Autogenous Dorsal Reconstruction: Maximizing the Utility of Diced Cartilage and Fascia

Jay Calvert, M.D., F.A.C.S.,^{1,2} and Kevin Brenner, M.D.²

ABSTRACT

The problem of reconstructing the dorsum of the nose is complex and a source of frustration for both patients and surgeons. Dorsal deficiencies due to various etiologies and the need for dorsal contouring cause the plastic surgeon to look to time-honored techniques such as osseocartilaginous rib grafts while also searching for other options that may be less technically challenging and have the benefit of temporal success. Diced cartilage wrapped with deep temporal fascia is just such a method to achieve reliable dorsal reconstructions. The various ways to use diced cartilage and deep temporal fascia are discussed.

KEYWORDS: Dorsum, radix, cartilage grafts, diced cartilage, fascia

Dorsal nasal reconstruction continues to present one of the greatest challenges in rhinoplasty surgery. As with all aspects of medicine and surgery, favorable treatment outcomes mandate a correct diagnosis beforehand. Although seemingly pedestrian, proper preoperative diagnoses are frequently overlooked by the operating surgeon. Improper diagnoses beget improper treatments with unfavorable results. This generates an unhappy patient and an even unhappier surgeon; both wondering where it all went wrong.

Prior to choosing a method for dorsal reconstruction, the surgeon should focus in on a thorough history, paying specific attention to trauma, nasal allergies, airway obstruction, and previous nasal and craniomaxillofacial surgery. Equally essential is a complete head and neck examination. This includes a speculum examination of the internal anatomy of the nose. Important structures that are frequently overlooked include the palate, the nasal sidewall, the turbinates, and the dynamic function

of the nasal valves. Inspection of the support structures of the nose helps delineate their individual relation to the dorsum. Evaluation of the skin is also paramount to understanding how grafts will or will not show over the long-term. Proper forethought will help the surgeon to forecast the effect that altering the septum and nasal bones can have on the overall nasal shape and function.

The difficulties with dorsal reconstruction seem to stem from attempting to correct multiple problems with a single graft. Traditionally, osseocartilaginous rib grafts using a variety of fixation methods have been the gold standard for major dorsal reconstruction. Cantilevered bone grafts, another common method for dorsal reconstruction, produce excellent results when well executed. However, we have found these methods to be technically challenging and temporally disappointing. Intraoperative and 6-month postoperative results are frequently acceptable. However, graft warping and twisting over time seem to be the rule rather than the

¹Veterans Affairs Hospital Long Beach, Long Beach, California;

²The Roxbury Clinic and Surgery Center, Beverly Hills, California.

Address for correspondence and reprint requests: Jay Calvert, M.D., F.A.C.S., Veterans Affairs Hospital Long Beach, 5901 E. 7th Street, Long Beach, CA 90822.

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D.D.S., and Joseph M. Gryskiewicz, M.D., F.A.C.S.

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exception. Thus, the concept of performing different grafts for different purposes has become an easier way to obtain optimal results that last over time. Separation of the cosmetic features from the support aspects of the reconstruction can, and should, be performed by using separate grafts for each purpose. It is with this fact in mind that the technique of using diced cartilage wrapped with fascia has become an integral part of the authors' practices. Described in this article are several techniques designed to simplify complex dorsal reconstructions that, if understood accurately and applied with a systematic approach, will serve secondary rhinoplasty surgeons well.

