Rhinoplasty Using Autologous Costal Cartilage

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Methods

Patients who had rib grafts used for augmentation septorhinoplasty from 2004 through 2011 were assessed for graft warping, graft mobility, graft viability, and maintenance of dorsal projection. A retrospective cohort study was performed using a medical chart review. A total of 286 rib graft septorhinoplasties were performed in the review period. In 124 cases, rib was used as a dorsal onlay graft. The mean duration of the clinical follow-up was 36 months. The patients’ mean age was 32 years. Sixty eight percent of patients had previous nasal surgery. The reasons for a surgical correction were underprojected nose (58%), low nasal dorsum (64%), deviated nose (48%), internal valve collapse (56%), external valve collapse (32%), and nasal obstruction (78%). In 86 patients (30%), rib grafts were combined with expanded polytetrafluoroethylene (e-PTFE); in all of these cases the implant material was used to improve the dorsal line. All the patients we used an open rhinoplasty technique.

 Patients were assessed at 1 week, 2 weeks, 1 month, 3 months, 6 months, and 12 months postoperatively. At each visit, the rib grafts were assessed for resorption, mobility, or warping by examination. Standard septorhinoplasty photographs were taken beginning at the 1-month visit.

Results

A total of 286 rib graft septorhinoplasties were performed in the 8-year period. The mean duration of the clinical follow-up was 24 months. The principal postoperative complication was warping of dorsal rib graft in 26% of the patients. None of the patients lost dorsal or tip projection. Undercorrected deviated nose was present in 12% of the cases. The internal and external valve collapses were corrected successfully, but
persisting nasal obstruction was present in 8% of the cases. There were no pneumothoraces. Ten percent of the patients had minor problems related to the thorax scar. In the group of patients having combined rib graft with e-PFTE, 8% presented infection or extrusion of the implant material. One patient presented necrosis of the transcolumnellar incision flap.

Discussion

Characteristics of Our Patients: The Mestizo Nose

The population of Latin America is made up of individuals with unique aesthetic facial features directly related to their ethnic origin, which differ in each country of the continent and even include marked facial anatomic variations in different geographic regions of each country. The root of these differences resides in the facial morphological features of the ethnic groups from each region of the continent prior to the colonization and the millions of possible genetic combinations that came about when the ethnic groups became selectively combined with European groups as a result of the selective migration to each region of the Latin American continent.

It is very difficult to standardize the morphological and anthropometric features of the patients we meet in our daily practice who desire a septrhinoplasty. Most Venezuelans have ethnic roots from different indigenous Venezuelan groups, from European immigrants, and from Africans brought into the country as slaves in colonial times.

Venezuelans range over a varied combination of ethnic inheritance. Historically, Venezuelan indigenous natives, Spanish settlers, and Africans have contributed in various degrees to the ethnic and cultural composition of Venezuela. Subsequently, waves of European groups (Italians, Portuguese, and Spaniards) immigrated to Venezuela in the 20th century and influenced many aspects of life in Venezuela. More than half the population has a mixed racial origin: mestizo (of European/Indian ancestry), mulatto (European/African), and sambo (Indian/African). About one-fifth of the population is of white European ancestry and one-tenth is black from African ancestry. The remainder is made up of a statistically small native Indian population.

In other words, the basis of our practice is essentially treating mestizo patients, closely followed by mulattos and sambos, but there are also groups of patients with direct white European, or African, or Asian, and even Middle Eastern ancestry. Our practice thus turns out to be a multicultural practice that demands from us a flexible surgical approach, adapted to the requirements of each patient and to our possibilities and skills as surgeons, as well as the imperative need to maintain a consistent aesthetic character between the results of the surgical procedure and the features that denote the ethnic origin of each patient.

What Our Patients Want

In general, our patients look for better projection and rotation as well as a better definition of the nasal tip complex, a narrower nasal base, and a dorsum that is aligned and established under the points that define the tip of the nose. In general, they tend to want a smaller nose contour.

