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A Three Level Impaction technique for Dorsal Reshaping and Reduction without Dorsal Soft Tissue Envelope Dissection.

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Abstract:	Background. Preservation Rhinoplasty (PR) techniques are continuously evolving in the last two years. Many variations of old-fashioned techniques have been proposed since Daniel coined this term in 2018. Authors want to introduce and describe indication for a new “three level impactions” technique allowing, in selected cases, a complete profile correction and dorsal reduction without the dorsal soft tissue envelope (STE) dissection. Methods. Three hundred fifty primary closed rhinoplasty cases were retrospectively studied from January 2018 and October 2019. Age, sex, race and technical details, surgical time and complications have been registered. Ninety-five dorsums were reduced and shaped without dissecting the dorsal soft tissue envelope, combining a 1) swinging door septoplasty with low septal strip resection, 2) endonasal bony cap mosaic osteotomies, and 3) Let down or Push down operation (LDO/PDO). Any dorsal component was resected. Results. All patients showed a dramatic change in profile height and shape without neither dorsal STE dissection nor bony cartilage dorsal tissue resection. The average follow-up time was 12 months (range 8-14 months). Conclusions. In selected patients, dorsum can be preserved without soft tissue envelope dissection, shaped and reduced by considering that its height and shape is made up by three levels: Dorsal keystone area (DKA), bone pyramid base and septum. By combining multiple endonasal maneuvers is possible to obtain a dramatic change without dissecting the soft tissue envelope and at the same time avoiding any dorsal tissue resection: mosaic osteotomies for DKA conversion from S to V shaped dorsum, LDO and low septal strip resection for impaction and quadrangular cartilage flap rotation for profile setting. It is a versatile

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INTRODUCTION

The philosophy and surgical techniques of Preservation Rhinoplasty (PR) philosophy has had a profound impact on rhinoplasty surgery and continues to evolve[1]. The lead author (redacted) has an extensive experience with both the high strip and low strip Dorsal Preservation techniques [2,3]. One persistent challenge has been the treatment of patients with S-shape humps due to intrinsic curvature of the bony cap which is often refractory to indirect flattening maneuvers. To solve this problem, the technique of endonasal mosaic micro-osteotomies of the bony cap was incorporated into our standard DP operations. This approach allows direct modification of the intrinsic curvature of the bony cap with the added benefit of not requiring any dorsal skin dissection. This article will concentrate on a series of ninety-five (95) primary rhinoplasties performed using a three-level impaction technique with the bony cap being modified using mosaic micro-osteotomies. The anatomical basis of the technique and its application within the spectrum of DP procedures will be discussed.

RELEVANT SURGICAL ANATOMY

The shape and size of the nasal dorsum remains the primary reason that Caucasian patients seek aesthetic nasal surgery. An in-depth evaluation of three relevant anatomical areas –the keystone area, the subdorsal septum, and the nasal walls – allows one to understand dorsal hump configurations and to select appropriate surgical techniques.

THE KEY STONE AREA. Palhazi et al. [4] introduced the concept of the cartilaginous vault being composed of a dorsal keystone area (DKA), which consists of the T-shaped dorsal septum, and a lateral keystone area (LKA), which reflects the cephalic portions of the upper lateral cartilages. The anatomy of the osseocartilaginous junction and in particular its area of overlap (8 to 9 mm on average)[4] at the keystone area (KA) is a direct reflection of its embryological development. As shown histologically [5], there is a juxtaposed layer of periosteum and perichondrium wherever there is osseouscartilaginous overlap. Another important feature of the keystone is the pyriform aperture ligament which consists of perichondrial/periosteal fibers joining the ULC and nasal bone [6–9]. This ligament can be as thick as 1 mm and attaches directly to the bone at its distal edge, confirming its anchor role. On the dorsal keystone area, the ligament is very thick (more than 1 mm) and made of multiple layers of fibrous periosteum and perichondrium in different directions [6]. As emphasized by Saban [10], the keystone area is not a rigid fixed structure, but rather a flexible chondro-osseous joint thus allowing change of the dorsal shape. Histological studies of the keystone area (KA) indicate that the periosteum on the deep surface of the bony cap, fuses with the perichondrium on the superficial aspect of the cartilaginous vault. The result is a flexible dorsum which allows the convexity of the dorsum to be modified by reducing the underlying cartilaginous septal support. Thus, the vault can be changed from convex to concave without losing its continuity.

THE SUBDORSAL SEPTUM. The subdorsal segment of the cartilaginous septum is a critical area, both in a longitudinal and vertical direction. Longitudinally, the sub-dorsal junction of the cartilaginous and bony septum is highly variable often extending quite cephalically towards the radix. According to East et al [5] and confirmed by Ferreira [11], the mean distance from Transverse Radix Osteotomy Plane (TROP) to the junction between the PPE and quadrangular cartilage (E-point) is -7.25mm (range: -19.2 to 5.22mm). A negative value denotes that the subdorsal septal junction between quadrangular cartilage and PPE (E point) is located posterior to the TROP, meaning that cartilaginous septum underlies the keystone area in the majority of cases. Thus, the direct septal support of nasal humps is usually cartilaginous rather than bony. With experience, release of the subdorsal cartilaginous septum from the junction point (E) to the rhinion pivot point (R) point can be achieved with careful dissection**.**

LATERAL BONY NASAL WALLS. The lateral bony walls are formed by the nasal bone and the ascending process of the maxillary bones which represent the lateral dorsal pillars. In cross section, the maxillary ascending branch is thicker compared to nasal bones. In contrast to hump modification which is directly influenced by resection of the subdorsal septum, reduction of dorsal height is achieved by osteotomies at the base of the lateral wall thus allowing preservation of the dorsum. The head of the inferior turbinates is often in close contact to the caudal portion of the lateral walls in the area of Webster's triangle. Since medial movement of the bone could impinge on this portion of the nasal valve area, a triangular portion of bone at Webster's triangle is excised, especially with reductions greater than 4mm.

V- the next Section needs your insight

HUMP ANALYSIS/CLASSIFICATION. To date, there have been relatively few articles detailing analysis and classification of both the dorsal hump and the dorsal profile. Subsequent to Topinard's five basic profiles, there were attempts made to measure profile angles and components of the nose. At the present time, two articles are of particular relevance. Recently, Saban [12] presented the concept of a combined reduction – hump reduction and dorsal height reduction- which is a particularly valuable concept for DP procedures (Fig. 1 a, b, c). In the traditional Joseph resection rhinoplasty, both goals were achieved in one major reduction. If one is not directly resecting the hump, then the dorsal hump must be eliminated by reducing direct support to the hump (septal strip excision) and allowing flexion at the chondro-osseous joint. These DP methods work well on cartilaginous structures, but not on intrinsic bony vault contour deformities, especially in the bony cap. Dorsal height reduction is then achieved with either a cartilage vault or bony vault impaction maneuver. Thus, the surgeon needs to analyze the shape and composition of the nasal hump as well as select an operative technique for the desired aesthetic profile change. The second critical paper is by Lazovic et al [2] who classified the dorsal profile into V-shape and S-shape based on profile analysis of bony hump anatomy (Fig. 2 a, b). The V-shape dorsum has a flat bony cap starting at the level of the Nasion (N) and finishing at the level of the Rhinion (R). The nasion is defined as the deepest point in the radix area of the bony vault on profile view. The rhinion is defined as the most caudal point of the paired nasal bones and marks the midline junction of the bony and cartilaginous vaults. The S shape dorsum has a curved bony cap. The line starts at the level of the Nasion, passes to a distinct point called Kyphion (K, the most prominent point of the nasal bone) before continuing to the Rhinion. The intersection of the two lines N-K and K-R creates the Kyphion angle (KA). Studies by Lazovic[2] and Palhazi[4] were done on cadavers, and extrapolation of their findings to patients seeking rhinoplasty can be challenging. With the increasing use of preoperative cone beam CT scans (CBCT) for analysis, it has become clear that the soft tissue envelope (STE) can obscure clinical presentation of the bony vault anatomy (Fig. 3 a, b, e, f). For this reason, one can often have a Hidden S-shape dorsum in which the bony vault has an intrinsic kyphion angle, but a V-shape clinical dorsal profile (Fig. 3 c, d). The diagnosis can be made on palpation as a distinct kyphion point (K) can be felt cephalic to the rhinion junction (R) within the bony cap. Although not essential, the diagnosis can be confirmed with a CBCT. It is these types of Hidden S-shape dorsums that are ideal for the three-level impaction technique. Ultimately, the surgeon must subdivide dorsal surgery into planned hump reduction and dorsal profile reduction / modification by analyzing their composition to determine the optimal operative plan.

MATERIALS AND METHODS

Three hundred (300) primary rhinoplasty cases from the same surgeon (redacted) who were operated on between January 2018 and October 2019 were studied retrospectively. This study was conducted in accordance with the Declaration of Helsinki. One hundred seventy cases (170) had at least a 1-year follow-up and were therefore included in the study. All of the included patients had not had any previous nasal surgery and therefore there were no secondary cases included. Age, gender, ethnicity, and anatomy as well as operative technical details were recorded (V- or S- shaped dorsum, bony cap treatment, septal operation, type of impaction). Patients had a follow-up at 1 week, 1 month, 6 months, and 1 year after surgery. All 170 patients had a dorsal preservation (DP) procedure. The study can be broken down into 3 groups. Group 1 consists of ninety-five cases (95) cases with mild or hidden S-shape dorsum which were corrected with a "three level impaction" technique and are the basis for this report. Group 2 is composed of forty-five cases (45) with V-shape dorsum which were corrected with a complete preservation rhinoplasty technique (PR-C: complete preservation of the drosum, STE, and alars)[13] with 40 low septal strip and 5 high strip resections. Group 3 is comprised of thirty cases (30) with a severe S-shape dorsum which were treated with the Ishida technique (cartilaginous vault compaction)[14]. The focus of this report is on the Group 1 case series and the three-level impaction surgical technique used to correct them.

