Diced and Crushed Cartilage Plus Autologous Fibrin Matrix Obtained by a Simple Process for Dorsal Augmentation of the Mestizo Nose

Yanko Castro-Govea, MD, PhD[1] Sergio Ayuzo del Valle, MD[1] Victor Cervantes Kardasch, MD, ScD[1] Erick Phillips Eparza, MD[1] Osvaldo Vazquez Costilla, MD[1]

[1] Department of Plastic Surgery, School of Medicine and University Hospital "Dr. José Eleuterio González," Monterrey, Nuevo León, México

Address for correspondence Yanko Castro-Govea, MD, PhD, Department of Plastic Surgery, School of Medicine and University Hospital "Dr. José Eleuterio González," Monterrey, Nuevo León, México (e-mail: goveayanko@hotmail.com).

Facial Plast Surg 2015;31:164–171.

Abstract

Several alternatives can be used for nasal dorsum augmentation. We report the use of crushed diced cartilage embedded in an autologous fibrin matrix. This construct is placed on the nasal dorsum and is gently molded according to the characteristics of each patient. Rhinoplasty and nasal dorsum augmentation were performed in 45 patients with Mestizo characteristics after a complete medical history and development of a surgical plan. A crushed diced cartilage autologous graft and an autologous fibrin matrix from peripheral blood processed using the Choukroun method was used. Pre- and postoperative photographs were taken at short- and long-term follow-up. Two separate variables were evaluated: reabsorption and irregularities. Three plastic surgeons evaluated the results, using a Likert scale: the first variable was considered very excellent in 88.9%, very good in 6.7%, good in 4.4% with no poor or very poor results. In the second variable, results were excellent in 88.9%, very good in 4.4%, good in 3.4%, and poor in 3.3% with no very poor results. Our patients carry a volume with an aesthetically pleasing contour and form with no changes over a mean follow-up period of 4 years. Long-term effectiveness continues to be the main topic of discussion; however, this method can be considered an alternative not only to augment but also to smoothen irregularities of the nasal dorsum. We used a simple method with good and stable long-term clinical results.

Keywords

- Mestizo nose
- dorsal nasal augmentation
- nasal dorsum smoothing
- platelet growth factors
- autologous fibrin matrix

An increased nasal dorsum in the Mestizo nose is a challenge amidst the variables to be treated in a cosmetic/functional rhinoplasty. Posttraumatic sequelae and congenital abnormalities may also be indicated in the management of the nasal dorsum. Establishing the form, a smooth contour without irregularities, and with dorsum height are the main goals, although these can be elusive goals in a primary procedure and even more so after a revision.

Profound knowledge is needed to create an aesthetic appearance of the dorsum, not only from a structural nasal anatomy point of view but also considering a facial cephalometric correlation.[1] From our own point of view, it is also important to understand the dynamic role played by the tissue covering and the multiple variables that must be considered when a cartilage graft is placed on the dorsum. Tebbetts[2] mentions nine variables related to tip grafts when they make contact with the soft tissues and even in expert hands these are difficult to control by the patient or the surgeon. These same circumstances are applicable for grafting of the nasal dorsum and they are subject to factors that can influence medium- and long-term results.

As previously mentioned, the septal cartilage graft is the best alternative to increase the nasal dorsum. Its benefits are diverse and have been well described.[3,4] When septal

Issue Theme Current Concepts, State of the Art Treatment of Facial Paralysis; Guest Editor, Patrick J. Byrne, MD, FACS

DOI http://dx.doi.org/10.1055/s-0035-1549038.
ISSN 0736-6825.

cartilage is insufficient, auricular cartilage may be another alternative; however, because of the type of cartilage and its characteristics, it may not be applicable when larger increases are needed.[5] Rib cartilage is undoubtedly the best choice when the first two are inadequate.[6] However, these grafts must be cut and carved to size, which may cause deformation such as warping and therefore be visible and palpable. To mitigate this effect, Sheen[7] used rib cartilage grafts carved into small morselized strips placed longitudinally on the nasal dorsum.

The benefits of using diced cartilage to increase the nasal dorsum have been well described by several authors.[8,9] The fact that it is manually molded and shaped is undoubtedly one of its most important benefits. Methods that use diced cartilage have provided several contributions in the past 15 years.

Erol[10] reported an extensive series of cases with a technique he called "Turkish Delight," which consists of wrapping diced cartilage 0.5 to 1 mm, in oxidized regenerated cellulose (Surgicel [Ethicon; Somerville, NJ]) placing it in a cylindrical form on the nasal dorsum. He used septal cartilage, auricular concha, and alar and costal cartilage. In their histological samples they found cartilage grafts scattered between fibrous connective tissue. Elahi et al[11] used diced auricular and septal cartilage, which were crushed and morselized and wrapped in a double layer, also of alloplastic material. If possible, they recommended an overcorrection of 20% in nasal dorsum augmentation.

Daniel et al[12] reported a prospective study of three groups —in one group, diced cartilage wrapped in temporal fascia was used as a autologous graft; in another Surgicel was used; and in a third group no wrap was applied. In the second group all patients experienced reabsorption, but this did not occur in the other two groups. The researchers attribute this reabsorption to a foreign-body reaction caused by Surgicel. Clearly, the alloplastic wrap seemed necessary, initially to prevent propagation of small grafts and subsequently to incorporate a wrap of autologous tissue in order to decrease the resorption rates of diced cartilage.

