Comparison of Outcomes Using Diced Cartilage With or Without Tensor Fascia Latae Wrapping in Rabbits

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Abstract

Background: Diced cartilage has been associated with several advantages and rewarding results, leading to its widespread application in various forms in rhinoplasty, but the outcomes of diced cartilage with and without tensor fascia latae wrapping have not been widely reported in evidence-based articles.

Objectives: The authors compared changes in weight, size, and histology of both bare and fascia-wrapped diced cartilage in rabbits as a model for human surgical outcomes.

Methods: One auricle from each of 15 rabbits was divided into 2 pieces, and both samples were diced. The tensor fascia latae of the rabbit was wrapped around 1 cartilage specimen from each rabbit (group A specimen); the other specimen received no wrapping (group B specimen). A group A specimen and a group B specimen were implanted into separate subcutaneous pockets in each rabbit. After 3 months, samples were removed from the recipient beds and weighed to compare pre- and postoperative weights. All specimens were examined for evidence of cartilage viability by histologic methods.

Results: There was a significant decrease in the weight of cartilage in group A. A nonsignificant weight increase was observed in group B. Histologic analyses of 5 parameters revealed no significant differences between the 2 groups, except for a significantly greater amount of new cartilage formation in group B.

Conclusions: Any type of wrapping around diced cartilage may inhibit its access to surrounding nutrients. Dicing increases the absorption surface, which may result in some overgrowth, but wrapping may have a negative impact on the viability of the diced cartilage.

Level of Evidence: 4

Keywords
rhinoplasty, diced cartilage, cartilage wrapping, fascial wrapping, postoperative deformities

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surgeons better predict surgical outcomes when using diced cartilage.

**METHODS**

Fifteen male New Zealand white rabbits, weighing 2000 to 2500 g and aged 12 to 16 weeks, were used in this analysis. The rabbits were treated according to the Declaration of Helsinki protocol, and this study was approved by the St Fatima Hospital research ethics committee, Tehran, Iran. Rabbits underwent general anesthesia by an intramuscular injection of ketamine 35 mg/kg and xylazine 5 mg/kg. One auricle from each rabbit was amputated, denuded of skin and perichondrium, and divided into 2 equal longitudinal pieces (Figure 1A,B). Both samples were diced into 0.5-mm pieces and inserted into a tuberculin syringe. All specimens were weighed in sterile conditions using a laboratory scale (0.01-g accuracy; Figure 2). To calculate the pure cartilage weight, the weight of the syringe was subtracted from the total weight of the specimen. The volume of cartilage in each syringe was also recorded.

Through a 2-cm incision on the upper posterior thigh of each rabbit, a 2 × 3-cm piece of tensor fascia latae was harvested (Figure 3A,B), and the incision was closed. We constructed a fascial tube by wrapping it around a syringe and suturing it with 4-0 chromic. The diced cartilage content of 1 syringe from each study rabbit was then injected into this fascial tube. Both ends of the tube were closed, and it was weighed again.

After harvesting the cartilage and constructing the fascial tube, a 1-cm transverse incision was made on each side of the spinal column of each rabbit. The fascia-wrapped diced cartilage (group A specimen) was implanted into a subcutaneous pocket on 1 side of the vertebral column; a sample of pure diced cartilage (group B specimen) was implanted in the subcutaneous pocket on the opposite side of the vertebral column by injection with a 1-mL tuberculin syringe. Intraoperatively, enrofloxacin 0.1 mg/kg was administered intramuscularly to all rabbits. As a prophylactic antibiotic, a co-amoxiclav suspension was added to the rabbits’ drinking water for 3 days postoperatively.

After surgery, the rabbits were caged for 3 months at a temperature of 22°C to 24°C, with free access to water and food. Three rabbits died during this period (rabbits 7, 12, and 13) and were excluded from the study. After 3 months, all remaining rabbits were sacrificed by intraperitoneal injection of high-dose sodium thiopental.

Through a single midline longitudinal incision on the spinal column, both sides were visualized (Figures 4 and 5). The samples were integrated as a clump, which made complete removal from the recipient bed and surrounding tissue easier. We then measured and weighed the excised tissues, and compared the pre- and postoperative weights of the specimens. To compare the pre- and postoperative results statistically, paired t tests were applied. To compare the end results between the 2 groups, independent t tests were used.

A pathologist performed microscopic analysis on all specimens to compare viability and new cartilage formation between groups. All specimens were stained by hematoxylin and eosin (H&E). Each sample was studied for fibrosis, cartilage integrity, new cartilage formation, number of nucleated chondrocytes, and ossification in each
high-power field in accordance with previous research by Kim et al.4 (Results are shown in Figures 6-8.) In each ×100-magnification field of H&E-stained specimens, 0% positive staining was categorized as negative, 1% to 24.9% as 1+, 25% to 49.9% as 2+, 50% to 74.9% as 3+, and >75% as 4+.