SURGICAL TECHNIQUE: THREE LEVEL IMPACTION

The "Three Level Impaction" method is a dorsal preservation **(DP)** technique in which the shape and size of the dorsum is changed without the need for dissecting the dorsal soft tissue envelope. In most DP procedures, impaction is achieved in two steps: septal strip resection to reduce the dorsal hump and osteotomies to mobilize the bony pyramid thus allowing dorsal height reduction. These integrated maneuvers allow one to minimize the hump and lower the nasal profile while preserving the anatomical integrity of the dorsum. The three-level impaction technique incorporates a series of multiple micro-osteotomies of the bony cap resulting in a mosaic fragmented configuration which eliminates the intrinsic curve of the bony cap and flattens it. Since the micro-osteotomies are done from an endonasal approach there is no need for dorsal skin dissection. The operative sequence is as follows.

LEVEL #1 SEPTOPLASTY AND SEPTAL STRIP REMOVAL. A swinging door septoplasty is performed via bilateral mucoperichondral flap exposure followed by release of the quadrangular cartilage (QC) - from the anterior nasal spine, premaxilla, vomer, and perpendicular plate of the ethmoid (PPE) (Fig. 4 a, b) [3]. Next, the subdorsal segment of the cartilaginous septum is released and the dorsal pivot point is selected which usually corresponds to the Rhinion (Fig. 4 a). Any posterior septoplasty is completed as indicated at this time. In order to create space for future impaction, two septal strips are removed – 1) a subdorsal strip cephalic to the pivot point, and 2) a triangular septal strip at the base of the QC (Fig. 4 b). The shape of the subdrosal strip resection can be either triangular or rectangular and is done with a **r**ongeur instrument. A triangular strip resection allows a hinge movement on dorsal impaction which avoids radix descent. In contrast, a rectangular strip resection is chosen for high radix patients where a radix drop is desired. Next, a limited low septal strip resection is performed to allow mobilization. An additional definitive resection of inferior septum will be done after the circumferential osteotomies. The quadrangular cartilage remains attached to the cartilaginous vault, but it is freed from the influence of the bony septum and can be moved in three dimensions.

LEVEL #2 MOSAIC MICRO OSTEOTOMIES OF THE BONY CAP. Micro osteotomies of the bony cap in a mosaic configuration allow flattening of a curved bony cap without the need for dorsal skin dissection (Fig. 5 a). The osteotomies are performed endonasally with a 2mm osteotome inserted between the muco-perichondral flaps in an oblique direction. Multiple fractures are created in the bony cap and at the level of the Kyphion angle to break the intrinsic curvature of the bony cap (Fig. 5 b). This portion of the bony vault is usually very thin and easy to break with the resulting fragments creating a type of mosaic. The fragments are not displaced as the periosteum keeps them in position (Video 1). It should be noted that a range of bony cap deformities are encountered in 3 dimensions: vertical bone thickness, transverse width, and longitudinal angulation. Therefore, the micro-osteotomies most frequently have a longitudinal H-shape with the parallel lines along the desired dorsal aesthetic lines and the transverse bar at the level of the kyphion (K point) thus breaking the bony kyphion angle. When the bony cap is thicker or wider, then multiple osteotomies are required resulting in a true mosaic configuration throughout the bony cap. The post-operative dressing is very important. After tape application, a pad is positioned over the dorsum to provide additional pressure to minimize any potential displacement. A thermoplastic cast is then applied to ensure even more stability for the mosaic micro-osteotomies.

LEVEL#3 PUSH DOWN OPERATION or LET DOWN OPERATION.

The choice between a Push Down Operation (PDO) and a Let Down Operation (LDO) depends on the size of the desired dorsal reduction. A PDO is performed if the reduction is less than 5mm while a LDO is preferred for reductions greater than 5mm. In both procedures, percutaneous transverse and radix osteotomies are performed first using a 2 mm osteotome. The radix osteotomy direction can change according to the case - oblique for a hinge motion or vertical for radix reduction. In the PDO procedure, the lateral low to low osteotomy is done with a 3mm guarded osteotome. It is placed endonasally and continues from the piriform aperture up to the level of the transverse osteotomy. Special attention must be paid to the blocking points that can prevent impaction. The blocking points are often created by the by the internal periosteum and the medial canthal tendon, both of which should be released to prevent a "spring effect" after impaction [11].

If a major reduction (>5mm) is required, then a LDO procedure is performed. Following the transverse and radix osteotomies, an inferior wedge of bone is resected from the piriform aperture up to the transverse osteotomy (Fig. 6 a). The resection can be done employing a guarded osteotome or a small Rongeur (Fig 6 b and c). When osteotomes are used, the superior osteotomy is done first to ensure stability and resistance. The LDO procedure is the most common procedure performed and has (in the authors' opinion) multiple advantages including the following: 1) minimizes narrowing at the level of internal nasal valve area, 2) precludes narrowing at the level of the piriform aperture, and 3) facilitates release of the piriform ligament with improved osseocartilaginous joint flexion.

FINAL FIXATION. After the 3 impaction maneuvers are performed, the septoplasty is completed by advancing and rotating the quadrangular cartilage (QC**)** flap in order to obtain final flattening of the dorsal profile. The QC flap should reach the anterior nasal spine (ANS) without tension. Special attention should be given to the final trimming of the QC base in order to ensure solid contact of the septum along the premaxilla and the ANS. If pushing downward on the dorsum results in a curve in the QC flap, then the QC size is excessive and additional 1 mm inferior strips are resected until the cartilage becomes straight. Once all these key points are addressed, the QC Flap is fixed to the ANS periosteum with a 4/0 PDS figure of eight suture.

RESULTS

The gender distribution of the 95 cases was 77 females and 18 males. The average age was 25 years with a range from 16 to 50 years. All patients were Caucasian and had closed rhinoplasty with an average follow-up time of 12 months. The average operative time was 100 minutes. The osseocartilaginous dorsum was preserved, and mosaic osteotomies were done at the level of the bony cap. There was no elevation of the dorsal soft tissue envelope thus ensuring anatomical continuity over the entire dorsum. In forty-five patients, the scroll area was dissected for tip modification and reconstructed at the end of surgery prior to closure. The average resection of the low septal strip measured 4 mm (range, 2-8 mm). In 85 patients (90%), Let Down Operation (LDO) were performed, while the Push Down Operation (PDO) was done in 10%. None of the 95 patients had revision surgery with "Three Level Impaction" technique up to now. No septal perforations were found on post-treatment speculum examination.

CASE STUDIES

Three representative case studies are presented as Figures 7 to 9 (Fig. 7, 8, 9); Three level impaction technique was performed in the case studies.

DISCUSSION

This three-level impaction technique can be discussed in terms of actual execution as well as how it fits within the spectrum of rhinoplasty techniques, especifically other DP procedures. CURRENT DORSAL PRESERVATION TECHNIQUES. Within the framework of Dorsal Preservation procedures, two broad approaches can be described: 1) the classical complete osseocartilaginous vault lowering, and 2) dorsal modification followed by cartilage vault lowering[15,16]. The classical DP operation with its septal strip excision followed by PDO or LDO produces excellent results in the majority of cases [17]. As broader application occurred by a greater number of surgeons over the past four years, two challenges appeared at either end of the nasal deformity spectrum. First, the significant S-shape nose proved challenging.

In many cases, the entire bony vault was disarticulated with a major drop-off at the radix and the osseo-cartilaginous vault pushed down into the pyriform aperture. Clinically, the profile would be straight, but the patient could still palpate a hump. The preserved dorsum with its curved bony cap was visible on CT-scan. The more severe the S-shape deformity, the higher the revision rate [18,19]. Second, disarticulation of the bony vault using circumferential osteotomies did not appear warranted or necessary for many smaller humps (<4mm). The concept of intact cartilage vault reduction was first demonstrated by Ishida in 1999. The procedure involved resection of a septal strip, excision of a cephalic bony hump, followed by cartilage vault push down to achieve the desired profile line. Subsequently, Ferreira et al. [20] proposed the "Spare Roof Technique" (SRT), which preserves the cartilaginous vault with resection of a portion of the caudal bony cap. A crushed cartilage graft is inserted before closure to insure a smooth contour. As noted by Kosins [15], the bony cap can be shaped by piezo or rasp reducing or minimize any dorsal deformity. Ishida recently modified the cartilage vault push down to reduce any dorsal irregularites following resecton of the bony vault [21,14]. The operation consists of the following steps: 1) septal strip excision, 2) release of the cartilaginous vault, 3) preservation of a bony cap segment, 4) adjustments of the bony dorsum, and 5) appropriate osteotomies. The critical difference is retention of a segment of the bony cap beginning at the rhinion (R), incorporating the kyphion point (K), and continuing cephalically towards the nasion (N) for a variable distance. These osteotomies achieve the following 3 things: 1) an intact segment of the bony cap in continuity with the cartilage vault is created, 2) the intrinsic S-shape in the bony dorsum, especially the Kyphion angle, is virtually eliminated, and 3) the remainder of the bony dorsum can be shaped with rasps or osteotomes. The advantage of the modified Ishida procedure is that it minimizes any dorsal irregularities associated with dorsal modification procedures and eliminates the need for crushed caritlage concealment grafts.

