

Crushed Cartilage: A Rescue Procedure in Rhinoplasty

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Abstract: While the use of crushed cartilage is now universally recognized as a valid procedure in rhinoplasty to mask irregularities and eliminate slight deficits, there is still no consensus as to the optimal degree of crushing and the rate of graft resorption over time. With a view to casting light on these 2 important aspects and providing some guidelines, the authors present a study of 123 patients subjected to grafts of cartilage with different degrees of crushing in the different areas of the nasal pyramid: upper third (45 patients), middle third (40), and lower third (38). The degree of crushing was medium for 95 patients and high for 28 who presented thinner and less elastic skin. Comparison of the performance over time of the cartilage grafts inserted in the same areas but with different degrees of crushing provides important indications as regard the best way of preparing the material. The results proved satisfactory with improvements for all of the 95 patients subjected to grafts of moderately crushed cartilage. The initial defect was instead still present, albeit with some partial improvement, at a distance of 12 months in 17 of the 28 patients where highly crushed cartilage was used. The study suggests that a moderate degree of crushing offers better results as regard flexibility and stability over time.

Key Words: Cartilage graft, crushed cartilage, degree of crushing (*J Craniofac Surg* 2017;00: 00–00)

The use of crushed cartilage in rhinoplasty to mask irregularities is a well-known and universally used procedure.^{1,2} While it cannot be used as a structural graft, this material has proved unquestionably valid in the closing phases of the operation.

In fact, in patients where severe defects such as saddle nose deformity with middle vault collapse need to be corrected, it is best to carry out wrapped diced cartilage graft. The materials most used to wrap the diced cartilage graft are the temporalis fascia or the AlloDerm.³ This technique allows excellent reconstructions in patient with severe or moderate saddle nose deformities.

On the contrary, it is precisely in situations where a few additional millimeters make it possible to avoid sequelae or make the difference between an acceptable and an excellent result that the crushed cartilage graft is indicated. In the literature, however, few authors have so far focused attention on critical analysis of this type

of graft, above all with reference to the indications, preparation and anchoring of this material.

Various scientific publications reporting the results of experimental studies on rabbits have instead undertaken a histologic analysis of crushed cartilage to determine the length of chondrocyte survival after crushing.^{4,5} It has also been shown that the survival of the chondrocytes of human septal cartilage cultivated in vitro varies in relation to the degree of crushing. The results of these studies all coincide and demonstrate an inversely proportional relationship between chondrocyte survival and degree of crushing.^{6–8} The clinical implications of these experiments are considerable because excessive crushing of the cartilage leads to greater resorption of the same. How much crushing is necessary? When should it be halted? Is hypercorrection necessary?^{9,10}

The aim of this article is to provide a precise prototype of this type of graft with particular reference to the optimal degree of crushing required.

PATIENTS AND METHODS

Operations of septorhinoplasty with the use of crushed cartilage were performed on 123 patients between January 2010 and September 2012. The patients involved presented defects in the form of structural deficits in various regions of the nasal pyramid during the final phase of the operation. They can be divided into 3 groups on the basis of the part of the nasal pyramid requiring a graft of crushed cartilage: upper third (45 patients), middle third (40), and lower third (38). The material was harvested in all patient from the cartilaginous septum. Intraoperative photographs were taken systematically in order to describe the degree of crushing of the graft.