ORIGIN OF THE TECHNIQUE OF USING DICED CARTILAGE WITH FASCIA

Plastic surgeons have primarily used autogenous cartilage grafting for reconstructing nasal deformities since its inception by König in 1896 and subsequent application by Goodale in 1901.¹ Whole, crushed, and diced cartilage grafts have been used and studied by various authors, but the long-term survival of diced cartilage grafts and long-term results of these procedures have not been well documented.²⁻²² Young was the first to establish the viability of diced cartilage grafts.² In 1944, their clinical utility was demonstrated by Peer when he introduced the technique of diced cartilage (DC) grafting in total ear reconstruction.^{3,4} He was struck by the ability of the diced cartilage pieces to be molded into the shape of an ear and found that the pieces would fuse together into a self-containing conglomerate. Wilflingseder corroborated these findings in 1983 and showed that a majority of cases achieved solid fusion of the diced cartilage mass with connective tissue filling in the interstices.⁵ It was noted that some cartilage absorption did occur in cases when not covered with perichondrium. However, it was Erol's modification of diced cartilage grafting for dorsal nasal augmentation in 2000 that has recently popularized its use.⁶ Erol's "Turkish delight" technique uses autogenous cartilage that is finely diced into 0.5- to 1.0-mm cubes, bathed in 1 mL of blood, and then wrapped with Surgicel (Ethicon, Somerville, NJ), a resorbable oxidized regenerated cellulose product frequently used as an intraoperative hemostatic adjunct. The entire graft is then soaked in an antibiotic solution. The rationale for this technique stems from the ability to create a moldable cartilage graft that can create better continuity and decreased visibility under the dorsal skin envelope. In 2004, Daniel and Calvert noted a series of clinical failures using similar Surgicel-wrapped diced cartilage grafts.⁷ The hypothesis for these failures was that Surgicel incited a foreign body reaction, ultimately leading to graft inflammation and subsequent cartilage absorption. They then showed how these failures were successfully corrected using diced cartilage grafts wrapped with deep temporal fascia.

These diced cartilage–fascia grafts have shown excellent long-term clinical survival. In 2005, Cakmak et al, using a rabbit model, showed that Surgicel-wrapped diced cartilage grafts displayed massive destruction of the chondroid matrix and extensive loss of cartilage viability.⁸ Then in 2006, Calvert et al analyzed the histology of both Surgicel-wrapped diced cartilage and fascia-wrapped diced cartilage grafts and showed the histologic superiority of autologous human fascia-wrapped diced cartilage grafts in the nasal dorsum.⁹ These findings were simultaneously and experimentally corroborated by Brenner et al, who showed that the viability of human cartilage grafts wrapped with fascia was significantly better than those wrapped with Surgicel.¹⁰

INDICATIONS FOR THE TECHNIQUE OF DICED CARTILAGE WRAPPED IN FASCIA

Dorsal reconstruction frequently requires some type of grafting to augment the upper and/or middle vault. The indications for grafting the dorsum with diced cartilage with fascia (DC-F) include a need for volume that itself provides no structural support. Though the DC-F grafts will become firm over time, they do not have the inherent strength to support other structures. The DC-F graft alone is versatile and can be used to increase volume, raise the radix, raise the entire dorsum, and camouflage the osseocartilaginous junction between the nasal bones and the middle vault. In conjunction with other distinct septal support/replacement grafts, DC-F works beautifully to create an aesthetically pleasing dorsal line (i.e., for reconstruction of a saddle nose patient).

The technique of using DC-F has been used to approach several different problems in dorsal reconstruction. As a result, many technical variations for graft creation and dorsal placement have been used. Each individual method has merit and can therefore be used to ameliorate a myriad of difficult problems. The following options are discussed to help demonstrate the technique's versatility.

TECHNIQUES

Diced Cartilage Grafts Wrapped in Fascia

The genesis of the current technique of using diced cartilage grafts wrapped with fascia clearly lies with Daniel who used it initially to correct Surgicel-wrapped surgical failures.^{7,17} The technique that has evolved began with the following basic maneuvers: (1) All harvested grafts are kept in dilute bacitracin antibiotic solution. (2) The cartilage is diced into 0.5- to 1-mm cubes (no blood is used) on the back table and packed into a hub-less 1-cc tuberculin syringe for easy handling. (3) The syringe is then wrapped in a rectangular piece of deep temporal fascia and secured along the cephalic edge

and side with a 4-0 plain gut suture. (4) An additional leading gut suture is sewn to the cephalic edge of the graft and used to seat the graft at the radix break point. (5) After placement into the dorsal pocket, the syringe is carefully removed through the access incision while simultaneously evacuating the cartilage contents into the fascia envelope with the syringe plunger. (6) The cephalic suture is then secured to the glabella with Steri-Strips (3M, St. Paul, MN) and the graft is molded to shape. The distal end of the graft frequently extends to the supratip area and can also be closed with a plain gut suture if needed.