MOSAIC MICRO OSTEOTOMIES. As previously emphasized, the challenge with the S-shape dorsum is the rigid kyphion angle intrinsic to the bony vault which cannot be flattened irrespective of septal strip excision. Previous surgical options have been to ignore it, resect it, or create a bony flap in continuity with the cartilage vault. A new option is mosaic micro-osteotomies done endonasally which minimizes the S-shape intrinsic to the bony cap in selected cases. The technique is as follows: 1) a 2mm osteotome is passed between the muco-perichondral flaps, 2) the initial osteotomies are beneath the bony cap passing along the desired drosal aesthetic lines on either side up to the level of the transverse / radix osteotomies, and 3) a transverse micrososteotomy is done at the level of the kyphion. The result is that the multiple fracture lines throughout the bony cap and at the level of the Kyphion angle thereby effectively breaks the intrinsic curvature of the bony cap. In most cases, the bony cap is very thin and easily broken thus resulting in a mosaic set of fragments which do not move as the periosteum keeps them in position. The bony cap is therefore segmented, but each piece is vascularized through its periosteal attachment. Approximation of the bony fragments is maintained with a dressing that consists of an external pad, taping and acrylic cast which is left on for 7-10 days. Since there is no STE dissection over the dorsum, the fibroblast and osteoblast activity will be more limited resulting in a faster post-operative recovery.

Micro-osteotomies in nasal surgery were described in 1970s and by Mattioli [22] in 1996 for standard osteotomies. The current paper describes the use of micro-osteotomies to eliminate the intrinsic curvature of the bony cap. This type of procedure is termed *osteoclasis* which is performed without releasing the periosteal connections. Osteoclastic techniques are often used in orthopedic surgery to treat bone deformities (i.e. osteogenesis imperfecta), especially in children where bone devascularization must be avoided during growth [23,24]. As shown in Figure 10 (Fig. a, b c, d), the CT scan demonstrates a flat bony cap post operatively following an extensive modification of a wide and rigid bony cap. The mosaic method allows the surgeon to address one of the primary causes of recurrent hump deformities following DP procedures – persistent curvature of the bony cap.

THREE LEVEL IMPACTION TECHNIQUE. Although mosaic micro-osteotomies can be used for very minor bony hump deformities as an isolated technique, the senior author (redacted) has found it most valuable as part of the three-level impaction operation. The first step is a swinging door septoplasty followed by a bipartite septal strip resection. The first septal strip excision is below the bony vault and usually starts at the level of the Rhinion before continuing to the level of the Nasion. The resected tissue from the subdorsal area can vary in composition: cartilaginous septum, bony perpendicular plate of ethmoid, or a combination. The second septal strip is at the inferior level of the quadrangular cartilage (QC) which allows the cartilaginous vault to impact downward. It is important to remove this tissue in order to create room to allow for flattening of the dorsal hump and for multi fractured bony cap.

Next, mosaic micro-osteotomies of the bony cap are done to flatten its intrinsic curvature and minimize any recurrent hump. Essentially, one is achieving the desired bony dorsal configuration similar to a cartilage conversion technique with three major differences. First, there is no dorsal skin dissection which is a major advantage as it lessens postoperative inflammation and is especially valuable in thin skin patients with a high risk of postoperative visible irregularities. Second, it maintains the entire bony cap without the need of resecting 4-8mm of caudal bony cap and avoids the risks associated with reshaping the remaining bony vault using power tools. Third, there is no need for concealer grafts of cartilage dust or other materials as there is no skin dissection. Essentially, one can eliminate the Kyphion Angle intrinsic to the bony cap thereby converting the dorsal profile from angulated to straight. Letdown operation allow to achieve more impaction compared to pushdown; the latter is formed by a sliding of the nasal bones inside the piriform aperture with a narrowing effect of the nasal base but this sliding must be limited in order to avoid internal nasal valve obstruction while the let down operation is represented by a wedge bony resection at the level of the ascending branch of the maxilla. Thus the bone stumps come into contact and is possible to control the impaction without any base narrowing. LDO and double septal strip resection allows the surgeon to avoid LKA dissection. As the LDO procedure releases part of piriform ligament, an LKA dissection is not necessary to achieve a straight dorsum profile**.**

AVOIDING DORSAL SKIN DISSECTION. One of the most severe sequelae of resection rhinoplasty is thinning and scarring of the soft tissue envelope, especially over the dorsum. To avoid damage of the STE, surgeons have progressively deepened the plane of dissection from subcutaneous to subSMAS to subperichodnrial/subperisoteal. Ideally, no dissection of the STE would have 5 major benefits. First, direct damage to the neurovascular and SMAS structures of the nasal STE would be eliminated. Second, one could avoid initiation of a major inflammatory cascade over the dorsum which results in postoperative edema and fibrosis. Third, one prevents any dead space formation which would be filled with new connective tissue and scar tissue during the healing process. Fourth, there is no permanent disruption of the nasal ligaments in the internal valve area as there is no dissection above that required for tip surgery. Fifth, the incidence of early postoperative morbidity (bruising, swelling), intermediate term patient disappointment (lack of definition, supratip-dorsal swelling), and late term sequelae (skin thinning, visible irregularities) would be either minimized or eliminated. Essentially, *a no dorsal skin dissection technique* is a major benefit. Dorsal preservation without STE dissection was first described by Gola et al. [25]. The procedure he favored consisted of a high subdorsal septal transection or strip excision followed by a a pushdown of the nasal vault without any dorsal skin dissection. His experience with over a thousand cases is summarized in his textbook [26] where he states that the primary complication he encountered was a residual hump. Saban, who was a Surgical Fellow with Gola, adopted many of his principles, but favored dorsal skin undermining [10]. Saban felt that elevation of the skin was especially required in deviated noses as the skin would maintain the deformity unless released. His preference for skin undermining probably reflects the wide range of asymmetric cases where unilateral let down and bony vault rotation without skin restriction were essential [17]. As validated by this study, it is possible to avoid dorsal skin dissection in the majority of primary rhinoplasties depending on the surgeon's preference of surgical techniques and patient population.

LEARNING CURVE. The limits of mosaic osteotomies were initially pushed to understand which patients benefited most and to understand the relative indications for both the 3-Level Impaction with mosaic osteotomies and the modified Ishida technique. A 2 mm osteotome is the right compromise because it easily breaks the bones but at the same time gives a good control to the surgeon to avoid excessive pressure with possible skin perforation. It is important to angulate the tip of the instrument in an oblique fashion so that just one corner of the cutting edge is in contact with the bone. This method allows the surgeon to minimize the required force of the hammer during the osteotomy thus reducing the risk of periosteum disruption and skin perforation. In this way the force of the hammer is transferred to a smaller surface and the pressure, according to the equation P=F\A (pressure=force\area), is increased (AGGIUNGERE REFERENCE Primary Rhinoplasty: A New Approach to the Logic and the Technicques- tebbets). Prior to beginning the opperation, it is important to mark on the skin the bony cap limits and its anthropometric points (Nasion, Kyphion and Rhinion). The drawings are important to define the fragmentation area. After the osteotome is inserted between the mucoperichondral flaps, the first target is the Kyphion in order to break the intrinsic bony curvature. The nurse taps the osteotome with the hammer using soft, but frequent strokes. With this method, the surgeon can feel the progression of the osteotome tip through the bone. The micro-osteotomies are continued caudo-cranially in the center of the marked area until the Nasion is reached. The feeling under the fingers should be a net softening of the tissue in the center and two bony osteotomy clefts at its sides which reflect the cephalic bony portion of the dorsal aesthetic lines. The size of the bony cap and its curvature are the main features that affect the entity of the fragmentation and therefore the osteotomies quantity; i.e. short bones are the easiest to correct because of low number of mosaic fragments while long and curved bones need more fragmentation.

After the central area has been fragmented, one should decide the height of the new DALs by braking the bony clefts at the desired height preceding with the same caudo-cranial direction by angulating the osteotome in an oblique medial to lateral direction.

PATIENT SELECTION

The shape of the nasal dorsum is determined by the cephalic bony vault, the osseo-cartilaginous nasal hump, and the cartilaginous dorsum. (2) As discussed in the Methods and Materials Section, our total clinical series consisted of the following 3 Groups: 1) Hidden S-Shape (95 cases, 55%), 2) V-Shape (45 cases, 26%), and 3) Severe S-Shape (30 cases, 19%). A progressive surgical approach was used as determined by the type / severity of the dorsal hump and not by the total amount of dorsal reduction.

V-SHAPE. The V-shape dorsum can be corrected with a standard DP technique as there is no need for bony vault reshaping. A straight or slightly concave profile can be achieved by septal strip excision and flexion of the chondro-osseous joint. PDO or LDO decision depends on total amount of reduction to be done. As there is no need for correcting an intrinsic deformity of the nasal bones / bony cap, a double level impaction technique is sufficient: a septal strip excision (low or high), followed by PDO or LDO. For those cases, it is possible to apply a no dorsal STE dissection techniques as SPQR V2/V3[3] for low septal strip resection or Gola et al.[25] variation for high septal strip resection. Of 45 V-shape cases, in 35 cases we perfomed SPQR, in 3 cases a Gola procedure, and in 7 cases an Ishida procedure because of a wide dorsum.

SIGNIFICANT S- SHAPE. In the S-shape dorsum, there are various degrees of curvature at the level of the bony cap which are measured by the Kyphion Angle (KA). It varies on average between 203 degrees in the male to 200 degrees in the female. Our decision is made more on "surgical judgement" rather than on an anthropometric radiologic measurement. The choice of surgical technique is base on multiple factors. The association of the radiological, photographic and palpatory study allow the surgeon to understand the 3D bony cap configuration (thickness, width, lenght, coronal and sagittal curvature) and its intrinsic features (resistance). The transition between no STE dissection\mosaic osteotomies and STE dissection\Ishida lies in the 3D bony cap configuration and its intrinsic features. A thin bony cap, short nasal bones and an elastic joint is the best indication for mosaic osteotomies. If the bony cap curvature is excessive with an important Kyphion and strong bony component, our favourite technique is DKA manipulation or resection with complete cartilaginous vault preservation. It is the lead Authors opinion (redacted) that the modified Ishida technique is the preferred method for dealing with significant S-shape deformities. Following septal strip excision and cartilage vault release, a continuous osseocartilaginous segment is preserved. The dorsal component of the underlying bony vault can be lowered and reshaped to achieve the desired profile line followed by vault impaction to achieve the desired height reduction.