The preparation of the crushed cartilage graft involved painstaking removal of mucoperichondrial residues and fragments of bone before insertion into a Cottle cartilage crusher (model 523900, Karl Storz, Tuttlingen, Germany). The degree of crushing was medium for 95 patients and high for 28 who presented thinner and less elastic skin. Decisions as to the amount of crushing required were taken solely on the basis of practical visual criteria. The medium level corresponds to the “crocodile skin” appearance shown in photograph 1 and confirmed by the use of raking light during this phase (Figs. 1-2). It should be noted that this degree of crushing is attained gradually, with the flexibility of the graft repeatedly evaluated by means of palpation between the thumb and index finger, and that structural continuity is preserved. The high level is instead reached when the graft is partially fragmented in appearance and no longer tends to resume its original position after pinching due to lack of elasticity (Fig. 3). The graft of crushed cartilage was immersed in saline solution and inserted with toothless forceps, its correct positioning being checked by means of the fingers of the other hand on the outside of the skin of the nasal pyramid. In the upper third, the graft of crushed cartilage was used for augmentation or to eliminate residual irregularities. In the first patient, it was often laid down in layers or on top of a thicker graft (septum or concha) in order to make the outline of the nasal dorsum less angular. In the second, it was placed in a single layer on top of irregular and jagged edges left after dorsal hump excision despite the use of rasping.

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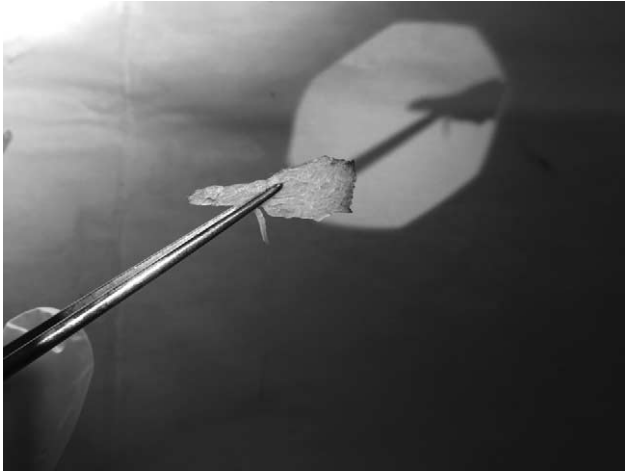


FIGURE 1. Intraoperative view of medium level of crushed cartilage corresponding to the “crocodile skin” appearance.



FIGURE 2. Intraoperative view of crushed cartilage positioning.

Crushed cartilage grafts were used in the middle third both to mask the sharp angle left by the use of spreader grafts sutured to one or both sides of the triangular cartilage and in patients with accentuated crooked nose where a certain degree of asymmetry remained on one side of the nasal pyramid at the end of the procedures used. No sutures were used in the patient with grafts in the upper and middle third because their rough surface is sufficient to prevent any downward slipping.



FIGURE 3. Three grafts with different degrees of crushing. Left to right: slightly crushed, moderately crushed, and significantly crushed.

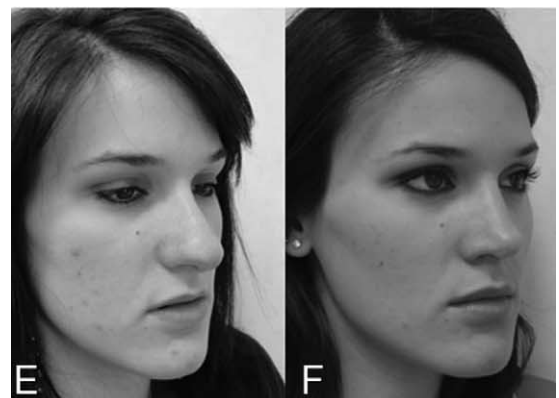


FIGURE 4. Patient 1: (A–C–E–G) Preoperative views of a patient before primary rhinoplasty. A significantly crushed septal cartilage was used to camouflage the excessive supratip breakpoint at the end of the operation. (B–D–F–H) Postoperative views after 24 months show the recurrence of the supratip breakpoint.