What We Offer: The Preoperative Negotiation Process

Our premise is to set realistic expectations about the results to be obtained from each surgical procedure. We do our best to understand the changes that our patients expect. Throughout the entire process we maintain an open and bidirectional communication that allows us to jointly establish a proper surgical plan, the result of which is satisfactory to both parties. We discuss the concerns of each patient in front of the mirror, and we find an effective strategy to show them pre- and postoperative photographs of patients with similar anatomic features. We explain the general characteristics of open surgery and the need to use it when we work with autologous costal graft. It is a priority for us to explain to our patients that the final result will be achieved starting from the first year after the operation and to let them know about the benefits and limitations of costal cartilage as graft material, the possible complications, and the advantages and disadvantages of alloplastic materials in case it becomes necessary to use them.

The Need for Grafts, Our Philosophy: Structural Septorhinoplasty

Septorhinoplasty is a surgical procedure with unique characteristics whose basic purpose involves the optimization of both the nose contour and nasal breathing function. Both objectives must be understood as one, assuming that surgically we manage an anatomic and functional unit with intimate and intricate cosmetic and functional relationships. In the authors’ opinion, the concept of functional septrhinoplasty has been the result of the natural evolution of nasal surgery, from the conjunction of a meticulous pre- and postoperative analysis of the results obtained and expressed by our patients and our permanent search for perfection. Today it is considered that every septrhinoplasty is functional and, as such, it can as a result either improve or harm nasal function. At this time, in the context of specific anatomic and functional knowledge of the potential causes of nasal obstruction and the physical forces that determine nasal air flow, nasal surgery is advancing toward an era of individual and personalized treatment of the nasal obstructive syndrome, beyond the historic and universal septrhoplasty, as the fundamental pillar of functional nasal surgery.

As nose surgeons, we must enhance our understanding of the role of every anatomic component of nasal architecture and the relationship and function of each one of them. We integrate this knowledge with the symptoms stated by our patients, improve our surgical techniques, and create new ones with the sole expectation of improving our patients’ quality of life. We, under the surgical magnifying glass, work toward obtaining better functional and aesthetic results.

Even though this concept is a modern addition to our surgical nomenclature, the specialized literature has shown growing interest in two specific anatomic areas that support its semantic, clinical, and surgical value: the internal nasal valve and the external nasal valve. Each one has strict
1. Stabilization of the nose base and control of the projection of the nasal tip complex: In every septorhinoplasty the nasal support mechanisms, both primary and secondary, are compromised during the time of the surgery, understanding and respecting the nasal support mechanisms, and reshaping the nasal structures instead of excessive resection. It implies a change of paradigm where nasal function is not sacrificed for an improved aesthetic nasal contour; instead, what is sought is a harmonic balance of the nasal contour within each patient’s own facial characteristics, giving priority to nasal functionality.

Technically speaking, structural septorhinoplasty is based on modern surgical techniques that have the following objectives:

1. Diagnosis and treatment of the deficiencies of the internal nasal valve: The causes relating to the nasal obstructive syndrome go beyond how the nasal septum, the volume, and the turbinates are disposed. Two frequent scenarios where this concept must be kept in mind are: patients who wish to have a primary septorhinoplasty with clinical evidence of nasal valve alterations, and patients with a history of septorhinoplasty who consult for nasal obstructive problems or require nasal revision surgery and have signs of alterations in these areas of the nasal anatomy.

3. Management of the external nasal valve by preserving the lower lateral cartilages: There are no doubts as to the need to maintain the lower lateral crura whole or the need to reinforce their strength during septorhinoplasty, not only because this surgical approach is favorable to the nasal lobe contour, but because of the aerodynamic implications in the nasal air flow that reductive techniques bring about in this region of the nose anatomy. We must also mention the importance of recognizing alterations in the physiologic orientation of the lateral crura as a factor with cosmetic and functional implications at the external nasal valve.8

Under the structural approach philosophy, where the trend is toward enhancing the nasal anatomic structures and the sensible use of grafts is predominant, the question that comes to mind is: What is the ideal grafting material? The most precise answer throughout history points to autologous grafts, and within this group, cartilaginous tissue, and among the different sources of the latter we could establish the following order as to their usefulness: (1) septal cartilage, (2) costal cartilage, and (3) auricular cartilage. The important thing to take into account when planning the surgical procedure, especially in revision surgical procedures, is the availability of those tissues on the one hand and their quality for being carved and used as structural grafts on the other hand.