Recently, Tasman[13] proposes an alternative to stabilize diced cartilage in dorsum augmentation without using a wrapper. For this, commercial tissue adhesive is used. The sealing effect of the adhesive fixes the scattering of the smaller grafts and provides some stability to the structure allowing manual molding without wrapping.

More recently, other authors have stabilized diced cartilage with autologous tissue adhesives obtained from peripheral blood, creating a relatively stable structure that can be used in patients who need nasal dorsal augmentation, either in open or closed approaches.[14]

Platelet-rich plasma (PRP) is defined as the portion of the plasma fraction that contains a concentration of platelets that is higher than baseline. Its components highly rich in platelets contain a high percentage of growth factors.[15–17] It is now known that platelet activation in response to vascular tissue damage and exposure results in the formation of a fibrin clot that provides hemostasis and secretes biologically active proteins called *platelet growth factors* (PGFs). PGFs are biological proteins that act by cell signaling binding to membrane receptors to activate highly specific cell functions essential for tissue regeneration and repair (chemotaxis, angiogenesis, cell proliferation and differentiation, and production of extracellular matrix).[13,18]

Platelet-derived fibrin gel is a hemostatic and sealant widely used in plastic surgery since 1995. It reduces the presence of bruising and provides a tissue adhesive effect.[19] Another therapeutic function has been the use of a fibrin clot combined with fat grafts for lipoinjection in facial cosmetic and reconstructive surgery.[20]

Choukroun et al[21] obtain a fibrin gel rich in platelets through a simple process that avoids the use of chemicals in the blood, which obviously makes it very attractive. This simple, but also complex, autologous biomaterial has great therapeutic potential in tissue engineering of cartilage and bone.[22]

Technically and globally, rhinoplasty in the Mestizo patient is of augmentation. Often in these cases the nasal dorsum is convex with a deep radix.[23] Given these features, combinations for managing the dorsum can be diverse: a simple cartilage graft for the radix when the height of the dorsum is adequate; a half-length graft when the height of the radix is ideal, coupled with an average or mostly prominent hump, which may require a graft to obtain a smooth contour; and a full-length dorsum when the total height of the dorsum is low (►**Fig. 1**). Thus, the common denominator in these patients is the use of a greater or lesser graft length/thickness in the nasal dorsum.

Based on the previous use of diced cartilage together with commercial or autologous tissue adhesives to perform nasal dorsal augmentation, the main topic of discussion continues to be long-term effectiveness. For this reason, we used a simple method in patients requiring nasal dorsum augmentation with good and stable long-term clinical results. Undoubtedly, we also suggest the method for smoothing irregularities of the nasal dorsum after hump removal.

We have combined diced and crushed septal cartilage with an autologous fibrin matrix obtained from peripheral blood using the same process described by Choukroun. Platelets and cytokines play a predominant role in this biomaterial; however, it is the fibrin matrix that is responsible for the therapeutic potential of PGF.[21] The main goal is to demonstrate the long-term effectiveness of this technique; therefore we present our experience of 4 years.

Material and Methods

The technique was used in 45 rhinoplasty patients mostly with Mestizo features in which nasal dorsal augmentation was necessary. The patients were 34 women and 11 men ranging from 17 to 53 years of age. In eight patients the reason for surgery was sequelae of an old facial trauma, the rest were for esthetic reasons. A complete medical evaluation was performed with pre- and postoperative photographs to aid in the evaluation of intermediate and long-term results. We standardized position, facial expression, and camera settings. The results were evaluated using