All results were analyzed with SPSS software version 19 (SPSS, Inc, an IBM Company, Chicago, Illinois).

RESULTS

The weights of the wrapped and unwrapped cartilage specimens preimplantation were not significantly different (Table 1). After 3 months, a significant decrease in weight was observed in the group with fascial wrapping (group A; P < .001), and a small, nonsignificant increase in weight was observed in the group with pure diced cartilage (group

Figure 2. Weighing the (A) wrapped and (B) unwrapped cartilage with a laboratory scale (0.01-g accuracy).

Figure 3. Tensor fascia latae harvesting: (A) incision line and (B) harvested fascia.
Figure 4. Viable fascia-wrapped and unwrapped cartilage specimens at 3 months after implantation, intraoperative view: (A) rabbit 3, (B) rabbit 5, (C) rabbit 8, (D) rabbit 11, and (E) rabbit 15.
Figure 5. Fascia-wrapped (right) and unwrapped (left) cartilage specimens were removed 3 months after implantation. (A) Rabbit 2, (B) rabbit 3, (C) rabbit 4, (D) rabbit 5, (E) rabbit 6, (F) rabbit 8, (G) rabbit 9, (H) rabbit 10, (I) rabbit 11, (J) rabbit 14, and (K) rabbit 15.
Figure 5. (continued) Fascia-wrapped (right) and unwrapped (left) cartilage specimens were removed 3 months after implantation. (A) Rabbit 2, (B) rabbit 3, (C) rabbit 4, (D) rabbit 5, (E) rabbit 6, (F) rabbit 8, (G) rabbit 9, (H) rabbit 10, (I) rabbit 11, (J) rabbit 14, and (K) rabbit 15.
Figure 5. (continued) Fascia-wrapped (right) and unwrapped (left) cartilage specimens were removed 3 months after implantation. (A) Rabbit 2, (B) rabbit 3, (C) rabbit 4, (D) rabbit 5, (E) rabbit 6, (F) rabbit 8, (G) rabbit 9, (H) rabbit 10, (I) rabbit 11, (J) rabbit 14, and (K) rabbit 15.
Figure 6. Hematoxylin and eosin–stained specimens at 3 months postimplantation, ×100 magnification. There was significantly more new cartilage formation in the unwrapped group: (A) <25% new cartilage formation in group A specimens vs (B) >50% new cartilage formation in group B specimens.

Figure 7. At 3 months postoperatively, there were slight increases in necrosis, fibrosis, and inflammation in (A) group A specimens vs (B) group B specimens, although these were not statistically significant.

Figure 8. At 3 months postoperatively, there were increases in ossification in (A) group A specimens vs (B) group B specimens, although they were not statistically significant.
B; \( P = .09 \); Figure 9). Absorption rates, as measured by independent \( t \) tests, showed significant loss of weight in group A (\( P < .001 \); Figure 10). No significant difference in histology score was found between the 2 groups, except that the amount of new cartilage formation was greater in the group B specimens (\( P = .001 \); Figure 11). Cartilage integrity (\( P = .82 \)), fibrosis (\( P = .07 \)), nucleated cartilage (\( P = .07 \)), and ossification (\( P > .99 \)) were similar between groups.

DISCUSSION

Dicing cartilage and implanting it as a graft for a variety of purposes, including nasal augmentation, has been popular since the 1940s.\(^5\text{-}^7\) Erol\(^8\) advanced this technique in 2000 by reporting his experience with wrapping diced cartilage in Surgicel (Ethicon, Inc, Somerville, New Jersey) in more than 2000 cases. However, several investigations showed that this material may produce a foreign-body reaction, thereby reducing graft viability and resorption.\(^4\text{-}^9\text{-}^{12}\)

Few authors have reported positive results with fascia-wrapped cartilage. Daniel\(^9\) and Daniel and Calvert\(^12\) investigated deep temporal fascia and reported less resorption and better results than with Surgicel. However, because the study participants were humans and results were evaluated subjectively, the study lacked objective laboratory investigation standards. Although we agree with Daniel and Calvert that fascia-wrapped diced cartilage has smooth borders and inhibits dispersion of cartilage pieces, we believe that wrapping a graft with another graft (eg, fascia around diced cartilage) is not logical, as it may inhibit proper nourishment of the implanted cartilage. In addition, close long-term follow-up may reveal decreased cartilage mass in the graft.