Usefulness of the Costal Cartilage in Our Practice

The criteria used to select autologous costal cartilage as graft material for nasal reconstruction are the following:

1. Patients with a defective height of the nasal dorsal line requiring more than 2 mm of grafts to achieve a proper balance with the nasal tip complex
2. Lack of projection of the tip of the nose: Goode’s index lower than 0.55 in the case of scanty or absent cartilaginous septum
3. Short aesthetic nose with cases of scanty or absent nasal cartilaginous septum
4. Collapse of the internal nasal valve in cases of scanty or absent nasal cartilaginous septum
5. Saddle nose deformity
6. Primary deviated or revision nose in cases of scanty, absent or bad quality nasal cartilaginous septum
7. Posttraumatic nose in cases of scanty, absent or bad quality nasal cartilaginous septum
How We Get It
Using the Louis angle as a reference, we locate the second intercostal space; then, at the fifth intercostal space, right below the mammary fold in female patients, with a surgical marker we draw a reference incision of ~2.5 cm (Fig. 1). We carry out the dissection by planes until we find the costal perichondrium, which we cut and dissect. We locate the union of the costal cartilage with the rib and the sternum, where we make a cut with the scalpel. Subsequently, the costal cartilage of the fifth or sixth rib is removed (Fig. 2), and we check that there has been no perforation of the pleura through the Valsalva maneuver. Then we proceed to close plane by plane and perform a subcutaneous bupivacaine infiltration.

How We Shape It
Once we have obtained the piece of costal cartilage, we proceed to shape it concentrically with a no. 10 scalpel, leaving the medullary portion of the costal cartilage and removing the eccentric portion of the cartilage. All of the pieces are then soaked in saline solution with clindamycin for a period between 45 minutes and 2 hours. We do this because of the natural and well-documented tendency of costal cartilage to warp once it is removed. This period of time gives us a range of initial safety related to the possible distortion of the graft during the surgical procedure; if the graft gets distorted, we proceed to reshape the piece once again before it is finally placed and fixed. After this, we proceed to shape the different types of grafts based on the specific needs of each patient (Fig. 3).

How We Do It According to Our Specific Needs
We try to be extremely careful when planning the carving of the graft material. We use the concentric portion of the graft, which is related to the chondrosternal union, in preparing grafts for the purpose of stabilizing and projecting the nasal tip complex, because it tends to have a flattened shape and is thinner. The rest of the concentric portion is used to reconstruct the nasal valves and elevate the nasal dorsum. We find the eccentric portions very useful as camouflage material in the refining stage of the surgical procedure.

The Preoperative Examination
Questionnaire
We start the preoperative examination by giving our patients a clinical questionnaire. It is common in our practice to find that patients for whom, in our opinion, an autologous costal graft would represent a primary option are patients who are looking for revision septorhinoplasty. Within this group are those patients who frequently have severe nasal structural alterations coexisting with nasal functional alterations. Perhaps the two scenarios that lie outside this premise are, on the one hand, patients who have a severely deviated nose and, on the other, patients with posttraumatic noses. This group of patients is definitely not satisfied with their nasal contour, and they tend to be demanding and very much detail-oriented as to the surgical results they wish to obtain. They also usually have a higher level of technical knowledge than...
patients looking for a primary septorhinoplasty. This first interview allows us to become aware of the expectations of each patient, to understand how real those expectations are, and to explain the available strategies to meet the expectations. It is very important at this stage that the patient understands that the more severe the damage of the different anatomic areas of the nasal structure, the more technically difficult it will be to make the surgical corrections, thus always avoiding unrealistic expectations and patient dissatisfaction in the postoperative period.

Physical Examination
We perform a complete nasal examination. We evaluate for prior topic vasconstriction and, with the help of rigid endoscopes, the nostrils: we evaluate both the structure and integrity of the nasal septum as well as the structures of the lateral nose wall and the rhinopharynx, including the internal and external nasal valves. We thoroughly palpate the entire nasal skin covering and soft tissues, as this provides information on the thickness, elasticity, and mobility of the underlying structures, and we note their coloration; this latter feature is very important as it provides indirect information on the proper irrigation of the skin covering. We also palpate the bony pyramid of the nose, the cartilaginous vault, and the nasal tip complex, as well as the caudal edge of the nasal septum, and this allows us to imagine and understand specific alterations of the nasal contour and establish an initial surgical strategy and correctly plan for the quantity and quality of graft material necessary to reconstruct the nasal structure.