HARVESTING THE DEEP TEMPORAL FASCIA

The method of harvesting the deep temporal fascia has evolved to become simple and expedient. The incision to expose the deep temporal fascia may be placed anywhere over the temporalis muscle. The most common position for placement is approximately 2 cm behind the anterior hairline, with the caudal edge starting 1 cm above the root of the helix. A curved incision is used to help prevent a straight-line contracture. No hair is trimmed nor shaved but may be temporarily stapled down to avoid interference with the harvest procedure. Lidocaine 1% with epinephrine is injected 10 minutes prior to incision to allow a hemostasis effect. The incision is made taking great care not to cut across the follicles. Dissection is taken down to the deep temporal fascia with sharp dissection. There are usually several veins that need to be cauterized during entry. The plane between the deep temporal fascia and the superficial temporal fascia is a bloodless plane and is opened with a sweeping motion using a scissor or Freer elevator (Fig. 1).

The deep temporal fascia is then marked to the appropriate graft size needed. An incision is then made with a no. 15 blade to just below the deep temporal fascia. It is useful to have a Ragnell retractor that can slip under the deep temporal fascia and elevate it up off the muscle. The bulk of the deep temporal fascia can be harvested without difficulty, and care must be taken to

Figure 1 Exposure of the deep temporal fascia.

Figure 2 Deep temporal fascia.

control bleeding (Fig. 2). The fascia is then set aside in gauze moistened with saline solution. Closure of the incision is performed with a single layer of staples in the scalp. The staples are generally removed after 7 days. Complications from this harvest are infrequent but could potentially include hematoma, sensory changes of the skin overlying the harvest site, pain, alopecia, visible scarring, and soft tissue deficits that may be palpable.

DICING THE CARTILAGE

Any type of cartilage (i.e., septal, conchal, or costal) may be diced and used for this technique. Typically, the cartilage is diced into 0.5-mm cubes on the back table using two fresh no. 11 blades. The cartilage is diced on a Sheen grid or other flat surface that allows for easy measurement of the size of the pieces. The finely diced cartilage can then be packed into a syringe for storage in saline containing bacitracin or similar antibiotic (Fig. 3). The syringe can then be wrapped in fascia or used in a manner described below.

Figure 3 Deep temporal fascia and diced cartilage.

Closed Graft ("Implant Method")

This approach allows dorsal graft creation by placing diced cartilage on harvested deep temporal fascia in a manner that resembles filling a crepe. When orienting the fascia, it may be beneficial to place the native deep (muscle facing) side of the deep temporal fascia outward, to allow integration with the soft tissue of the nose. The native superficial side of the deep temporal fascia inherently has a gliding surface and could potentially facilitate graft slippage. The fascia is then folded over the cartilage and closed with a 4-0 plain gut suture (Fig. 4). This closed graft can then be placed on the dorsum much like a silicone implant. Fixation occurs with the leading percutaneous stitch taped to the glabella; additional fixation at the supratip can be done if necessary. Typically, this method is used when there is a defined pocket for the graft.

The Dorsal Tent

This variation of the DC-F graft is used when the deep temporal fascia alone is first brought into position under the dorsal nasal skin. Here, two separate plain gut sutures are placed at both corners of the most cranial aspect of the fascia. One stitch is placed through the right aspect of the radix; the other is placed through the left side. This puts the fascia in position just deep to soft tissue of the nose as a liner graft. Diced cartilage is then placed in the space deep to the fascia such that the fascia is simply draped over the diced cartilage. This variation is useful as a camouflage technique and is used commonly when the level of augmentation required is only 1 to 2 mm. A theoretical advantage of having only the superficial surface covered with fascia is reduced slippage of the graft on its deep surface.