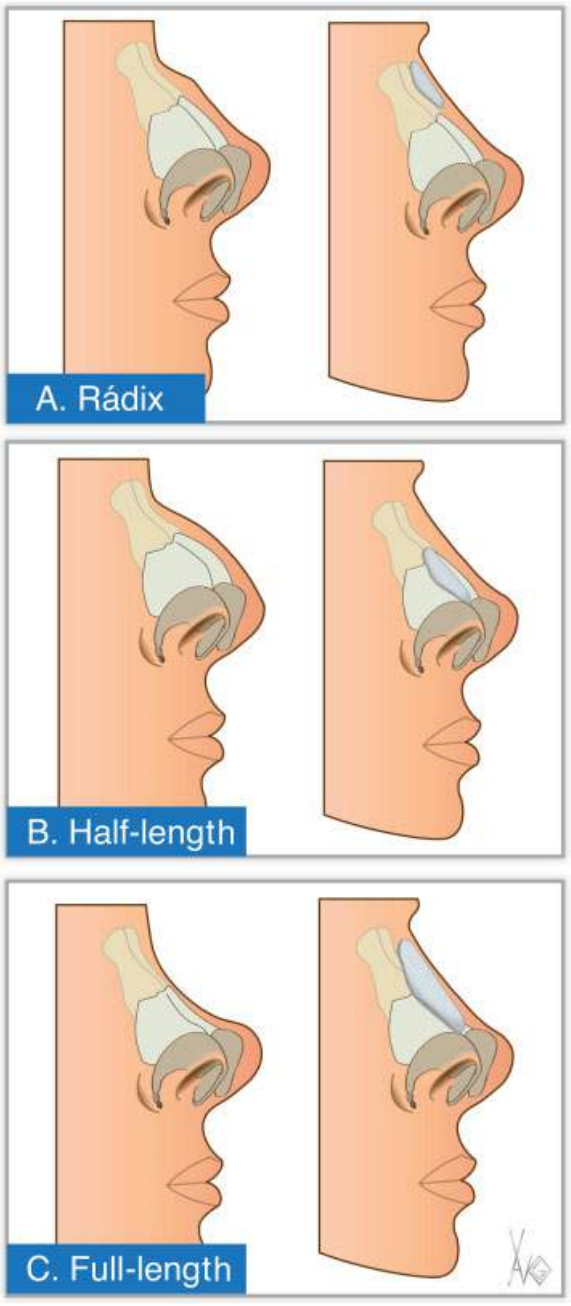

Fig. 1 Different anatomical standards of the nasal dorsum with Mestizo features. (**A**) A deep radix with ideal height of the dorsum, (**B**) ideal radix height with a hump, and (**C**) total height of the dorsum is low.

variables rated by three plastic surgeons that were not involved in the procedure and were blinded to the operator performing the procedure, and according to the patient's degree of satisfaction with the results. The majority of the patients underwent surgery with general anesthesia. There were 35 primary cases and 10 secondary cases, with 33 cases being done with an open approach and 12 with a closed approach. We obtained informed consent from all patients, who were also informed fully regarding the aim of the study. The clinical study was approved by the appropriate institutional review boards from the "Dr. José E. González" University Hospital. Patients were not allowed to smoke for 10 days before and after the procedure.

Surgical Technique

We infiltrate work areas with a solution of 1% lidocaine with epinephrine (1:100,000) for vasoconstriction and to hydrodissect tissues. It is important to carefully dissect and elevate the soft tissues of the nasal dorsum, strictly following a uniform plane. Also, the symmetry of the lateral limits of the dorsal pocket dissection must be preserved to avoid lateralization of the graft. Dissection at the level of the radix is supraperiosteal, and we carefully conserve its limits.

Diced and Crushed Cartilage

After collecting the septal graft, we separate the amount necessary to perform modeling of the nasal tip, if needed. The excess material is reserved for nasal dorsum augmentation; when this is insufficient, we use auricular and rib cartilage. On a worktable, we cut the cartilage into small approximately 2- to 3-mm pieces with a #15 scalpel blade, then each of these small segments are crushed and multifragmented with a Kocher clamp. These grafts are placed in a small metal container (or on a lid). Afterward, only a few drops of saline solution at room temperature are applied to maintain the mixture moistened while the fibrin matrix is prepared.

Platelet-Rich Autologous Fibrin Matrix

The autologous fibrin clot is obtained in a way similar to the process described by Chouckroun.[21] After obtaining peripheral blood, it is placed in two red tubes without anticoagulant, depositing 4 mL in each tube. The tubes are then placed opposite each other in the centrifuge and rotated at a speed of 3,000 rpm (revolutions per minute) for 10 minutes. After centrifugation, the fibrin clot is ready to be immediately mixed. The length of the fibrin clot is usually 3 to 4 cm. The relationship is approximately one tube of centrifuged blood for each 1 cm^3 of crushed cartilage.

The fibrin clot is removed from the previously centrifuged tube with a dissecting forceps (usually it has a blood clot adhered to it, which must be removed) and placed in the device that contains the crushed grafts. The fibrin clot that we obtain is gelatinized and it must be gently fragmented fairly quickly and mixed with the multifragments of cartilage. During this maneuver, the clot slightly decreases in volume due to the release of plasma that contains PRP. The crushed cartilage must be mostly dry. For this purpose we use gauze to absorb residual water. If a greater amount of time passes before the fibrin clot is mixed, it can acquire a chewing gum-like consistency; therefore we recommend mixing it quickly with the crushed cartilage. The final mixture is semihard with this consistency being produced by the cartilage fragments embedded in the matrix. This mixture is malleable once it is placed on the dorsum of the nose. The function of the fibrin clot is not to provide volume but rather to act as a scaffold together with the platelets, which have a high percentage of growth factors.

We use 1- or 2-mm syringes (according to the amount to be grafted) whose tip is cut at an angle of approximately 45°.

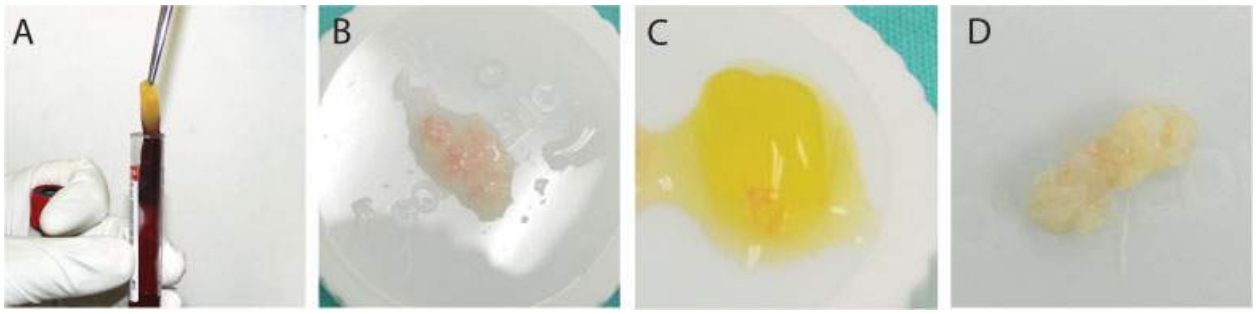

Fig. 2 Crushed cartilage graft sequence and the process for obtaining autologous fibrin matrix. (**A**) Fibrin clot is removed from the previously centrifuged tube; (**B**) crushed septal cartilage. (**C**) Autologous fibrin matrix (gelatinized aspect); (**D**) appearance of the construct.

