In recent years, there has been a trend toward nasal skeleton reshaping, instead of reduction and excision. Jacques Joseph (1865-1934) performed his first cosmetic rhinoplasty on May 11, 1898. The reduction and excision approach, initiated at the beginning of the 20th century, was used as the standard technique for rhinoplasty for more than 60 years. Use of the spreader graft, tip graft, and radix augmentation was suggested by Jack Sheen and Mark Constantian. The development of open-approach rhinoplasty with demand for a strong columella and alar strut was recommended by Gunter and Friedman. The vascularization and significant growth in weight of the perichondrially attached diced cartilage samples are evidence of the viability of this material. The structural integrity and solid framework afforded by this option suggest that the material should be used more frequently in nasoskeletal augmentation.

**Abstract**

**Background:** Diced cartilage is a valuable material that has recently been added to the graft options in rhinoplasty. Shaping, fixation, and resorption are the main concerns with this material. Perichondrially attached diced conchal cartilage may be a new possibility to solve some of these problems.

**Objectives:** The authors evaluate the outcome of perichondrially attached diced cartilage in a rabbit model and compare the results with injectable cartilage grafting.

**Methods:** Ear cartilage was removed from 1 auricle in each of the 16 rabbits included in this study; samples were divided in 2 pieces. After precise weighing, both segments were diced. The perichondrium was left attached to 1 of the pieces. Both segments were inserted in 2 separate pockets in the dorsum of the animal. After a 3-month period, both samples were removed and measured for growth/resorption.

**Results:** At the beginning of this study, the difference in weight between groups was statistically insignificant (P = .213), but 3 months after insertion, significant growth was observed in the perichondrial group (P = .019).

**Conclusions:** The vascularization and significant growth in weight of the perichondrially attached diced cartilage samples are evidence of the viability of this material. The structural integrity and solid framework afforded by this option suggest that the material should be used more frequently in nasoskeletal augmentation.

**Keywords**

rhinoplasty, diced cartilage, perichondrial attachment, nasal reconstruction

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limited due to either previous resections or the danger of dorsum collapse posed by overresection. This is why rhinoplasty surgeons are always looking for alternative sources, such as alloplastic material or heterotopic autologous cartilage from the concha or rib. Alloplastic material has a high chance of extrusion. The concha is composed of delicate elastic and convoluted cartilage, so it will not provide the optimal shape and support. Rib cartilage blocks have problems related to warping and visibility, and some surgeons may hesitate to use this valuable resource.

In this report, we discuss diced cartilage as a solution to solve some of these problems. Of note, there are certain disadvantages to wrapping diced cartilage with Surgicel (Ethicon, Inc, Somerville, New Jersey) or fascia: resorption and the need for another incision to harvest fascia, respectively. Free diced cartilage, although promising as a useful tool in the hands of the experienced rhinoplasty surgeon, involves issues related to the scattering of small cartilage pieces in the larger pocket and the difficulty of sculpting the material and then maintaining the desired shape. The ideal diced cartilage graft is one in which the small pieces are attached together with some connective tissue. This allows the material to be molded and provides the option of suturing and fixing it to the desired position. The conchal cartilage has a distinct perichondrium, which is resistant to the sharp edge of the dicing blade and keeps these small pieces together without tearing or the loss of structural integrity. This combination of perichondrium and diced cartilage gives the surgeon the ability to shape the graft on the bench by rolling it on itself, which “sutures” the cartilage pieces by fashioning a tube or by placing the graft as a lining under the thin skin of the nose to cover the underlying irregularities. In this article, we investigate the characteristics, viability, and longevity of this new tool in a rabbit model.

**METHODS**

Sixteen white male New Zealand rabbits 12 to 14 weeks of age and weighing 1500 to 2000 g were selected for this study. Under general anesthesia induced by an intramuscular injection of ketamine 50 mg/kg and xylazine 5 mg/kg, 1 auricle from each rabbit was amputated by a veterinary surgeon and divided into 2 pieces longitudinally (Figure 1A-C). One piece (half of 1 ear cartilage) was denuded of all soft tissues; the perichondrium was preserved on the other half, so the small pieces were kept attached together as a single sheet. Both samples were weighed accurately (Figure 3A,B). One of the 2 pieces became the control and the other was diced into 0.5-mm pieces (Figure 1D).