HIDDEN S- SHAPE. These cases look like a V-shape dorsum on profile, but on careful examination and palpation, a bony curvature with a distinct kyphion point (K) is present. The thick soft tissues in the radix area reduces the expression of the bony curvature thus creating the illusion of a straight bony profile. It should be noted that the majority (95/170, 55%) of our DP cases had this deformity. Bony cap manipulation is necessary for the final result. Otherwise, patients will complain of a persistent hump on palpation or a visible deformity on oblique view. Mosaic micro-osteotomies resulting in osteoclasis modify the intrinsic bony cap deformity thereby eliminating the Kyphion point and angle. Essentially, one converts the preoperative S-shape bony cap to a V-shape as the bony fragments heal in their new position. The three-level impaction technique is effective in dealing with the mild S-shape dorsum, but only if the dorsal aesthetic lines (DAL) are ideal. Patients with straight, wide DALs are considered a contraindication for mosaic osteotomies as the width remains unaltered and therefore unacceptable. Another relative contraindication occurs in when the bony component of the hump is very dominant and thick as numerous osteotomies would be required to fragment the bony cap with possible post-operative irregularities.

As the micro-osteotomies are done through an endonasal approach (inside-out direction), there is no need to elevate the dorsal soft tissue envelope. The avoidance of damaging the dorsal skin envelope is a major advance. As reviewed by Kovacevic et al.[27] a damaged soft tissue envelope is a major concern following primary rhinoplasty and a major challenge in secondary cases. Unpredictable scarring and contraction does occur and can lead to significant aesthetic and trophic sequelae. Potential damage of the dorsal STE is a real risk in the area overlying the bony cap which is the thinnest portion of the dorsal skin and thus predisposed to damage. Mosaic osteotomies allow the surgeon to expand the indications for a *"no dorsal skin dissection"* approach to a greater number of cases and to reduce the risk of postoperative morbidity.

STUDY LIMITATIONS

The limitations of this study include its retrospective nature. Furthermore, this technique was performed by the first two authors for a few months before the start of the inclusion period. The learning curve is ongoing. One-year follow-up is adequate for an article, but inadequate in terms of long-term longevity of dorsal preservation in particular. The reader interested in larger studies with long-term follow-up is referred to articles by Saban et al. [17,28,29] . Finally, no formal airway obstruction measurement tool was used although none of the patients in this series subjectively complained of airway obstruction and no anatomical nasal obstruction was noted on postoperative examination.

CONCLUSIONS

The present three-level impaction technique has two distinct advantages compared to standard DP techniques - minimizes the chance of residual hump formation by incorporating micro mosaic osteotomies to eliminate the intrinsic bony cap curvature and avoidance of dorsal skin undermining. The operation consists of the following 3 components: 1) septal surgery with a subdorsal and low septal strip resection, 2) mosaic osteotomies for bony cap conversion from S- to V- shape, and 3) LDO and low septal strip resection for impaction and quadrangular cartilage flap rotation for profile setting. This procedure is used in the majority of the lead author's primary rhinoplasties and is the centerpiece between minimal humps and severe S-shape dorsums. When proper patient selection is undertaken, it is a versatile technique which promotes fast recovery and natural results.

Conflict of Interest. None of the authors has declared any conflict of interest (financial or non-financial) from being named as an author on the manuscript.

FIGURE LEGENDS

Figure 1 - Concept of two-part dorsal reduction consisting of Hump Reduction and Dorsal Height Reduction.

Figure 2 - Cadaver dissections. (A) A V-Shape bony dorsum with a straight line from nasion (N) to rhinion (R) with absence of the kyphion point and thus no kyphion angle. (B) S-Shape bony dorsum with a distinct kyphion point (K) and therefore a kyphion angle (KA)

Figure 3 - Range of dorsal deformities. (A) Patient with a V-shape dorsum. The bony vault is flat therefore no need for bony vault shaping. (B) A Hidden S- shape dorsum. There is a mild S shape dorsum on palpation that is confirmed by CT scan, but the external profile is more of a V-shape dorsum. The palpable bony cap curvature indicates the need for bony cap reshaping. (C) Severe S-shape dorsum. This case requires extensive bony vault reshaping and the authors' preferred method is an Ishida technique.

Figure 4 - Swinging Door Septoplasty wiht Bipartite Septal Resection. (A) A "swinging door" septoplasty is achieved by total mobilization of the quadrangular cartilage from its bony attachments. The subdorsal dissection releases the QC-PPE junction and then turns caudally towards the Rhinion. (B) The excisional cuts for removal of the inferior strip should be done in a triangular fashion, less anteriorly and more posteriorly.

Figure 5 - Mosaic Micro Osteotomies of the Bony Cap. (A)) Markings for bony cap osteotomies indicated by small dots. It is shaped by the letter H with the bilateral longitudinal bony cap osteotomies passing along the to DKA from the Rhinion up towards the Nasion. Transverse osteotomies interrupt the Kyphion in order to break its angle. Accessory transverse osteotomies can be added in order achieve more concave profile line. Circumferential osteotomies for complete mobilization are indicated by heavy dash lines. In such case, transverse, radix and LDO osteotomies (B) A) 2 mm osteotome is used to perform osteotomies. The osteotome is inserted between muco-perichondral flaps and is inclined in an oblique fashion to realize small fractures along the lateral border of the bony cap.

Figure 6 – A) LDO: Bony wedge resection performed with a 4mm osteotome. The inferior is always performed after the superior.

b) 3d model showing the shape and position of the bony wedge to resect in let down technique.

c) Bony wedge resection can be done with the help of a Rongeur instrument taking care to avoid any twisting motion during small bony fragments resection. This allows to avoid any unwanted fracture lines.

Figure 7 – Three level impaction technique case example. A 30-year-old female complained of a slight dorsal hump with bulbous, droopy and plunging tip on smiling. Pretreatment (A, C, E, G, I) and 1-year posttreatment (B, D, F, H, J) views are shown. A subperiochondrial-subperiosteal dissection of the tip and septum was selected with preservation of all ligaments. Tip suturing was performed with cephalic dome sutures, 2.5-mm lateral steal procedure with the association of a columellar strut for tip stabilization. Her dorsum was found to be ideal on anterior view but on profile it was a tension nose with an overprojected dorsum. Clinically was a V shape but radiology and palpation were showing a hidden S shape bony dorsum. A three level impaction was performed by avoiding STE dissection, associating mosaic osteotomies for bony cap fragmentation, LDO (6mm wide bony wedge resection) and 8mm low septal strip resection for whole dorsal impaction. Right profile curvature was achieved by QC flap rotation and fixation to anterior nasal spine. 4 mm caudal septal resection for columellar show correction. Postoperatively the nasal hump has been eliminated, the dorsal aesthetic lines are symmetric, the nasal tip is well projected with good definition.

Figure 8 – Three level impaction technique case example. A 25-year-old female presented with a dorsal hump and plunging tip on smiling. Pretreatment (A, C, E, G, I) and 1-year posttreatment (B, D, F, H, J) views are shown. A subperiochondrial-subperiosteal dissection of the tip and septum was selected. Tip suturing was performed with cephalic dome sutures and a 4-mm lateral steal procedure. Columellar strut was inserted for tip stabilization. Dorsal aesthetic lines were found to be ideal on anterior view but on profile it was slightly overprotected with V shape bony dorsum. A three level impaction was performed by avoiding STE dissection, associating mosaic osteotomies for bony cap fragmentation, LDO (4mm wide bony wedge resection) and 6mm low septal strip resection for whole dorsal impaction. Right profile curvature was achieved by Qc flap rotation and fixation to anterior

nasal spine. Caudal septum was not resected in order to maximize tip stability and improve columellar show. Postoperatively the nasal hump has been eliminated, the dorsal aesthetic lines are symmetric, the nasal tip is well projected with good definition.

Figure 9 – Three level impaction technique case example. A 27-year-old female presented with a dorsal hump and plunging tip on smiling caused by depressor septi muscle hiperactivity. Pretreatment (A, C, E, G, I) and 1-year posttreatment (B, D, F, H, J) views are shown. A subperiochondrial-subperiosteal dissection of the tip and septum was selected. Tip suturing was performed with cephalic dome sutures, a 2-mm lateral steal procedure and medial crura overlay for infralobul curve treatment. Columellar strut was inserted for tip stabilization. Front view was ideal but on profile it was slightly overprotected with a hidden S shape bony dorsum. A three level impaction was performed by avoiding STE dissection, associating mosaic osteotomies for bony cap fragmentation, LDO (5mm wide bony wedge resection) and 6mm low septal strip resection for whole dorsal impaction. Correct profile curvature was achieved by QC flap rotation and fixation to anterior nasal spine. Postoperatively the nasal hump has been eliminated, the dorsal aesthetic lines are symmetric, the nasal tip is well projected with good definition.