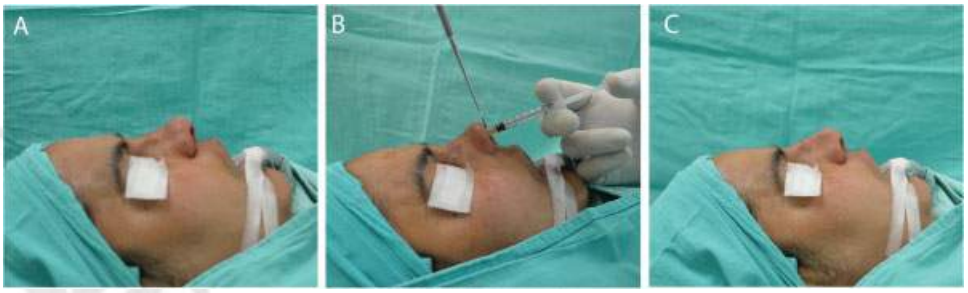

Fig. 3 Intraoperative view. A 27-year-old woman with posttrauma nasal sequela. Placement of the construct, nasal dorsum augmentation (full length) with a closed approach. (**A**) Aspect of the anatomy of the nasal dorsum before placement of the construct, (**B**) elevation of the nasal flap with an Aufricht retractor; construct in a syringe (1 mm) and placement by gently pushing the plunger, and (**C**) appearance after placement of the construct.

The plunger is withdrawn to introduce the implant with a small surgical spoon softly compressing the material within the syringe. The process of combining the cartilage grafts with the fibrin matrix and their subsequent application ideally should not exceed 2 minutes on average; in this way the fibrin matrix is gelatinized agglomerating the crushed cartilage, resulting in a stable semihard construct ready to be placed (►**Fig. 2**).

Implant Placement, Modeling and Shaping of the Nasal Dorsum

After the appropriate changes to the nasal dorsum are made, we place a malleable construct. With the aid of an Aufricht retractor placed in the pocket, we lift the dorsal flap to introduce the beveled tip of the syringe up to the radix (the shape of the tip facilitates insertion of the syringe into tight spaces) and immediately place the implant by gently pushing the plunger. With this same maneuver, only with greater traction of the dorsal flap, placement of the construct is possible through a closed approach (►**Fig. 3**).

Obviously the implant acquires the circular shape of the syringe and once positioned below the dorsal flap is gently molded and shaped digitally until the estimated volume is obtained, with a smooth contour, without irregularities, and aesthetically pleasing. It is noteworthy to mention that we must manually place the construct so that it adapts perfectly to the surface of the nasal dorsum (even more so if irregularities exist); only in this way can we finish modeling the anterior surface of the implant which is in close relationship with the soft tissue cover (►**Fig. 4**). Particularly, we did not perform overcorrection, as mentioned before the result depends entirely on the volume of the cartilage placed on the dorsum and on the effect of the fibrin clot.

Finally all approaches are closed. Internal nasal splints are applied as well as an external nasal splint using several layers of adhesive tape. The latter must be uniform and provide maximum control of adhesive tape tension so that no area of the dorsum is crushed.

A careful analysis of the anatomy of the nasal dorsum, in addition to the rest of the aesthetic units of the nose and their

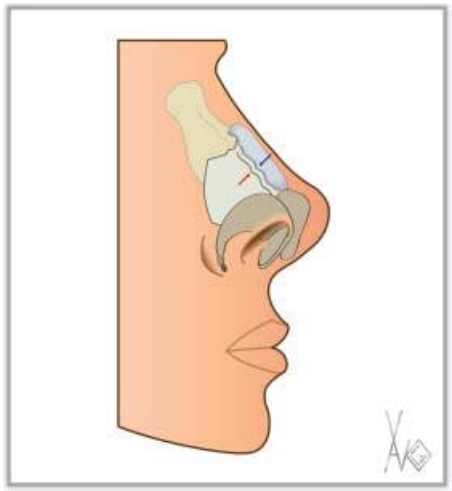

Fig. 4 The posterior face of the construct (*blue arrow*) adapts to the irregularities of the nasal dorsum (*red arrow*).

Fig. 5 Construct in different sites of the nasal dorsum. (**A**) Radix, (**B**) half length, and (**C**) full length.