Photographic Documentation
We take photographs in six projections of every one of our patients. We think it is important to take photographs prior to the nasal surgical procedure, as this provides information on the original nasal structure of the patient and can orient us to the possible scenarios that we could face during the septorhinoplasty.

Open Surgery of the Nose
We perform an open surgical approach by making an inverted V transcolumellar incision at the middle of the columella, which is connected through bilateral marginal incisions. The structures of the nasal tip complex are dissected and the nasal dorsum is approached at the level of the subperiosteum initially creating a tight pocket, providing for the potential need to place autologous costal grafts in the nasal dorsum. The nasal septum can be approached by means of an intranasal hemitransfixion incision, or by dissecting the intercrural space after completing the open surgery, depending on the surgical plan to be executed.

The underlying reason for choosing open surgery is that there are specific nasal alterations that require a broad exposure of the nasal surgical area for them to be both diagnosed and corrected, and that under the structural septorhinoplasty approach we very frequently anticipate the need for extensive reorientation of the nasal structure or the use of autologous grafts and, consequently, the need to position them, fix them, and assess them once we have completed the work on every nose anatomy subunit. Also, it may possibly be necessary to reshape the grafts in the final stage of refining the surgical procedure, at which time we can evaluate the influence and relationship among each one of these subunits and the overall outcome of the execution of the surgical procedure as planned.

Surgical Approach
We conceptualize the operating process we use as a flexible surgical approach, based on an initial surgical plan drawn up on the basis of all the clinical evidence gathered during the preoperative stage (Fig. 4). Based on this initial plan we can determine the quantity and the origin of the graft material to be used. Once the plan is laid out, we distribute ourselves in two teams of two surgeons each; one of them is in charge of obtaining the autologous costal graft from the fifth and sixth rib, basically because we consider that it is at those ribs where we can find the highest amount of straight, uncurved cartilaginous tissue, and two other surgeons are in charge of the first stages of the septorhinoplasty. If there have been prior surgical procedures using heterologous graft material, we expose it during the surgery and proceed to dissect it very thoroughly, preserving as much as possible the skin covering and the soft tissues.

After obtaining the costal graft we are going to use, the head nasal surgeon already has a clear idea of how much and what type of graft material will be required during the surgery, and his assistant will shape the autologous costal graft concentrically. This perhaps is the stage where we can prevent the most frequent postoperative complication we have found: the warping of the rib chondral graft. The concentric carving of the soft internal portion of the cartilaginous graft allows us first to put aside the costal perichondrium (which is responsible for much of the external tensile forces related to the warping of the graft), and second, to be
able to use the soft tissue of the costal cartilage, which has been shown to have fewer bonds between the polysaccharides of the cartilaginous stroma, also related to the warping of the costochondral graft.\(^1\) When the carving of the chondral grafts to be used is finished (especially when nasal dorsum grafts are used), all of the material is dipped into clindamycin solution; then the nasal surgery is continued and the surgical procedure for obtaining the chondral graft is completed. In this regard, we leave the grafts to soak in a solution with antibiotics for at least 45 minutes before we evaluate them again, test them, and fix them to the nasal structure. Once the dissection time in the open surgery septorhinoplasty is up, we assess the integrity of the nasal mucosa and the nasal septum and, if necessary, we perform a septoplasty at this time.

If there is some hyaline cartilage from the septum available, we take it provided that we do not jeopardize the stability of the nasal structure. If the nasal cartilaginous support structure is compromised, we proceed to reconstruct it with costochondral graft. We reposition, or replace the dorsal edge of the septum, as well as its caudal edge, to stabilize the lower and middle third of the nasal structure.

At this point we focus our attention on establishing the projection and rotation of the nose tip (Fig. 5), now having available an arsenal of cartilaginous grafts that will allow us to set it with individualized indices and angles to attend to the needs of each patient. Then we evaluate the nasal cartilaginous vault and, if necessary, we proceed to reconstruct it. Usually we use spreader grafts that stabilize the vault, significantly improve the area of the internal nasal valve, and give us a stable surface in case we need to place a chondral dorsal graft. Now we perform another thorough inspection of the chondral dorsal graft and its spatial disposition, length, thickness, and edges, and we evaluate the ends and tentatively place it in its final position, assessing its relationship with the freshly established nasal tip complex, wrapping it with perichondrium or autologous temporary fascia, and fixing it in its final position (Fig. 6). We proceed to evaluate the nose as a whole, with all the grafts in place, and to decide whether it will be necessary to do some final refining of the nasal tip complex (Fig. 7). We then close all the endonasal incisions and the transcolumellar incision and place septum splints and an external nasal splint.