Figure 10 – a) Nasal bones – pretreatment; b) Nasal bones – postoperatively at 12 months. CT scan demonstrates a flat bony cap post operatively following an extensive modification of a wide and rigid bony cap. The mosaic method allows the surgeon to address one of the primary causes of recurrent hump deformities following DP procedures – persistent curvature of the bony cap

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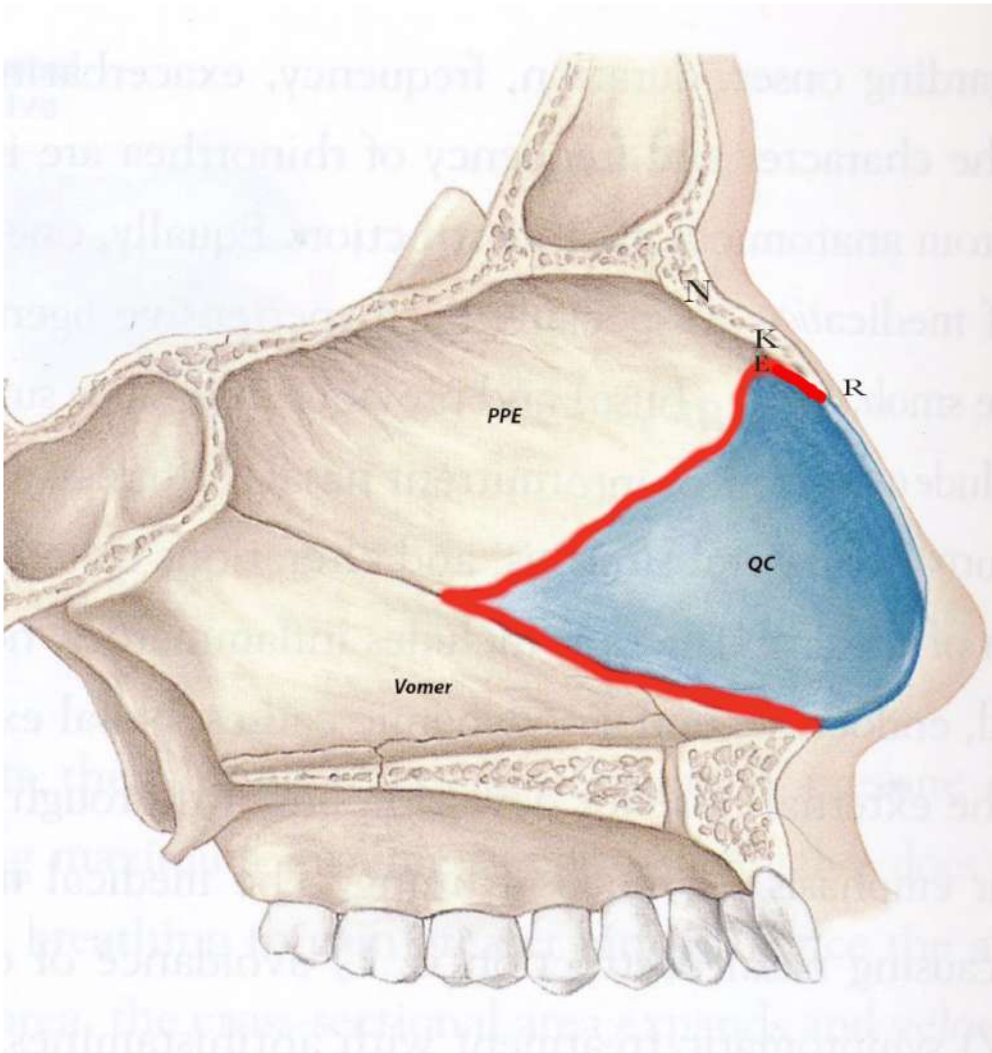

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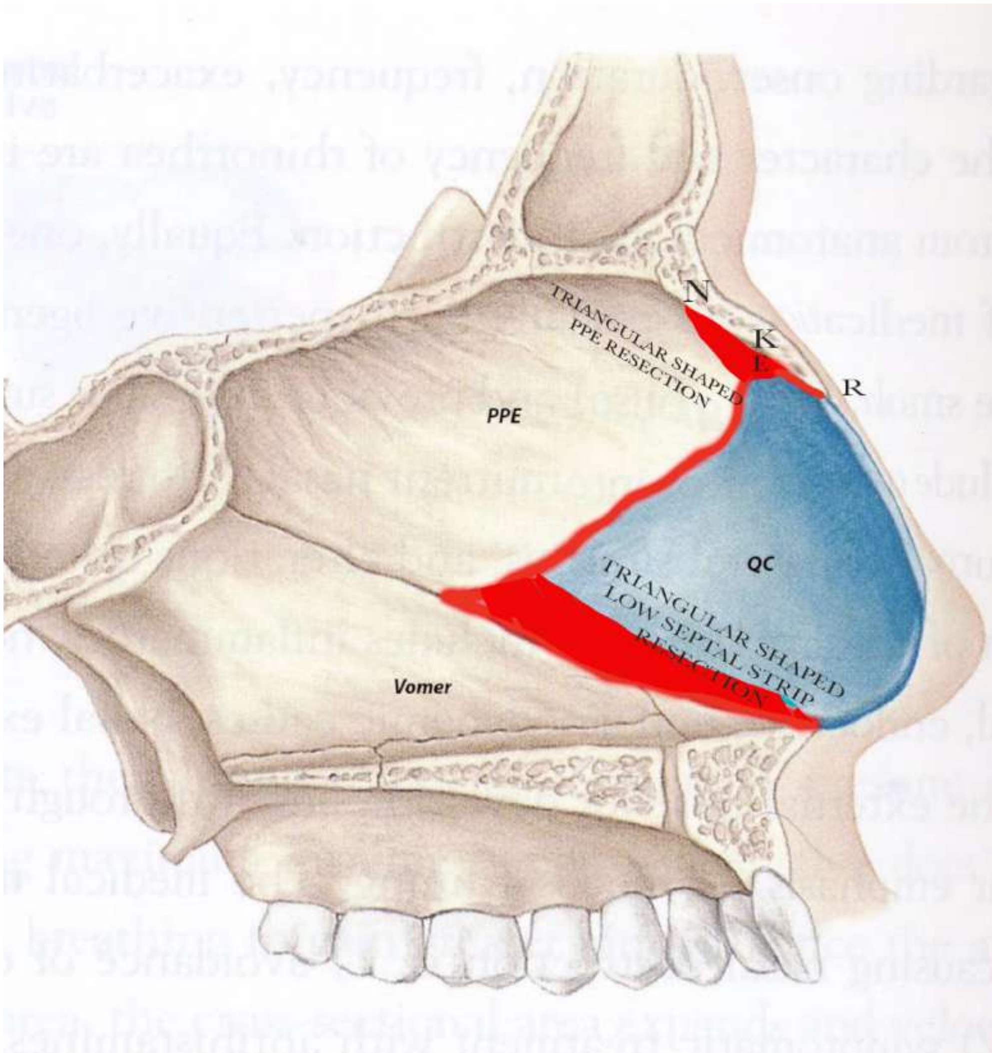

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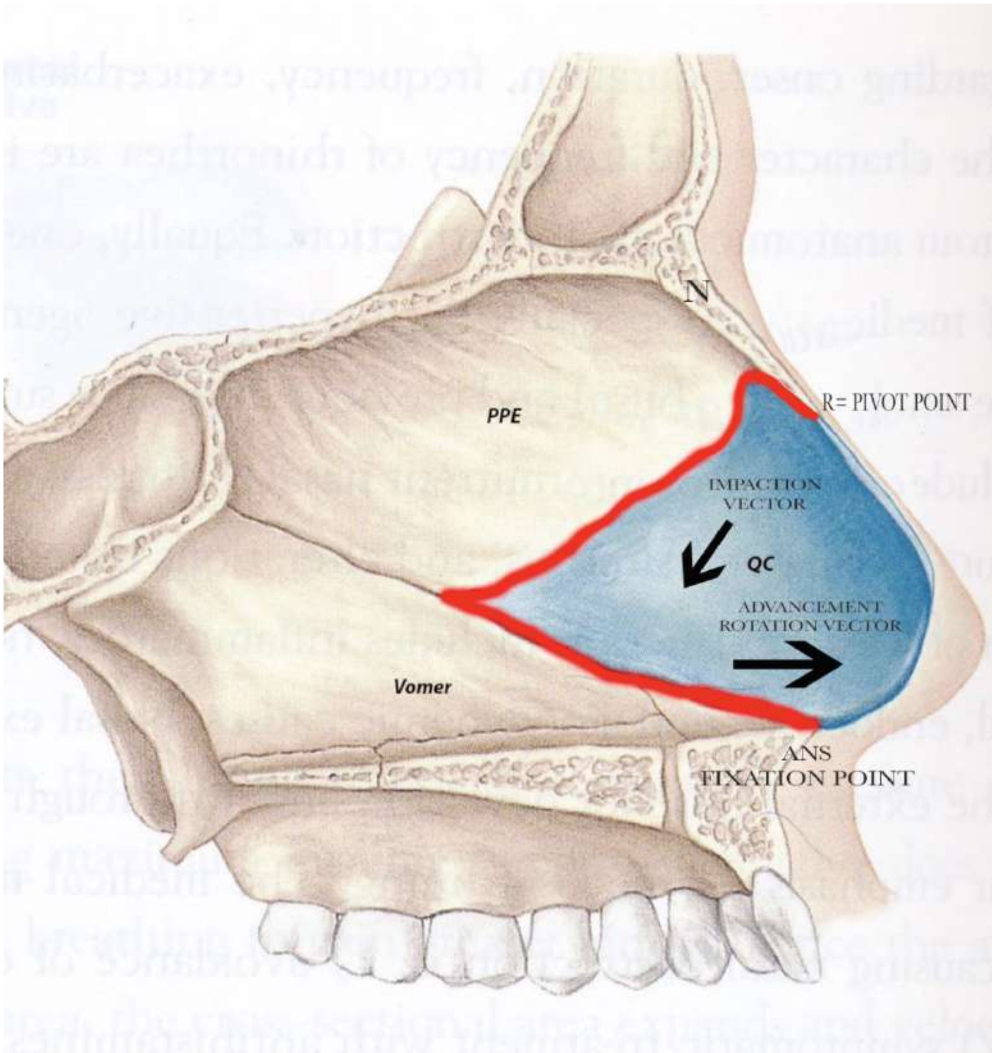