Suturing the Caudal Graft Edge to the Septal Angle to Create More Supratip Break

After placing the DC-F graft in position, the distal aspect of the fascia may be sutured to the septal angle to limit the distal extension of the graft. Doing so helps to create a more defined supratip break, confines the graft to a limited area of need, and secures the graft ensuring that it does not move about the dorsum.

No matter the variation of DC-F graft used, the surgeon should attempt to achieve the ideal shape on the table at the time of surgery. Cartilage absorption is not an issue with these grafts, so overcorrection is not needed. Postoperatively, the graft is malleable for 10 to 14 days. The patient is instructed not to wear glasses for 6 weeks. In contrast with the diced cartilage grafts wrapped in Surgicel, the diced cartilage grafts wrapped in fascia remain distinctly palpable postoperatively. As an example, DC-F grafts that have been placed in Asian patients feel very similar to a silicone implant. The major difference, however, is that they tend to be more adherent to the

Figure 4 Diced cartilage and fascia as closed graft.

underlying structures. Thus far in the authors' practices, there has been no indication of absorption, clinically or histologically, with diced cartilage grafts wrapped in fascia.

Diced Cartilage Alone

Diced cartilage can be placed in the nose without any wrapping material. The basic technique is to fill a 1-mm syringe with the diced cartilage. The plunger is then inserted to compact the cartilage as much as possible. The hub of the syringe is then cut off with a no. 10 blade. This "chondro-jet" facilitates direct placement of the cartilage along the side of rib grafts, in the radix region, or along the pyriform aperture. Diced cartilage grafts have dramatically improved the quality of our rib grafts, facilitating graft blending into the lateral walls without visibility. However, diced cartilage grafts have three potential problems: aberrant dispersion, palpability, and visibility. Additionally, absorption is likewise a theoretical concern. Creating a tight recipient dorsal pocket or, alternatively, placing the grafts in a fascia container can control dispersion. Visibility can occur under extremely thin skin, so proper patient selection is critical.

Composite Dorsal Reconstruction

Composite dorsal reconstruction is a concept that developed around the idea of separation of the structural components of the nasal vault from the aesthetic dorsal lines. The concept is simple: First, restore the structural foundation with costro-chondral, costro-osteo, or costro-osteo-chondral grafts. Restoration of the integrity of the upper, middle, and lower vaults is frequently contingent upon the creation of a stable foundation. Further, using hearty rib grafts can be essential, particularly when a thick and/or cicatricial skin envelope is threatening to squelch your newly designed framework. Second, create the desired aesthetic lines using any combination of whole and or diced cartilage grafts. As demonstrated by Daniel and Calvert, diced cartilage,

both with and without a layer of deep temporal fascia, behave beautifully in the subcutaneous space.⁷ They contribute significantly to the elegant aesthetic lines that define a natural appearing nose.

Complications

The complications of using this technique are predictable and correctable. Because the cartilage is mobile for 10 to 14 days after placement, there can be defects that arise from poor management of the graft postoperatively. Edges are usually not visible, but they can be in a particularly thin-skinned patient. Overcorrection and undercorrection are probably the most common complications seen with this technique and must be managed accordingly. Malposition of the graft and mobility of the graft may also be seen in a rare number of cases. Absorption of the graft has not been seen in the longest of follow-ups (6 years).

CASES

Case 1

The first patient was a 44-year-old man who reportedly was dropped on his face at 1 year of age. He

never developed a dorsum and photos of him as a child show this defect to be present at the earliest ages. His presenting complaint consisted of a flattened dorsum with a wide alar base and poorly projected tip. He suffered from significant left-sided nasal stenosis, which greatly impaired his nasal breathing. Computed tomography scan analysis revealed an intact nasal spine, which effectively ruled out Binder's syndrome. He desired dorsal reconstruction and tip reshaping.