Coskun et al\(^13\) and Kim et al\(^4\) compared diced cartilage wrapped in fascia vs Surgicel and fascia vs AlloDerm.

| Table 1. Weights of Wrapped and Unwrapped Cartilage Specimens Before and 3 Months After Implantation |
|-----------------------------------------|-----------------------------------------|-----------------------------------------|-----------------------------------------|
| Rabbit | Weight (g) Preimplantation | Without Fascial Wrapping | With Fascial Wrapping | Without Fascial Wrapping | With Fascial Wrapping | Without Fascial Wrapping |
| 1 | 1.21 (0.57) | 0.64 | 0.28 | 0.67 |
| 2 | 1.27 (0.46) | 0.64 | 0.29 | 0.65 |
| 3 | 1.40 (0.81) | 0.79 | 1.25 | 1.16 |
| 4 | 1.54 (0.83) | 0.84 | 0.88 | 0.9 |
| 5 | 1.35 (0.90) | 0.84 | 1.4 | 0.86 |
| 6 | 1.59 (0.71) | 0.75 | 0.34 | 0.63 |
| 8 | 1.03 (0.70) | 0.53 | 0.72 | 0.69 |
| 9 | 1.16 (0.71) | 0.6 | 0.5 | 0.54 |
| 10 | 1.44 (0.73) | 0.68 | 0.53 | 0.55 |
| 11 | 1.00 (0.58) | 0.54 | 0.83 | 0.79 |
| 14 | 1.83 (0.80) | 1.02 | 1.04 | 1.32 |
| 15 | 1.60 (0.83) | 0.84 | 1.4 | 1 |

\(^a\)Data in parentheses indicate the weights of pure and wrapped diced cartilage (total specimen weight minus weight of wrapped fascia).
respectively. These studies were performed histologically, and the authors did not compare the weight of samples to calculate the actual amount of resorption. However, histologic changes, including fibrosis, cartilage integrity, new cartilage formation, number of nucleated chondrocytes, and ossification, cannot be accurately measured quantitatively. Because it is an objective method involving less human intervention and error, weighing the specimens before and after long-term implantation should yield a more accurate conclusion.

Brenner et al. implanted 3 different forms of human diced cartilage in rats: Surgicel wrapped, human temporal fascia wrapped, and unwrapped. They demonstrated that temporal fascia wrapping provoked the least inflammatory reaction. However, they did not weigh the specimens before and after removal. Notably, the host vs. graft reaction at heterogeneous sites was inhibited by fascia in the wrapped group and was enhanced in the unwrapped group.

Other authors have found that resorption in fascia-wrapped cartilage is significantly greater than with bare

Figure 10. Comparison of absorption rates by independent t test between group A specimens (wrapped cartilage) and group B specimens (unwrapped cartilage) after 3 months.

Figure 11. There were no significant differences in histology scores after 3 months between the wrapped and unwrapped groups: (A) cartilage integrity, (B) nucleated cartilage, (C) fibrosis, and (D) ossification.
cartilage. Unwrapped cartilage has no resorption and may grow in size and weight minimally, especially if it is covered with perichondrium.15-17 Firat et al18 and Fatemi et al19 compared different wrappings around cartilage and bare cartilage and found extensive resorption in the wrapped group, with no resorption in unwrapped cartilage grafts.

Dicing increases the surface area of the cartilaginous pieces and allows the chondrocytes better imbibition through more contact with nutrients. We believe that the reason for the decreased weight of wrapped cartilage resulted from the fascia acting as a barrier to nutrients and impaired plasmatic diffusion to chondrocytes.18 The question that remains is how a graft can cover another graft and still remain viable. In unwrapped cartilage, there is no impediment around the chondrocytes; thus, cell viability is maintained, and the cartilage weight will increase by absorbing more fluid and nutrients from the surrounding tissues. In addition to histologic examination in our study, we measured pre- and postoperative weights, increasing the accuracy of our outcome assessment by an objective method not possible in human participants.

Finally, the thicknesses of rabbit tensor fascia latae and human superficial and deep temporal fascia have been measured by microscopic examination in formalin-fixed specimens. The average thickness of tensor fascia latae in the rabbit specimens was 0.2 to 0.9 mm, which is almost equal to the thickness of the temporal fascia latae in humans (0.8-1.0 mm for superficial temporal fascia and 0.5-0.7 mm for deep temporal fascia). However, the effect of the specific physiology of the rabbit tensor fascia latae compared with that of the human temporal fascia cannot be ignored.15

CONCLUSIONS

Any barrier around a graft (such as tensor fascia latae around diced cartilage) will limit the diffusion of nutrients to the target graft to some degree. This inhibition may be detected in long-term follow-up. Unwrapped diced cartilage has its own shortcomings, such as difficulty in keeping the exact structure and configuration over the dorsum. Ultimately, it is important to bear in mind that wrapped diced cartilage may decrease in size and volume in the long term. We believe it is most appropriate to minimally overcorrect when implanting wrapped diced cartilage and to avoid overcorrection when implanting bare diced cartilage.

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