**Combination of Costal Cartilage with Heterologous Material**

**Usefulness of e-PTFE as Heterologous Graft Material in Septorhinoplasty**

For those patients we consider, after a clinical evaluation and preoperative analysis, to be candidates for using costal cartilage, we hope to use the graft material in several ways:

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**Fig. 5** Reposition and stabilization of the complex of the nasal tip using a chondral caudal extension graft.

**Fig. 6** Dorsal chondral nasal graft placement camouflaged with temporal fascia and fixed to skin in the area of nasal radix.

**Fig. 7** Stage of final evaluation, refinement, and camouflage nasal tip complex.
1. As structural grafts: Grafts shaped and meant to provide structural support to the nasal pyramid, for instance, columellar struts, caudal septal extension grafts, spreader grafts, among others, or as grafts that are shaped to replace specific structures of the nasal anatomy that are either compromised or absent, such as alar batten grafts.

2. As contour grafts: Grafts that, although not belonging to the normal nasal structure, help to improve the contour of the nose, such as cap grafts, shield grafts, lateral crus struts, or alar rim grafts, or those we use as camouflage in specific areas and with specific criteria such as morselized cartilage.

3. As enhancement grafts: Grafts meant to fill or enhance nasal anatomic regions that have been excessively resected during surgery, or are compromised due to specific pathologies; for example, the graft used to increase the nasal dorsum.

We are convinced that there is no better graft material for nasal surgery than autologous cartilage due to its innumerable advantages, among which the following stand out: it is easy to shape, it is biosafe, it has a low rate of resorption, a sufficient amount is available under normal conditions, it has a low rate of infection, and it has a low incidence of rejection.

We could then generalize that, for the first two groups of grafts mentioned, there is no competition whatsoever for this type of graft material from any other graft or implant material. However, costal cartilage grafts do present the potential complication that, when being used as a graft specifically to enhance the nasal dorsum, the graft may become deformed or have a tendency to warp, which results in postseptorhinoplasty complications such as deviated or raised nasal dorsal lines. Certainly effective measures have been described to reduce the possibilities of this happening,

but this specific circumstance always represents a risk for the nasal surgeon. For these reasons, e-PTFE is important in certain stages of the septrhinoplasty.

Why We Combine It with Autologous Costal Graft

The need to combine autologous costal graft with heterologous implant materials stems, on the one hand, from the great usefulness of costal grafts for making structural grafts in both primary and revision septrhinoplasty procedures in Latin America, and on the other hand, from the potential disadvantage of its tendency to warp when used as a nasal dorsum enhancing graft, a type of graft that is valuable in our practice.

This is in addition to the potential disadvantage (extrusion and infection) of heterologous implant materials when they are used in the nasal tip complex, although there have been successful results in some cases that show their usefulness as heterologous material for the nasal dorsum.

The alloplastic material that we use exclusively as graft material for the nasal dorsum is e-PTFE (expanded polytetrafluoroethylene), a carbon polymer bonded to fluorine forming an array of PTFE inert nodules and thin PTFE fibers with pores that range in diameter from 10 cm to 30 cm. We chose it among the rest of alloplastic implant materials for several reasons:

1. It is manufactured in sheets with different thicknesses, thus allowing us to choose the appropriate thickness according to the magnitude of the defect to be corrected and to select the number of sheets we will be using on an individual basis according to the needs of each patient.

2. The reduced diameter of its pores allows for very limited growth of the surrounding tissue to invade the material but at the same time allows for a mature layer of connective tissue to grow around it that stabilizes it and facilitates its removal if necessary.

3. It can be easily cut and shaped in different shapes and sizes.

4. Complications of e-PTFE are related to two factors: the surgical technique, meaning that the higher the amount of implant material used, the higher the probability of complications in the shaping and placing of the implant in this regard (in publications reporting the highest rate of complications the percentage reaches 2.9%15), and biological complications or complications inherent in the implant material, with a 1.9% complication rate directly related to infectious processes or postoperative extrusion.