Two 1-cm transverse incisions were made on either side of the spinal column of each rabbit. A sample of pure diced cartilage was injected in the subcutaneous pocket on 1 side through a 1-mL tuberculin syringe. The diced cartilage attached to the perichondrium was fashioned into a tube shape and inserted in a subcutaneous pocket on the opposite side of the vertebral column (Figure 2A,B). During the operation, 0.1 mg/kg atropine was administered subcutaneously to all rabbits. A co-amoxiclav suspension was administered in the rabbits’ drinking water for 3 days postoperatively as a prophylactic antibiotic. Animals were preserved in their cages for 3 months. Two rabbits died during this period and were excluded from the study. The animals were kept in their standard cages at 22 to 24°C with 12 intermittent hours of light and darkness. They had free access to water and food. After 3 months, all animals were sacrificed by means of an intraperitoneal injection of a high dose of sodium thiopental. Through generous longitudinal incisions on both sides of the spinal column, both samples were positioned under direct visualization. Two samples were integrated as a clump (which made complete removal easier from the recipient bed) and weighed accurately (Figure 3A,B). The pre- and postoperative weights of the specimens were compared. A paired *t* test was used for the pre- and postoperative comparison of results. To compare the end result between groups, an independent *t* test was applied.

The authors used the same technique described here in a patient study. Although no data from that trial are presented in this report, the results 6 months after harvesting, dicing, and placement of the graft in 1 case is shown in Figures 4 through 6 and in a video, which can be seen at www.aestheticsurgeryjournal.com. You may also scan the code on the first page of this article to be taken directly to the video on www.YouTube.com.

**RESULTS**

At the beginning of the study, the mean weight of the pure-diced group was 0.63 ± 0.18 g. The mean weight in the attached perichondrium group was 0.71 ± 0.14 g (Table 1). This difference is most likely due to the weight of the attached perichondrium, although it should be mentioned that during the dicing, weighing, and transferring procedures, some tiny pieces of cartilage may have been lost, which may have added bias to the result. Three months after the cartilage was inserted, the mean weight changed to 0.60 ± 0.13 g in the pure-diced group and to 0.75 ± 0.18 g in the group with perichondrium (Figure 7). A paired *t* test was applied to analyze the results. Before insertion of the cartilage, the difference in weight between the groups was statistically insignificant (*P* = .213). Postoperatively (3 months later), this difference became significant (*P* = .019).
Figure 1. (A) Rabbit ear amputated and divided in 2 equal segments. (B) Perichondrium preserved in half of the ear cartilage. (C) Two pieces were divided, with saved perichondrium on 1 side. (D) Two segments after dicing.

Figure 2. Insertion of diced and perichondrial-attached diced cartilage into the pockets on each side of vertebral column of a rabbit specimen. (A) Perichondrial group, and (B) diced group.
Figure 3. Specimens were removed after 90 days and weighed. Cartilage grafts in both groups were transformed into solid masses. (A) Perichondrial group, and (B) diced group.

Figure 4. The same harvesting technique is shown in a human case. (A) Exposure of the conchal cartilage with its attached perichondrium. (B) The harvested concha is shown with its attached perichondrium. (C) Segment A was used for dorsal augmentation and segment B as a tip graft.
A review of the MEDLINE database revealed that the first published paper on dicing autogenous cartilage was published more than 64 years ago, although Daniel reported on its application in rhinoplasty approximately 70 years ago. Erol popularized this technique by wrapping diced cartilage in Surgicel in 2000. Further investigation proved that this material may produce foreign body reactions, which reduce graft viability and resorption. In contrast, bare cartilage is not resorbed and may proliferate significantly.