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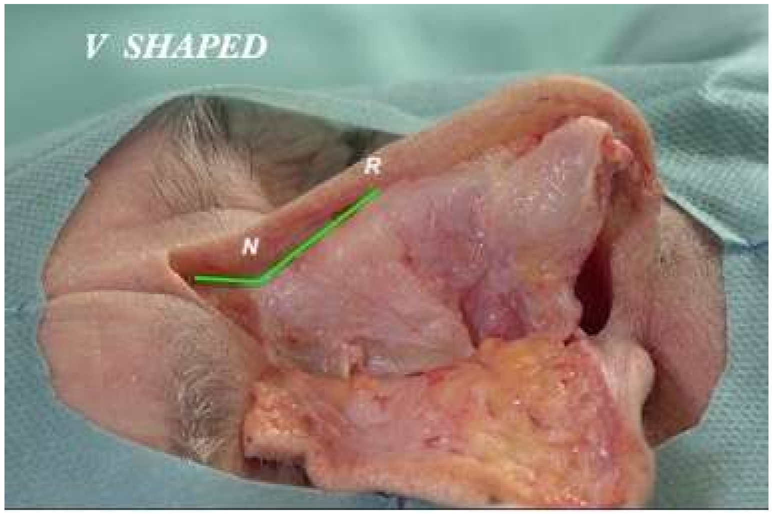

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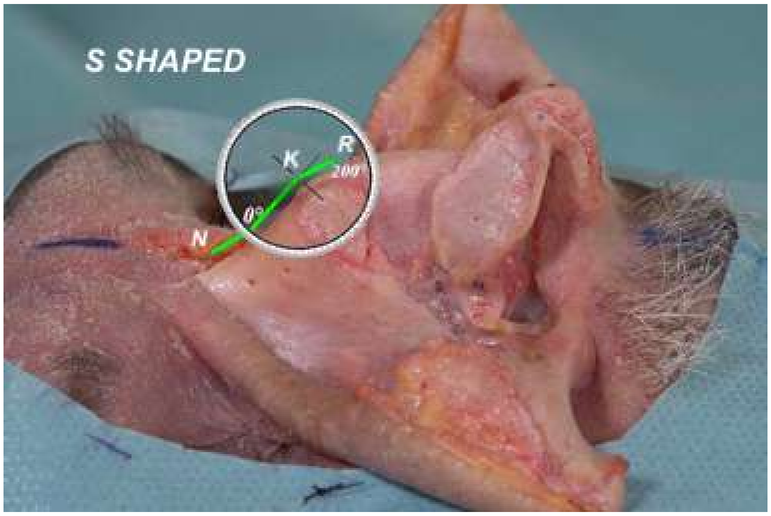

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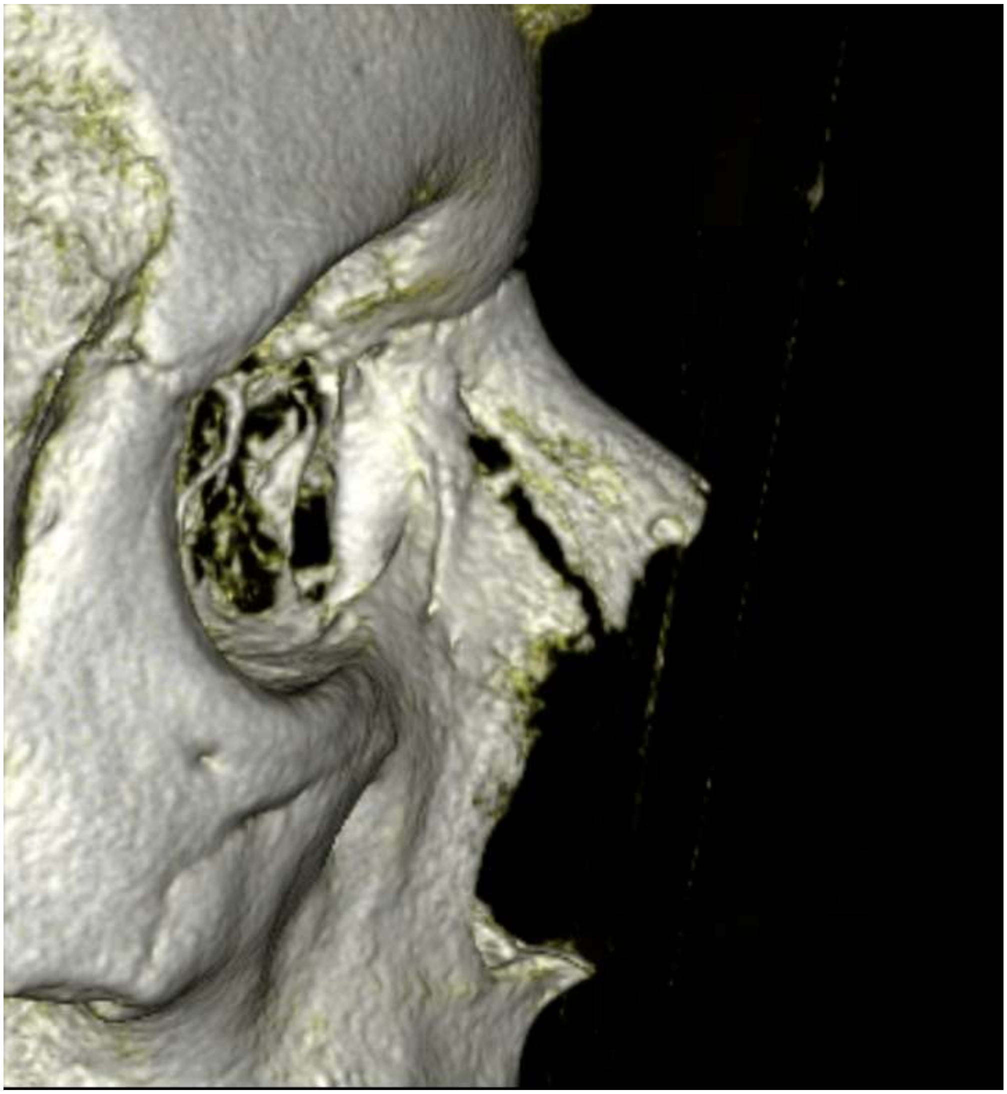

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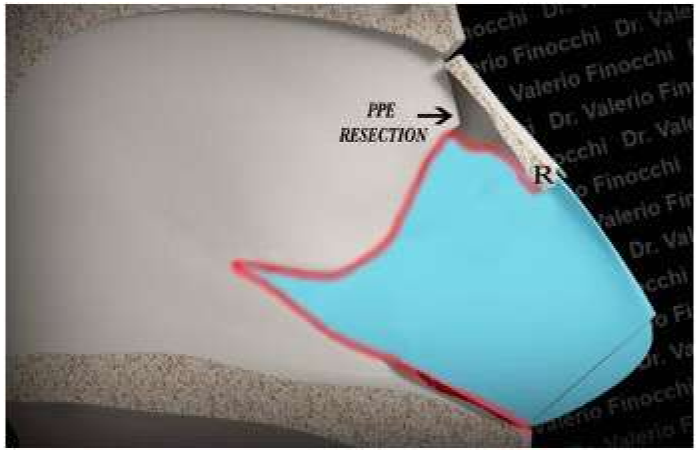

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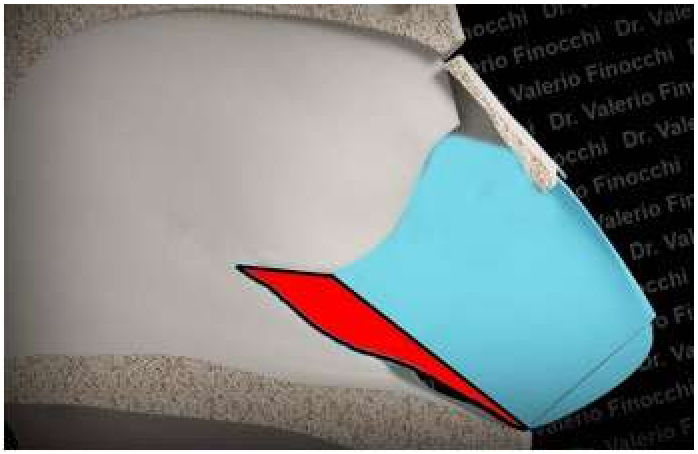

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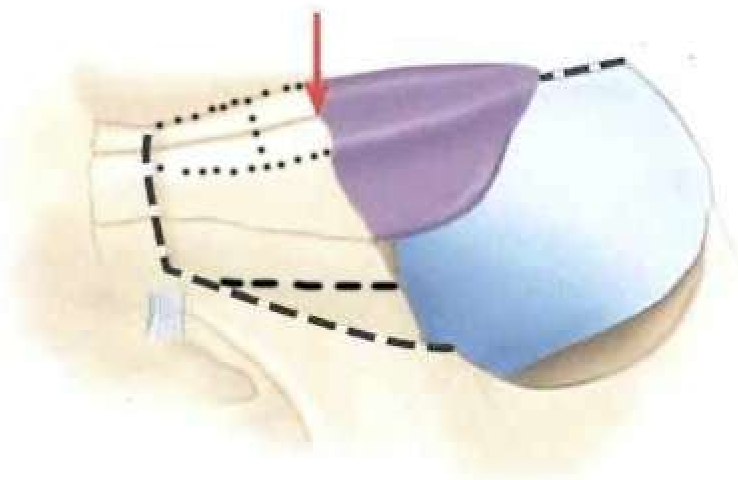