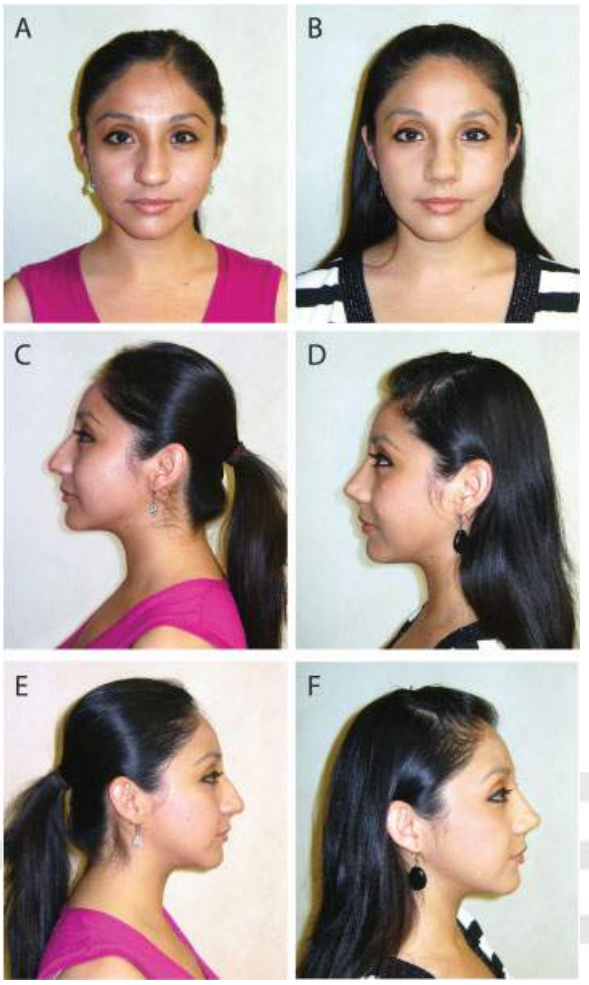

Fig. 6 Usual example of a patient with a typical Mestizo nose (**A, C, E**). Preoperative view of a 24-year-old woman; the nasal dorsum has sinking of the radix subsidence and a small bone/cartilaginous hump (**B, D, F**). Postoperative view 18 months after the procedure. After removing the hump the construct was used to provide a slight increase and obtain a smooth and regular contour; it was also placed in the radix. In addition, a columellar support and a cartilage graft in the nasal tip was used.

relationship with the thirds of the face, is essential to establishing the requirements of the cartilage grafts regarding the length and volume that the nasal structure, in general, demands (►**Fig. 5**).

Results

We included 45 patients with Mestizo features who required increased nasal dorsum augmentation. In four patients only a radix graft was placed without manipulation of the dorsum because this unusually had great irregularity. In seven patients radix graft placement was not necessary. In the remaining patients combined grafts were used. In no case was the increase greater than 3 mm.

Results were documented in the short and long term with a range of 6 months to 4 years (with a mean of 2 years), where we visualized a satisfactory volume without displacement and with a smooth contour that has persisted over time (►**Figs. 6** and **7**).

Probably the most frequent question on the use of cartilage grafts in augmentation of the dorsum in any of its variants, in this case crushed and embedded in an autologous fibrin matrix, was the permanence of volume (resorption) and the presence of irregularities. In this regard, we evaluated these two variables separately. The first method consisted of variables rated by three plastic surgeons that were not involved in the procedure and were blinded to the operator performing the procedure. This evaluation was performed on average 2 years postoperatively. Results were categorized with a Likert scale as excellent, very good, good, poor, and

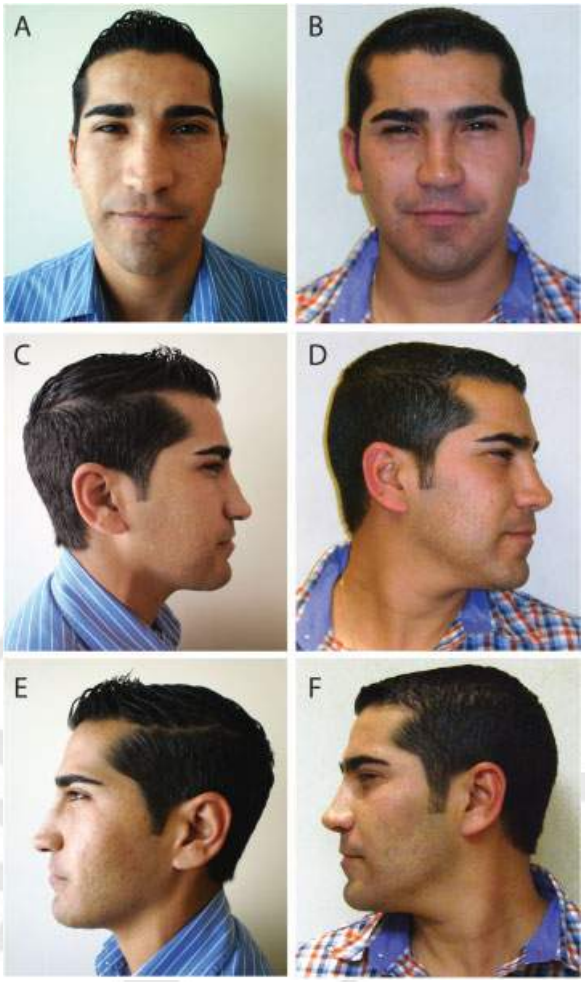

Fig. 7 Example of a moderately low dorsum with irregularities (**A, C, E**). Preoperative views of a 30-year-old man (**B, D, F**). Postoperative views 4 years after the procedure. Dorsum height is increased and the irregular surface was corrected. In addition, a columellar support with augmentation of the nasolabial angle and modeling of the tip with sutures was used.