Analysis of the defect showed that there was little or no dorsal projection from the radix to the supratip region. He also had poor tip projection. The alar base was wide, and the nostrils were very large. In this case, the goal was to create a stable and cosmetically pleasing dorsum and to blend the dorsum with the tip while simultaneously projecting the tip in a balanced manner.

The solution: stacked split rib grafts with cartilaginous L-strut for septal reconstruction with DC-F. A separate columellar strut was placed to project the tip with tip suturing technique. The stacked split rib grafts were designed to project the radix so the L-strut could be placed in a stable position. This allowed for a stable reconstruction that has been maintained for more than 4 years. The DC-F created the aesthetic shape that

Figure 5 Case 1 Anterior posterior view preoperatively and postoperatively.

Figure 6 Case 1: Left lateral view preoperatively and postoperatively.

blended the glabella to the radix and the middle vault with the supratip (Figs. 5–7).

Case 2

This is a 36-year-old man with history of multiple operations that began with a reduction rhinoplasty at

Figure 7 Case 1: Base view preoperatively and postoperatively.

age 19. He subsequently underwent four major operations and several minor procedures in an effort to achieve the result he desired but ultimately was left with the result pictured here. The dorsum was over-resected; the tip was elevated and somewhat overdefined. The nasal bones were evident with the classic “inverted V” deformity. He desired dorsal reconstruction with the creation of a more natural nose. He had significant vestibular stenosis with constant airway obstruction and drainage. The stipulation was that the patient was a bodybuilder and wanted the operation performed

Figure 8 Case 2: Anterior posterior view preoperatively and postoperatively.

Figure 9 Case 2: Left lateral view preoperatively and postoperatively.

without the use of autologous rib. He had had a minor ear cartilage harvest with one of his previous procedures but otherwise had significant ear cartilage to complete the reconstruction.

Solution: dorsal reconstruction with diced cartilage and fascia and tip reconstruction with lateral crural grafts, and a columellar strut. Osteotomies were performed to mobilize the nasal bones laterally.

Figure 10 Case 2: Base view preoperatively and postoperatively.

Figure 11 Case 3: Anterior posterior view preoperatively and postoperatively.

Spreader grafts were placed to reconstruct the internal valves. A dorsal graft was also placed that was composed of DC-F. The previous cartilage grafts were removed leaving the medial crura to be sutured to the columellar strut. The result has been stable for 3 years, although the limitation of the size of the dorsal graft was immediately evident based on the volume of cartilage obtainable from the ears. The patient has

been accepting of this fact and very satisfied with his result (Figs. 8–10).

Case 3

The patient is a 22-year-old woman with no significant history other than she desired a more cosmetically pleasing nose. Her dorsum was the focus of her complaints; the “hump” bothered her most specifically. She requested a more aesthetically pleasing nose without the hump and without looking “scooped out.” She brought many photo examples of classically over-reduced dorsums (with low radices and stylized tips) that she clearly was not interested in for herself. Examination of her nose revealed a fairly deep radix with skin stretched tightly over the radix such that it camouflaged the truly low preoperative bone position. The concern was that once the “hump” was removed, the patient might have an overly reduced dorsum with a low radix take-off and a stylized nose.

Answer: closed rhinoplasty with dorsal reduction and DC-F as a radix graft. This patient required a dorsal reduction to lower the cartilaginous vault and nasal bones, but she also needed the radix filled to create the

Figure 12 Case 3: Left lateral view preoperatively and postoperatively.

Figure 13 Case 3: Base view preoperatively and postoperatively.

proper dorsal line. Her desire to have a nonstylized nose was the challenge in this case as her nasal bones were already low at the level of the radix. Spreader grafts were performed in addition to maintain her airway (Figs. 11–13).

CONCLUSION

In conclusion, the technique of DC-F has been a useful method of dorsal reconstruction as a standalone technique and in concert with other methods of building the dorsum. There are many permutations and surgical variations of the technique. The authors believe that proper preoperative analysis will help the surgeon to derive clear indications so that the correct graft variation is used with a clear purpose. There is no substitute for preoperative diagnosis and planning when using the DC-F graft. The technique is safe, easy to perform, has minimal morbidity, and is our favored method for addressing difficult problems in dorsal reconstruction.