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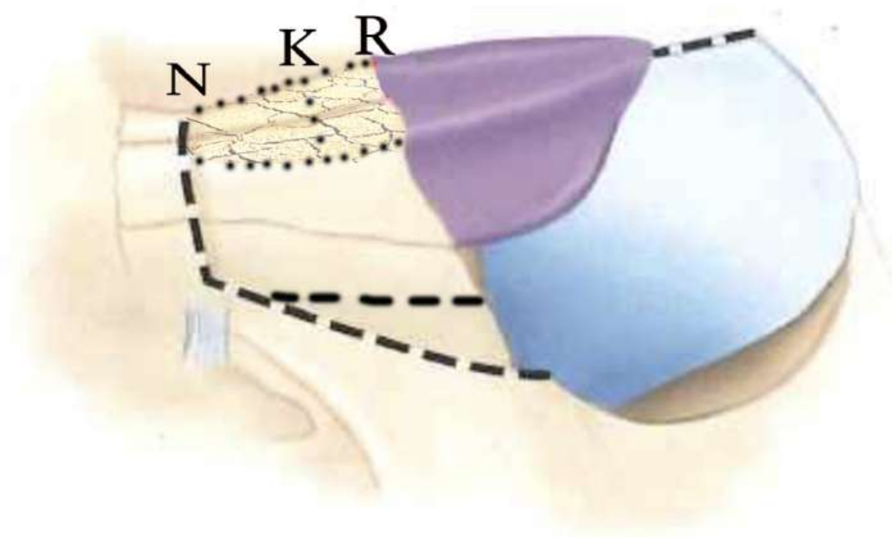

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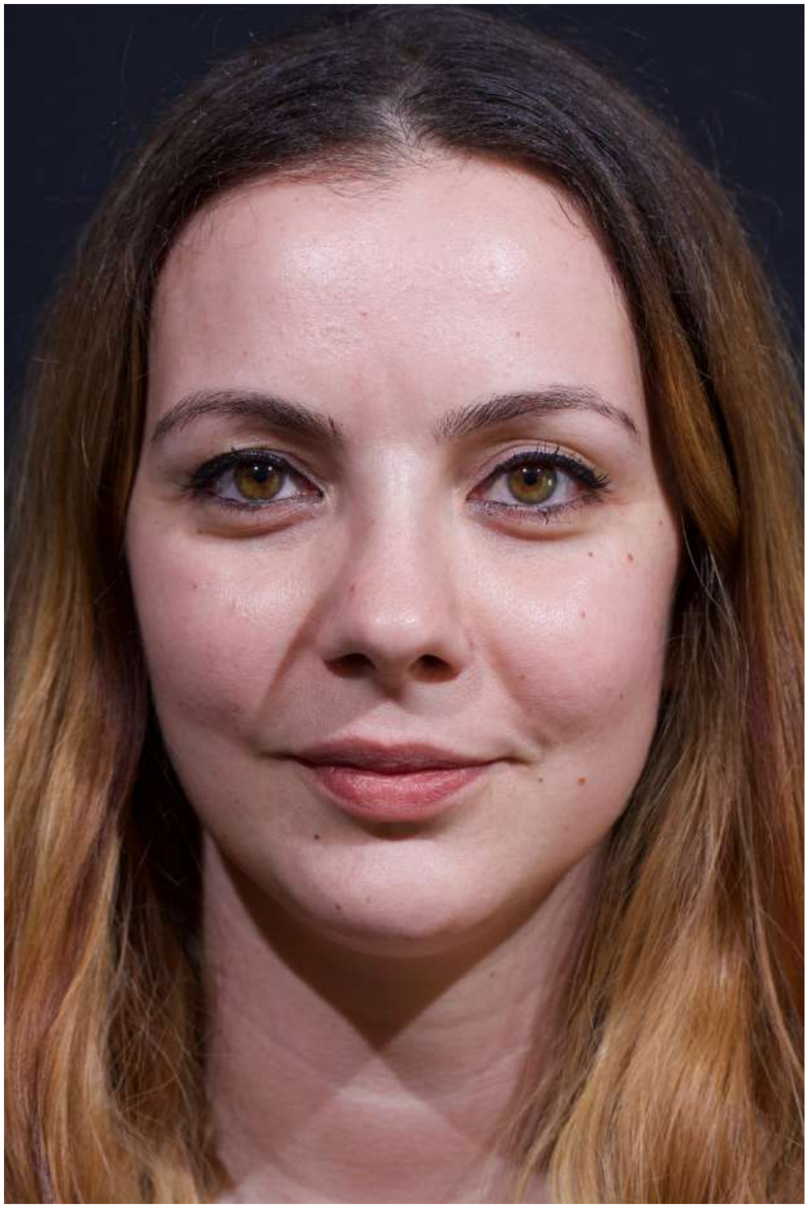

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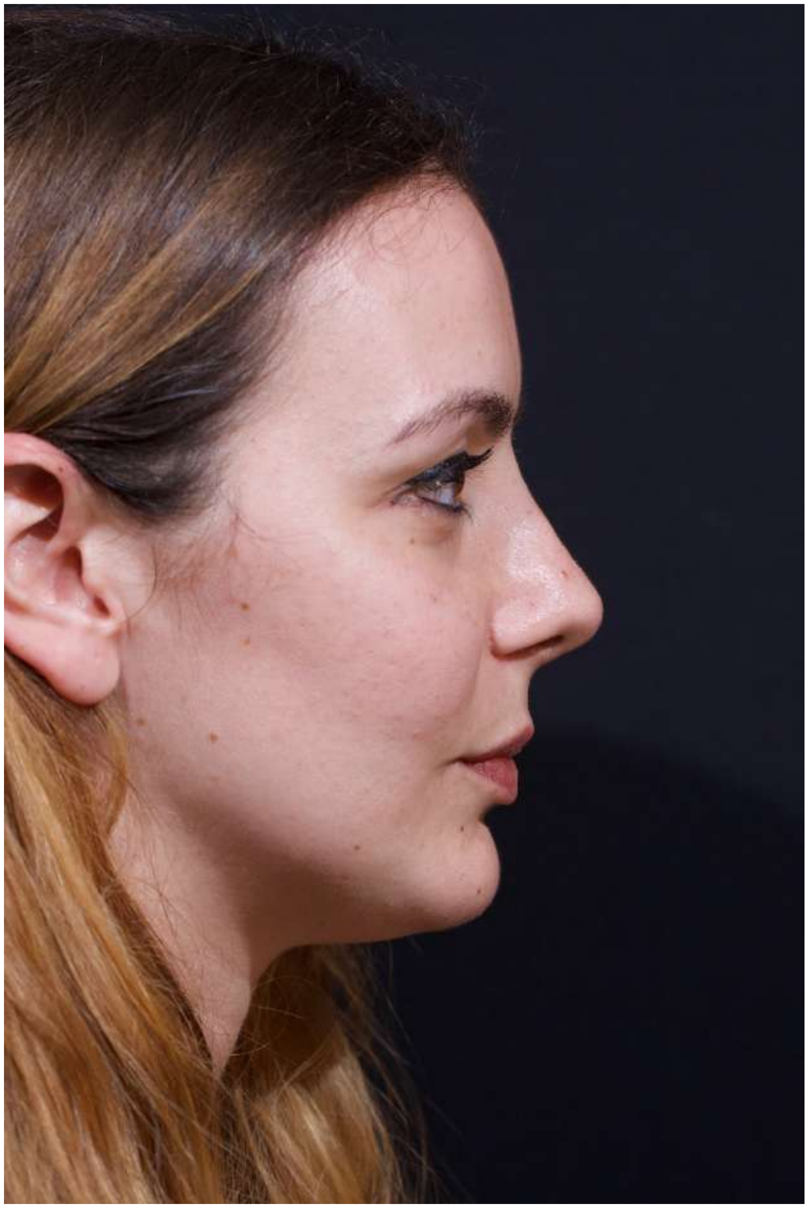

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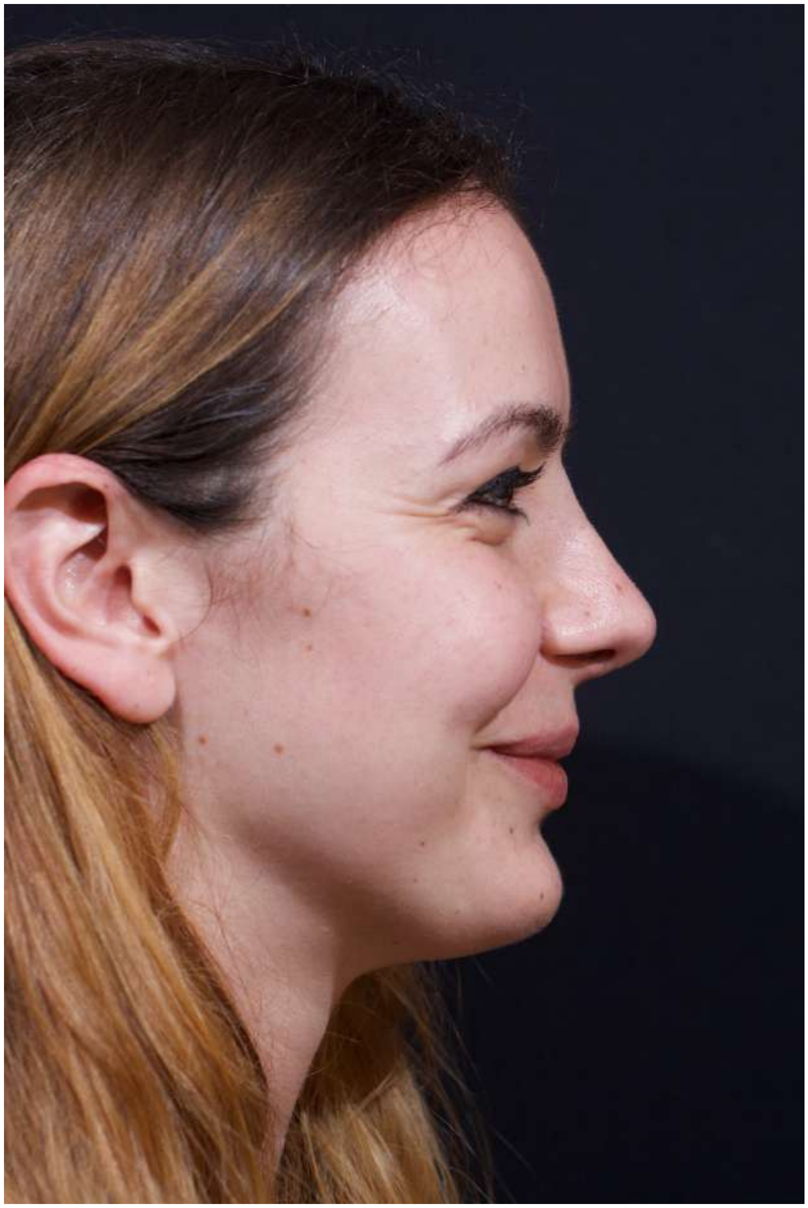