very poor. Three photographs of each patient (frontal, right, and left lateral view) were shown side by side on a PowerPoint presentation: Preoperative pictures were placed on the left and on the right were postoperative photographs. The reviewers only scored the right and left lateral view, which were the larger images with the same dimension as well as brightness and contrast. The time of each image presented was 1 minute. The results of the first variable evaluated were considered by the surgeon reviewers as very excellent in 88.9%, very good in 6.7%, good in 4.4%, with no poor or very poor results. With regard to the second variable, the results were excellent in 88.9%, very good in 4.4%, good in 3.4%, and poor in 3.3%; there were no very poor results. The second method consisted of the patient's degree of satisfaction with the results using a visual analogue scale (VAS), categorizing the results with five variables: very satisfied, satisfied, somewhat satisfied, dissatisfied, and very dissatisfied. Forty-one patients were very satisfied, two were satisfied, two were somewhat satisfied, and there were no patients dissatisfied or very dissatisfied.

Nasal retouching was performed in four patients: one because of mild sinking of the radix and another because of moderate prominence of the radix. In this patient, the prominence was removed and a biopsy of the material was sent to pathology for evaluation. Another patient had a mild lateral displacement of the construct, and one sinking in the dorsum. There were no complications.

These less favorable outcomes were possibly related to patient characteristics, particularly because of greater thickness of the soft tissue covering. With a certain frequency this becomes greater due to inherent inflammation during surgical manipulation.

In this sense, we believe that a miscalculation in the volume of the construct on our part is possible, also an accurate estimate to remove a hump. Regarding the patient who had a depression on the dorsum, he inadvertently changed the patches, particularly at the level of the supratip, applying them with greater pressure, hoping to produce an upturned nasal tip, and this actually occurred; however, he was not entirely satisfied with the final result. After retouch surgery these patients were very satisfied with the results.

Discussion

The use of diced cartilage without wraps and stabilized with tissue adhesives, either commercial or obtained from an autologous fibrin clot, is becoming increasingly popular.

We use diced crushed cartilage to a multifragmentation level similar to that described by Guerrerosantos et al,[24] except that we do not use wrapping. These crushed diced cartilages are stabilized in a matrix of autologous fibrin (biomaterial), which constitutes a platelet-rich concentrate that is responsible for the great therapeutic potential due to the growth factors and peripheral stem cells they contain that are vital for tissue repair and regeneration.

On the other hand, we must not forget that the pocket created is a wound, and that its response to tissue and vascular damage will favor the formation of a platelet plug and blood clot whose goal is hemostasis and platelet activation in situ, which in turn will allow the secretion of PGFs responsible for tissue regeneration.[25] We believe that the autologous fibrin matrix with growth factors contained in platelets and released during the natural process of hemostasis has a synergistic effect on the mesenchymal stem cells and other elements that form the implant, improving healing.

It has been shown that PRP can be used with or without activation by calcium chloride; even more, release of growth factors is not significantly affected by the presence or absence of the activator.[26]

The simple process for obtaining the fibrin matrix allows a short but reasonable time to mix the crushed cartilage with the autologous matrix and insert it into the syringe and place it in the nasal dorsum. Because of the gelatinized state of the fibrin clot, it must be fragmented and embedded with the minigrafts of cartilage to increase its consistency; this mixture is compacted much more easily inside the syringe, which provides a cylindrical form to the construct that must be molded once placed on the nasal dorsum. Rapid polymerization with

commercial tissue adhesives basically depends on the addition of thrombin.[27] Some authors have shown in in vitro models that the structure and mechanical properties of the fibrin clot are important; in this respect, the rigidity of the matrix significantly influences the formation of capillaries by endothelial cells in response to bFGF (basic fibroblast growth factor vascular) or VEGF (endothelial growth factor) stimulation.

The resource of combining a crushed cartilage graft with an autologous fibrin matrix is not intended to regenerate chondral cells, but rather to promote the viability of chondrocytes through the modulating action of different PGFs contained in the three-dimensional structure of the matrix, which in turn creates a framework that leads to the formation of connective tissue and stabilizes the construct. This establishes the neoformation of blood capillaries that allow diffusion of nutrients to the chondrocytes.[28]

We think that this technique offers the same results as other techniques; however, we also think that it may be better in the sense that it is technically easier and faster than others. Also, the process to obtain the fibrin matrix does not include chemical substances, and though it is true that there is no scientific evidence of adverse effects with the use of sodium citrate as an anticoagulant as well as calcium chloride as an activator of PRP, it is always better to avoid using substances that are foreign to the body.

Some authors have reported histological findings in patients in whom the diced cartilage was placed as free bits and fascia-wrapped grafts. Calvert et al[29] showed histological features, such as healthy cartilage pieces with viable chondrocytes in their lacunae, positive glial acid protein staining, and organized capsule and fibrosis surrounding the cartilage pieces, an event that we were able to prove in two histological samples of patients requiring a touch-up. In these samples, the spaces between the crushed cartilage grafts had small components of fibrosis and viable chondrocytes. On the other hand, there are conflicting reports on the viability, resorption or scarring of chondrocytes after crushing or cutting. This controversy is ongoing. Viability apparently depends on whether cartilage is slightly, moderately, or severely crushed, but this was not the aim of this study.[30]

It is important to consider that any manipulation of the nose tip, especially those that augment projection and cephalic rotation can alter the overall perception of nasal dorsum height, moreover when the dorsum has been increased.

