin-skinned patients. It is also useful in refining and softening the tip. Usually, it does not need a big amount of cartilage. Then, almost every remnant from trimming could be used as cap graft.

Alar rim grafts [29] could be made only by cartilage or they can be harvested as composite grafts [30]. They can be used to strengthen the alar cartilages, thus preventing their retraction or collapse. Otherwise, they are used to correct alar notching and retraction in secondary cases. They can be positioned both with a closed and an open approach. Usually, conchal cartilage is the first choice as a donor source.

The hardest part is a careful remodeling of the cartilage grafts, especially in the noses with thinner soft tissues, where

Table 2 Grafting evolution in nasal surgery

Grafts, procedures, and surgeons	Year
Septal and auricular cartilage (*Nasenplastik und sonstige Gesichtsplastik*) described by Joseph	1931
Diced cartilage grafts in reconstructive surgery (not for rhinoplasty) described by Peer	1943
Diced cartilage grafts in rhinoplasty reported by Denecke HJ	1967
Columellar batten proposed by Goldman	1953
Endonasal incisions	Until the 1970s
Columellar strut and spreader graft described by Baum	1977
Onlay graft described by Peck	1983
Crushing cartilage proposed by Schultz-Coulon HJ	1983
Shield and spreader grafts proposed by Sheen	1984
"Turkish delight procedure" diced cartilage wrapped in Surgicel proposed by Erol	2000

the edges of the grafts cannot be camouflaged. So, it would be possible to obtain a good result using a more malleable crushed, or diced cartilage in larger pieces [31], or in smaller (less than 0.2 mm) [32] wrapped or not in fascia, or Surgicel, or acellular matrix. Correction of these irregularities using common graft materials are sometimes challenging.

Crushed cartilage, minced cartilage, and diced cartilage with or without wrapping in fascia are the most popular examples [33].

Cartilage blocks will usually result in visible and palpable edges if placed as onlay grafts (especially in thin skin patients). Crushed cartilage will have an unpredictable course of resorption considering the extent of crushing and fascia or other autologous soft tissue materials need a separate location of harvesting [33].

The use of diced cartilage grafts in reconstructive surgery was described by Peer many years ago [34] though it was not for rhinoplasty. A number of studies describing diced cartilage have followed since then, but the technique has never achieved widespread use. In recent years, however, an interest in using diced cartilage for augmentation rhinoplasty has resurfaced. Described diced cartilage not only in larger pieces [31] but also in smaller pieces (less than 0.2 mm) [32] wrapped or not in fascia, or Surgicel (oxidized cellulose polymer), or acellular dermal matrix to obtain a smooth consistency. Sometimes to aggregate the diced cartilage used fibrine glue or patient's own blood. But to implant them, it is necessary to incise and dissect the soft nose tissues as classic rhinoplasty.

The use of diced cartilage rather than a solid piece of cartilage attracts surgeons because of its greater flexibility and minimal risk of warping, and it obviates the requirement of single large graft. A critical issue for biomaterials is absorption or extrusion and the same has been presented as a concern in diced cartilage rhinoplasty [35]. Histology of the diced cartilage graft demonstrated the viability and stability of the graft 41/2 years after insertion [36].

To overcome the disadvantages of its potential reported problems like palpability and visibility of diced grafts, surgeons have described the use of autogenous, synthetic, or alloplastic wraps to camouflage the cartilage construct. A great deal of controversy exists about the techniques that have been advocated, and the scaffold for delivering diced cartilage has yet to be determined.

Besides, dicing or mincing the cartilage into desired small pieces that can pass from an injecting cannula using conventional blades is difficult and sometimes impossible. There are studies in the literature using an otologic burr or other powered devices to mince the cartilage into injectable pieces, but the degree of damage to chondrocytes in the histologic evaluation may not support the possibility of long-term survival [37] (Table 2).

Conclusions

Cartilage grafts are a versatile and pivotal technique in rhinoplasty. They are characterized by numerous possibilities regarding the donor site, and a broad spectrum of graft types is described in the international literature.

The surgeon should put an effort in a precise preoperative evaluation of the patient in order to choose if to use a graft or not and to find out which graft type can fit the case at its best.

In nasal tip surgery, particularly, cartilage grafts play an important role in conveying structural support to the tip, and smoothing and hiding irregularities. Therefore, it should be known and mastered in order to obtain a natural and desirable result.

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Compliance with ethical standards

Conflict of interest Gentile P, Storti G, De Angelis B, Albano A, and Cervelli V declare that they have no conflict of interest.

Ethical approval All procedures performed in studies 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. For this type of article formal consent from a local ethics committee is not required.

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