We avoid the use of this graft material in the nasal tip complex to prevent an increase of the pressure on the skin cover and soft tissue and the subsequent possibility of its becoming ischemic and ulcerous, and we also avoid its use in patients with septum perforations, patients who are immunosuppressed or are undergoing pharmacological immunosuppressive therapy, and patients with insulin-dependent diabetes mellitus, to try to reduce the possibility of postoperative complications with an infection. Our approach in using this type of graft material, when it must be used, consists first of all in carrying out the entire structural work. This means that we reposition and establish the nasal tip complex, reconstruct and stabilize the cartilaginous vault, and in the final stage of the surgery, we do the nasal dorsum enhancement with e-PTFE. We try to cut out a tight pocket that will allow the proper lodging of the implant, preventing it from folding or becoming distorted or being subject to excess pressure from the soft tissue. In addition, we perform a strict hemostasis of the implant-receiving pocket. As for the management of the implant, our logistics consists in having only one member of the team handle it, from its extraction from the sterile package with a new pair of latex-free sterile gloves, shaping and carving it with surgical instruments that have not yet been used during the operative procedure and dipping it in pure cindamycin solution in a concentration of 900 mg/mL until it is finally delivered to the head surgeon, who places the implant in the pocket that has been carved for that purpose and fits it snugly inside. We finish by sewing the implant to the cartilaginous vault with absorbable suturing material (Fig. 8).

Common Complications and Strategies to Solve Them

When one understands that septrhinoplasty is one of the surgical procedures with the highest level of difficulty in facial plastic surgery from the planning, execution, and analysis of
the results obtained, it then becomes easy to understand that there are different ways to approach and resolve specific problems in each nasal subunit, and that each of these techniques is being used in different countries more or less successfully, depending on the type of challenge the surgeons face every day, and the technique used depends more on the facial features of each ethnic group and the concept of beauty inherent in each of them. In our continent, as we already mentioned, the use of costal cartilage has been very successful both when used alone or in combination with some types of alloplastic materials. It is also true that it is not free from complications, which we must foresee and know how to correct when they show up. Complications inherent to the site where the graft material is harvested can be prevented with an accurate surgical technique; we avoid the possibility of pneumothorax caused by penetration of the parietal pleura by preserving the perichondrium layer of the posterior side of the costal cartilage portion chosen to be used as grafting material.22

As for the complications arising from the septorhinoplasty itself, the one we have encountered most frequently is the warping of the nasal dorsum.10 However, we feel that, to the extent that we try to achieve perfection when carving and shaping the graft, during the preparation of the cartilaginous bony tissue that will be receiving the implant and when fixing it to both the nasal structures and the skin of the nasal dorsum, the probabilities of complications can be greatly

Clinical Case A revision rhinoplasty in a 34-year-old woman who had two Porex (Gore-Tex; WL Gore and Associates, Flagstaff, Arizona) implants in the dorsum and columella. (A–F) Preoperative photos. (G) Gunter diagram of the surgical procedure, which consisted of removal of Porex implants. The placement of a caudal septal extension graft of autologous costal rib graft and three layers of expanded polytetrafluoroethylene on the nasal dorsum. (H–M) Postoperative result.
reduced. In those cases where we have found warping of the dorsal graft, we wait for at least 9 to 12 months and perform a revision septorhinoplasty, carve the graft until we get the right configuration, and place it again with absolute care on the nasal dorsum. The skeletonization of grafts through the skin covering and soft tissues is another potential complication in both nasal dorsum and nasal tip complex grafts. In this regard, the strategies we have developed are to avoid placing them in patients with very thin skin and using temporary fascia or morselized cartilage to increase the thickness of the skin covering and soft tissues.

As for the use of e-PTFE, the most frequent complication is the infection of the alloplastic material, which we handle by removing the implant.

Conclusions

Most Venezuelan patients looking to have a primary or secondary septrhinoplasty share common characteristics in nasal aesthetic contour. Under the philosophy of open structure rhinoplasty, we have found autologous cartilage rib graft alone or in combination with e-PTFE to be very useful in selected cases to get the results that our patients desire. Under this philosophy and with the planned and measured use of autologous grafts and selected implants materials in specific nasal subunits, we can approach excellence in nasal surgery.

References