This method is used to augment the nasal dorsum; however, sometimes, irregularities may result from removal of a hump. In these cases, the surgeon may feel that it is necessary to smoothen the dorsum by sanding or filing, but this can cause excessive removal of the nasal dorsum and lower its height; in addition, there may still be irregularities. The crushed diced cartilage autologous graft obviously increases volume, but it can also be used to smoothen irregularities because the construct must be molded by hand.

A precise understanding of nose anatomy and its correlation with cephalometric facial proportions and angles is important for adequate surgical planning, in addition to providing a better perception of the relation between dorsum height and the nasal tip.[31] These measures were taken into consideration in our surgical planning. Although dorsum augmentation was small to moderate, it probably would have been beneficial to do millimetric measures during long-term follow-up.

The use of PRP in maxillofacial and orthopedic surgery has demonstrated its effectiveness because the presence of the previously mentioned growth factors included in the PRP promotes a shorter wound healing period.[32,33] It is therefore evident that in a pocket of soft tissues, vascular healing and final tissue remodeling will be of greater quality.[34–36]

Conclusion

We probably cannot speak of absolute permanence, because our maximum follow-up period was 4 years; however, so far the patients carry a volume with a shape and form that is aesthetically satisfying and without changes over the years. It would be advantageous to perform a histological analysis to determine whether chondrocytes are still viable in the long term and to determine the evolution of the graft with this technique to help clarify the concern that we all have of potential resorption. We hope to do this in the future with more patients.

Another fact that we wish to highlight is that in this technique PRP does not need to be activated. This is useful because chemical substances are not used, making this procedure simple and faster.

One aspect very important to mention is the fact that the construct itself does not adhere to the deep tissues (periosteum/perichondrium) of the nasal dorsum, making it possible to mobilize it manually. We have not detected any complaints; however, in our work, we do not recommend augmentations greater than 3 mm.

We know that one of the difficult challenges to achieve is the aesthetic modeling of the nasal tip in patients with Mestizo features and that this condition is directly proportional to the thickness of the soft tissue cover; however, we must also make every effort to reach a high aesthetic level of volume and contour of the nasal dorsum. It would have been convenient to objectively measure the results in dorsum height obtained. This could be considered in cases where greater augmentation is needed.

Strictly speaking, the implant is composed of three elements: cells (chondrocytes), biomaterial (platelet-rich autologous fibrin matrix), and growth factors. This malleable construct represents a highly attractive option for moderately augmenting the nasal dorsum, with the great advantage of manually molding and shaping the dorsum as needed. The platelet-derived fibrin gel, together with the action of growth factors, conceptualized as an implant, represents a matrix that stabilizes and integrates crushed cartilage grafts with the maximum benefits of being a 100% autologous, easily reproducible method that avoids the use of chemicals for its production.

In this regard, we believe that the use of this therapeutic resource can be considered an attractive alternative, not only to augment but also to camouflage irregularities of the nasal dorsum or even those that result after removal of a

hump. The only limit in the versatility of this application is imagination.

Conflict of Interest

The authors declare that they have no conflicts of interest.