REFERENCES

- Goodale JL. A case of nasal deformity from a median furrow corrected by subcutaneous implantation of the septal cartilage. *Boston Med Surg J* 1901;145:93
- Young F. Autogenous cartilage grafts. *Surgery* 1941;10:7
- Peer LA. Diced cartilage grafts. *Arch Otolaryngol* 1943;38:156–165
- Peer LA. Reconstruction of the auricle with diced cartilage grafts in a Vitallium ear mold. *Plast Reconstr Surg* 1948;3:653–666
- Wilfingseder P. Cranioplasties by means of diced cartilage and split rib grafts. *Minerva Chir* 1983;38:837–843
- Erol O. The Turkish delight: a pliable graft for rhinoplasty. *Plast Reconstr Surg* 2000;105:2229–2241
- Daniel RK, Calvert JW. Diced cartilage grafts in rhinoplasty surgery. *Plast Reconstr Surg* 2004;113:2156–2171
- Cakmak O, Bircan S, Buyuklu F, Tuncer I, Dal T, Ozluoglu LN. Viability of crushed and diced cartilage grafts: a study in rabbits. *Arch Facial Plast Surg* 2005;7:21–26
- Calvert JW, Brenner K, DaCosta-Iyer M, Evans GR, Daniel RK. Histological analysis of human diced cartilage grafts. *Plast Reconstr Surg* 2006;118:230–236
- Brenner KA, McConnell MP, Evans GR, Calvert JW. Survival of diced cartilage: an experimental study. *Plast Reconstr Surg* 2006;117:105–115
- Kelly MH, Bulstrode NW, Waterhouse N. Versatility of diced cartilage-fascia grafts in dorsal nasal augmentation. *Plast Reconstr Surg* 2007;120:1654–1659
- Velidedeoglu H, Demir Z, Sahin U, et al. Discussion of block and Surgicel-wrapped diced solvent-preserved costal cartilage homograft application for nasal augmentation. *Plast Reconstr Surg* 2005;115:2081–2093; discussion 2094–2097
- Yilmaz S, Ercococen AR, Can Z, et al. Viability of diced crushed cartilage grafts and the effects of Surgicel (oxidized regenerated cellulose) on cartilage grafts. *Plast Reconstr Surg* 2001;108:1054–1060; discussion 1061–1062
- Ertas NM, Hucumenoglu S, Besalti O, et al. The effects of oxidized regenerated cellulose on diced cartilage xenografts: an experimental study. *Ann Plast Surg* 2000;45:224–225
- Cardenas-Camarena L, Guerrero MT. Use of cartilaginous autografts in nasal surgery: 8 years of experience. *Plast Reconstr Surg* 1999;103:1003–1014
- Ortiz-Monasterio F, Olmedo A, Osoy LO. The use of cartilage grafts in primary aesthetic rhinoplasty. *Plast Reconstr Surg* 1981;67:597–605
- Daniel RK. *Rhinoplasty: An Atlas of Surgical Techniques*. New York, NY: Springer; 2002
- Gunter JP, Rohrich RJ. Augmentation rhinoplasty: dorsal onlay grafting using shaped autogenous septal cartilage. *Plast Reconstr Surg* 1990;86:39–45

19. Guerrerosantos J. Temporoparietal free fascia grafts in rhinoplasty. *Plast Reconstr Surg* 1984;74:465-475
20. Elahi MM, Jackson IT, Moreira-Gonzalez A, Yamini D. Nasal augmentation with Surgicel-wrapped diced cartilage: a review of 67 consecutive cases. *Plast Reconstr Surg* 2003; 111:1309-1318; discussion 1319-1321
21. Sheen JH. The ideal dorsal graft: a continuing quest. *Plast Reconstr Surg* 1998;102:2490-2493
22. Miller TA. Temporalis fascial grafts. *Plast Reconstr Surg* 1980; 65:236-237