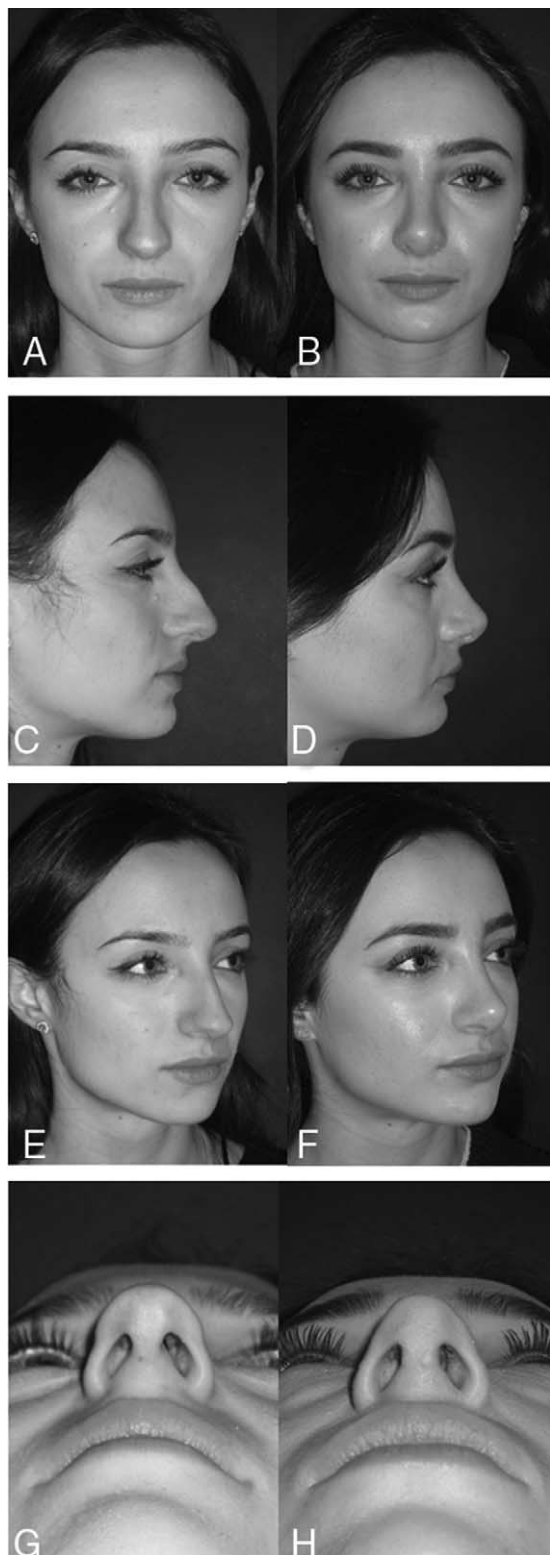


FIGURE 5. Patient 2: (A–C–E–G) Preoperative views of a patient before primary rhinoplasty. A moderately crushed septal cartilage was used to camouflage the excessive supratip breakpoint at the end of the operation. (B–D–F–H) Postoperative views after 24 months show the stable correction of the excessive supratip breakpoint.

In these patients, accurate postoperative taping for 2 weeks is very important in order to maintain the placement of the graft over time and to counteract gravity and facial animation.

Crushed cartilage grafts were used at the nasal tip to correct asymmetries of the domus or small deficits of projection at the end of the operation. An important and very useful indication was to fill the excessive supratip break point during the final step of rhinoplasty (Figs. 4-5). The positioning was carried out in these patients under visual control and a suture with 6.0 nylon sometimes proved useful to avoid even slight movement.