References

1 Daniel RK. Cefalometría correlacional en rinoplastia Aesthetic Plastic Surgery Rhinoplasty. Irvine California: Elsevier; 1993:687
2 Tebbetts JB. Rethinking the logic and techniques of primary tip rhinoplasty: a perspective of the evolution of surgery of the nasal Tip. Otolaryngol Clin North Am 1999;32(4):741–754
3 Strauch B, Erhard HA, Baum T. Use of irradiated cartilage in rhinoplasty of the non-Caucasian nose. Aesthet Surg J 2004; 24(4):324–330
4 McKinney P, Loomis MG, Wiedrich TA. Reconstruction of the nasal cap with a thin septal graft. Plast Reconstr Surg 1993;92(2): 346–351
5 Sajjadian A, Rubinstein R, Naghshineh N. Current status of grafts and implants in rhinoplasty: part I. Autologous grafts. Plast Reconstr Surg 2010;125(2):40e–49e
6 Park JH, Jin HR. Use of autologous costal cartilage in Asian rhinoplasty. Plast Reconstr Surg 2012;130(6):1338–1348
7 Sheen JH. The ideal dorsal graft: a continuing quest. Plast Reconstr Surg 1998;102(7):2490–2493
8 Kelly MH, Bulstrode NW, Waterhouse N. Versatility of diced cartilage-fascia grafts in dorsal nasal augmentation. Plast Reconstr Surg 2007;120(6):1654–1659, discussion 1654–1659
9 Daniel RK, Sajadian A. Secondary rhinoplasty: management of the overresected dorsum. Facial Plast Surg 2012;28(4):417–426
10 Erol OO. The Turkish delight: a pliable graft for rhinoplasty. Plast Reconstr Surg 2000;105(6):2229–2241, discussion 2242–2243
11 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(3): 1309–1318, discussion 1319–1321
12 Daniel RK, Calvert JW. Diced cartilage grafts in rhinoplasty surgery. Plast Reconstr Surg 2004;113(7):2156–2171
13 Tasman AJ, Diener PA, Litschel R. The diced cartilage glue graft for nasal augmentation. Morphometric evidence of longevity. JAMA Facial Plast Surg 2013;15(2):86–94
14 Bullocks JM, Echo A, Guerra G, Stal S, Yuksel E. A novel autologous scaffold for diced-cartilage grafts in dorsal augmentation rhinoplasty. Aesthetic Plast Surg 2011;35(4):569–579
15 Anitua E, Tejero R, Alkhraisat MH, Orive G. Platelet-rich plasma to improve the bio-functionality of biomaterials. BioDrugs 2013; 27(2):97–111
16 Araki J, Jona M, Eto H, et al. Optimized preparation method of platelet-concentrated plasma and noncoagulating platelet-derived factor concentrates: maximization of platelet concentration and removal of fibrinogen. Tissue Eng Part C Methods 2012;18(3): 176–185
17 Galliera E, Corsi MM, Banfi G. Platelet rich plasma therapy: inflammatory molecules involved in tissue healing. J Biol Regul Homeost Agents 2012;26(2, Suppl 1):35S–42S
18 Lubkowska A, Dolegowska B, Banfi G. Growth factor content in PRP and their applicability in medicine. J Biol Regul Homeost Agents 2012;26(2, Suppl 1):3S–22S
19 Sommeling CE, Heyneman A, Hoeksema H, Verbelen J, Stillaert FB, Monstrey S. The use of platelet-rich plasma in plastic surgery: a systematic review. J Plast Reconstr Aesthet Surg 2013;66(3): 301–311
20 Cervelli V, Palla L, Pascali M, De Angelis B, Curcio BC, Gentile P. Autologous platelet-rich plasma mixed with purified fat graft. Aesthetic Plast Surg 2009;33(5):716–721
21 Choukroun J, Diss A, Simonpieri A, et al. Platelet-rich fibrin (PRF): a second-generation platelet concentrate. Part V: histologic evaluations of PRF effects on bone allograft maturation in sinus lift. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2006;101(3):299–303
22 Castro-Govea Y, Cervantes-Kardasch VH, Borrego-Soto G, et al. Human bone morphogenetic protein 2-transduced mesenchymal stem cells improve bone regeneration in a model of mandible distraction surgery. J Craniofac Surg 2012;23(2):392–396
23 Castro-Govea Y, del Campo AF, Chacón-Martínez H, Pérez-Porras S, Vallejo-Estrella RO, Cervantes-Kardasch V. A procedure to prevent cephalic rotation of cartilage grafts in the nasal tip. Aesthet Surg J 2009;29(2):98–105
24 Guerrerosantos J, Trabanino C, Guerrerosantos F. Multifragmented cartilage wrapped with fascia in augmentation rhinoplasty. Plast Reconstr Surg 2006;117(3):804–812, discussion 813–816
25 Burnouf T, Goubran HA, Chen TM, Ou KL, El-Ekiaby M, Radosevic M. Blood-derived biomaterials and platelet growth factors in regenerative medicine. Blood Rev 2013;27(2):77–89
26 Lee JW, Kwon OH, Kim TK, et al. Platelet-rich plasma: quantitative assessment of growth factor levels and comparative analysis of activated and inactivated groups. Arch Plast Surg 2013;40(5): 530–535
27 Brown LF, Lanir N, McDonagh J, Tognazzi K, Dvorak AM, Dvorak HF. Fibroblast migration in fibrin gel matrices. Am J Pathol 1993; 142(1):273–283
28 Kessler MW, Grande DA. Tissue engineering and cartilage. Organogenesis 2008;4(1):28–32
29 Calvert JW, Brenner K, DaCosta-Iyer M, Evans GR, Daniel RK. Histological analysis of human diced cartilage grafts. Plast Reconstr Surg 2006;118(1):230–236
30 Bujía J. Determination of the viability of crushed cartilage grafts: clinical implications for wound healing in nasal surgery. Ann Plast Surg 1994;32(3):261–265
31 Byrd HS, Hobar PC. Rhinoplasty: a practical guide for surgical planning. Plast Reconstr Surg 1993;91(4):642–654, discussion 655–656
32 Pal US, Mohammad S, Singh RK, Das S, Singh N, Singh M. Platelet-rich growth factor in oral and maxillofacial surgery. Natl J Maxillofac Surg 2012;3(2):118–123
33 Hsu WK, Mishra A, Rodeo SR, et al. Platelet-rich plasma in orthopaedic applications: evidence-based recommendations for treatment. J Am Acad Orthop Surg 2013;21(12):739–748
34 Brenner KA, McConnell MP, Evans GR, Calvert JW. Survival of diced cartilage grafts: an experimental study. Plast Reconstr Surg 2006; 117(1):105–115
35 de Groot PG, Urbanus RT, Roest M. Platelet interaction with the vessel wall. Handbook Exp Pharmacol 2012;210(210):87–110
36 Chen CW, Corselli M, Péault B, Huard J. Human blood-vessel-derived stem cells for tissue repair and regeneration. J Biomed Biotechnol 2012;2012:597439