The next step in this technique was the application of temporal fascia. The pieces of diced cartilage integrated into a single cartilage mass, but there were shortcomings—namely, the need for a second incision over the temporal area. Many patients refused to undergo such an incision. Recently, several authors have demonstrated the increased resorption of wrapped diced cartilage as compared with bare diced grafts. Histological analysis has demonstrated that the chondrocyte regeneration of an AlloDerm (LifeCell, Inc, Branchburg, New Jersey)-treated group was significantly superior to that of a fascia-treated group. In 2009 at the American Society for Aesthetic Plastic Surgery (ASAPS) meeting in Las Vegas, Nevada, Erol described syringe injection of diced cartilage without any wrapping. He achieved good outcomes with no resorption. This approach eliminates the wrapping material, which acts as a barrier to the blood supply. The only shortcoming of this technique is the lack of structural integrity and the possibility of small cartilage pieces dispersing in a larger pocket. To prevent this problem, we decided to preserve the perichondrium when dicing the conchal cartilage. In harvesting the concha, the donor site was hidden, and no visible scar was produced. Conchal cartilage is elastic, is difficult to crush, and will not produce strong structural support as in septal or rib cartilage grafts.

The cartilage is thick and will provide a substantial volume of graft material when diced. It is a simple task to remove the concha and its attached perichondrium in 1 piece. Due to the relatively thick soft tissue that is attached to this structure, it is easy to cut and dice the cartilage into very small pieces (0.5 mm) without cutting or disturbing the attached soft tissue. This attachment allows us to make deep cuts in the concha without damaging the underlying perichondrium, so the small pieces of cartilage remain attached together by the underlying soft tissue and stay in 1 piece (Figures 1D and 5B). The end product is a soft, pliable mass of small pieces of cartilages that are attached together by the underlying soft tissue and can take any form or shape (Figures 1D and 5A,B). Pieces will not disperse or lose their form at the time of insertion and can be rolled and sutured to produce any form, including a tube-shaped structure (Figure 5A,B). The cartilage can also be fixed to the recipient site by suturing it to the desired location or used as a cover in patients with thin nasal skin. This method is valuable when the use of conchal cartilage is intended. This technique will not restrict the addition of more diced cartilage; all remnants of the resected cartilage can be diced and overlaid, just as in routine rhinoplasty.

The results of our study show that perichondrially attached cartilage will not be resorbed, remains viable, and grows minimally in size, as demonstrated by previous authors. We believe that the growth in the weight of the perichondrially attached diced cartilage graft could be due to either better vascular connection to the recipient bed or proliferation of chondrocytes. These hypotheses need further investigation in future studies. The perichondrium will not produce any barrier to nutrition compared with fascia or Surgicel, which may lead to more resorption. In our study, both diced and perichondrially attached diced cartilage demonstrated effective attachment to the surrounding tissues with good vascularization. Both
types of cartilage were integrated to solid masses (Figure 3A,B).

Our findings in this rabbit model suggest that cartilage grafts with attached perichondrium may survive better than diced-cartilage grafts. Further investigations of septal and rib cartilage will be necessary to prove the benefits of perichondrium in humans. The perichondrium of the concha is thicker in human beings than in a thin rabbit ear, so dicing is easier.

Figure 6. (A, C) This 38-year-old woman presented after a previous rhinoplasty operation with overresection of the dorsum and tip. (B, D) Six months after rhinoplasty with the authors’ technique. The patient’s right conchal cartilage was used as a tip graft and dorsal augmentation.

CONCLUSIONS

In an attempt to address the possible shortcomings of working with diced cartilage, we preserved the attachment of the perichondrium to the diced ear cartilage. Three months after the insertion of grafts in 14 rabbits, the viability, growth in weight, and solid and rigid framework of the cartilage in the perichondrially attached group were evident. Perichondrially attached, diced conchal cartilage provides the possibility of
shaping and fixing this combination to the nasal skeleton. It can be used either as a cover in patients with thin nasal skin or as a dorsal augmentation graft. When the conchal cartilage is intended for structural augmentation in rhinoplasty, this technique may convert the weak and irregularly shaped conchal cartilage to a more useful tool.

Disclosures
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REFERENCES

Table 1. Weight of Cartilages at the Beginning and End of the Study

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Figure 7. Linear schema showing the difference in weight between the 2 graft groups at the beginning and 3 months after the insertion of cartilage. There was a significant increase in the weight of the perichondrium-attached group.