RESULTS

For every patient selected, postoperative photographs were compared at intervals of 1 month, 3 months, 1 year, and at the last postoperative control. The follow-up was from 36 to 46 months with a mean of 39.2. The final clinical and photographic examination ascertained the results obtained with the crushed cartilage graft either in isolation or together with other procedures. These proved satisfactory with improvements for all of the 95 patients subjected to grafts of cartilage crushed to a medium degree. The initial defect was instead still present, albeit with some partial improvement, at a distance of 12 months in 17 of the 28 patients where a high degree of crushing was used. A revision operation with a further graft of auricular cartilage proved necessary in 5 of these patients, while the residual defect was accepted by the patients in the remaining 12 and no further operation was considered necessary. Revision was necessary in 2 of the 95 patients with the medium-degree group but not because of the use of crushed cartilage. In 1 patient, the nasal tip collapsed due to failure to insert a columellar strut, which was rectified in the revision operation. The other involved a slight relapse of crooked nose due to persistent elastic memory not countered by a sturdy spreader graft. In this patient, the existing spreader graft was strengthened by a further spreader graft of auricular concha on the same side. It should be noted that in these 2 revisions, the crushed cartilage had not been used in the areas where a further operation was required but only in the area of the upper third during the first operation. The degree of satisfaction with the result was evaluated by means of a questionnaire compiled by the patient, the family doctor, and 2 surgeons of the same department but not belonging to the surgical team. The questionnaire is the same as the 1 published by the authors in 2010.¹¹ It should be noted that the last postoperative control revealed slight resorption in the area of the grafts in every patient, never >1 mm and practically invisible without prior knowledge of the exact position.

DISCUSSION

The optimal degree of cartilage crushing must ensure that 2 conflicting requirements are met as well as possible. On the one hand, the graft must be highly flexible and malleable; on the other, it must not be so crushed as to endanger chondrocyte survival. It is often hard to identify this narrow borderline. The numerous histologic studies in the literature on the survival of this type of graft in relation to the degree of crushing suggest that a moderate degree is ideal to ensure satisfactory durability without at the same time creating further irregularities due to excessive thickness.⁴⁻⁸ While the literature offers a wealth of ultrastructural studies, studies on guinea-pigs and indications, it is far less conclusive, however, as regard the practical use of the cartilage in relation to its degree of crushing. Moreover, it proves particularly difficult to identify the optimal degree of crushing on the operating table, where the graft is fashioned by such crude methods as repeated compression against a hard surface.

It is in fact impossible to establish a precise number of hammer blows of precisely defined force because this is something wholly subjective and not susceptible of standardization. It has been suggested that the optimal degree of crushing can be identified on the basis of whether the cartilage bends due to gravity when held between 2 fingers.¹² This can be regarded as useful but not completely effective in that such bending is observed in both moderately and highly crushed cartilage. In actual fact, the end result of the use of one or the other can be very different indeed due to the considerable degree of resorption of highly crushed cartilage.

In the light of our study on a large number of patients, it appears clear that identifying an ideal prototype of the crushed cartilage graft can prove very difficult if it is not facilitated by means of immediate but careful visual inspection. In this delicate phase of reconnaissance, a model based on experience and improved with the aid of raking light on the operating table can offer the best results. It is no coincidence that the macroscopic reference to a “crocodile skin” appearance distinguishes the attainment of an optimal degree of crushing with an ideal compromise between a limited degree of resorption and the absolute invisibility and impalpability of the graft beneath the skin. Palpation of the graft and pinching between the thumb and index finger offer further precious help in assessing its effectiveness. It is thus possible to ascertain an optimal degree of crushing as regard structural continuity and sufficient thinness of the graft at the same time. Our experience, based on a sample of 123 patients with a mean follow-up of 39.2 months, demonstrates both lasting survival and validity of the graft as well as its imperceptibility to sight and touch. The data drawn from the clinical results also show that the degree of crushing obtained with the method described is the one that offers the best guarantee over time, as the group of patients subjected to grafts of highly crushed cartilage presents a greater degree of resorption over time with increased visibility of the original defect.

CONCLUSIONS

Crushed cartilage constitutes a precious type of graft enabling rhinoplasty to correct even the slightest defects and achieve excellent results. While this is unanimously agreed upon in the literature,

there is far less agreement on precisely how such grafts should be prepared. The study carried out is based on an objective method of graft preparation and comparison with the results obtained with a higher degree of crushing. The findings demonstrate the effectiveness of crushing that preserves the continuity of the graft as well as a sufficient degree of structural elasticity, 2 properties regarded as essential to achievement of the set objectives. One practical element of great importance emerging from study of the results obtained is therefore that the continuity of the cartilage should be preserved by avoiding an excessive degree of crushing.

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