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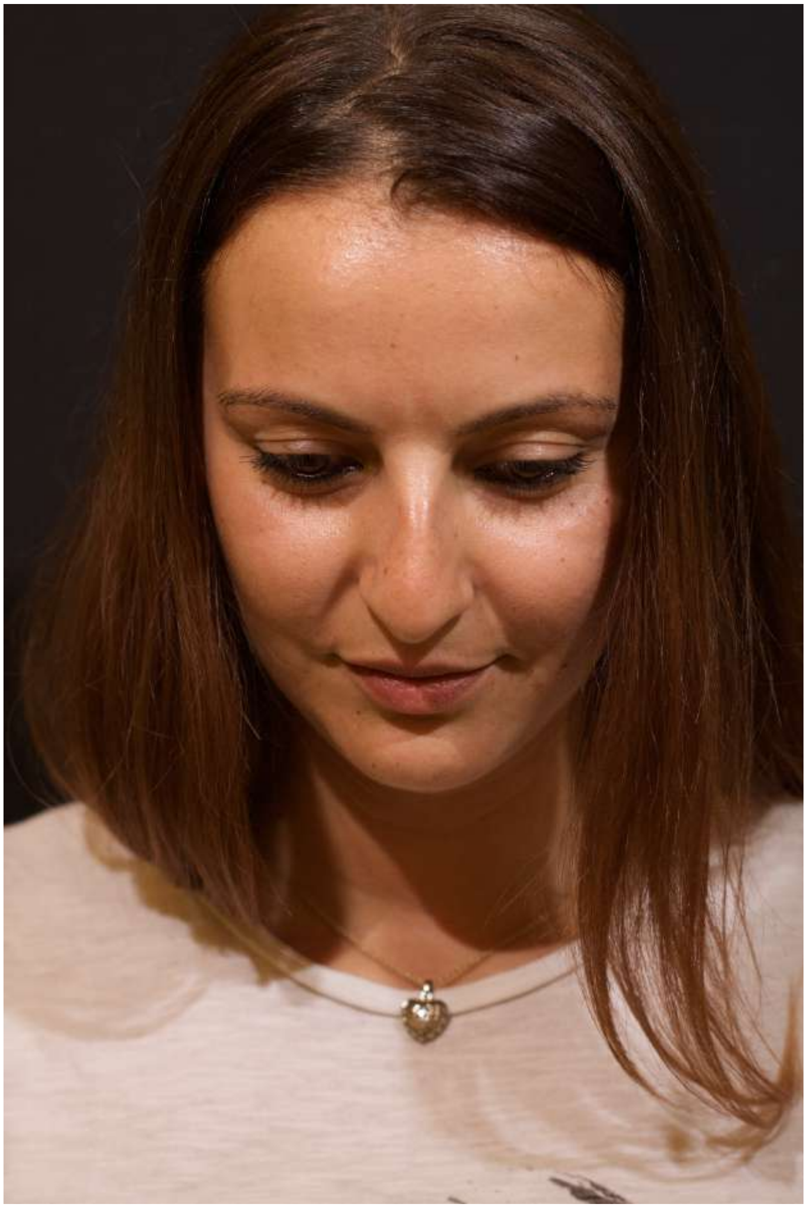

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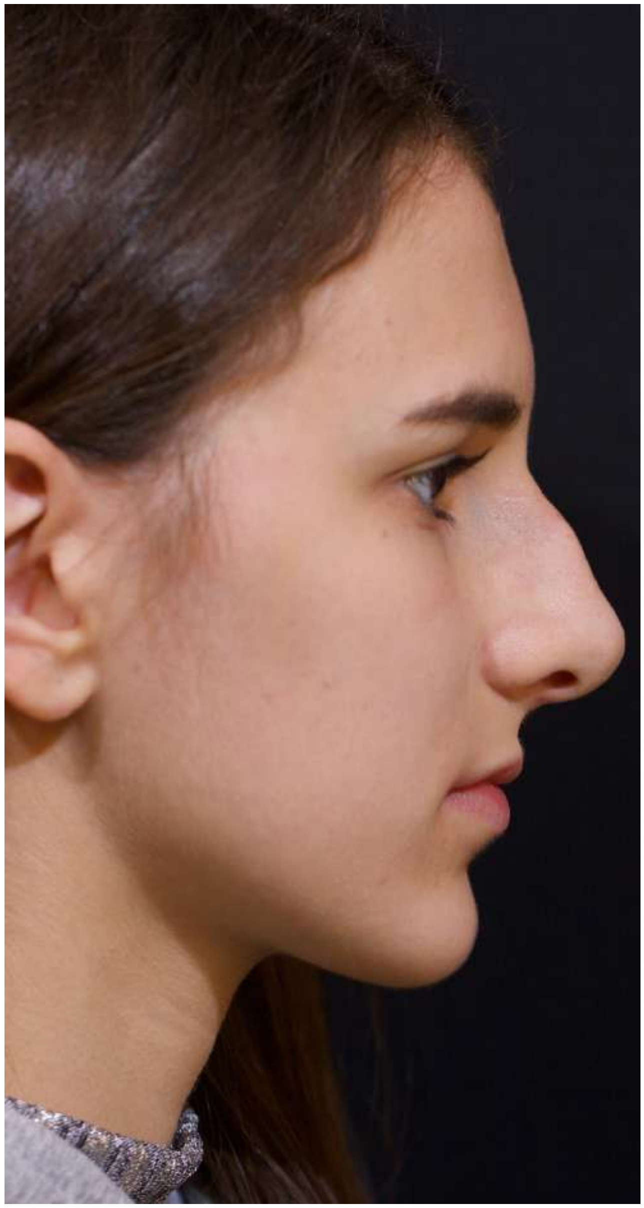

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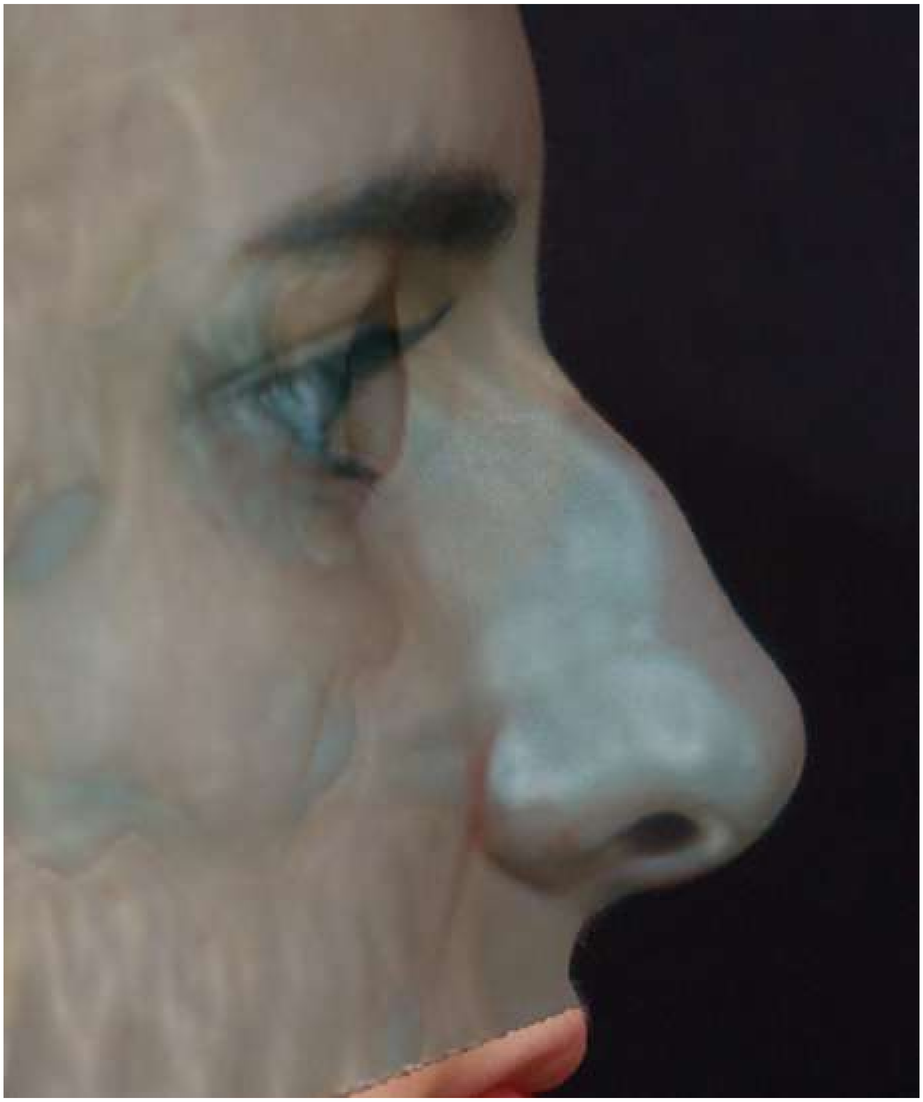

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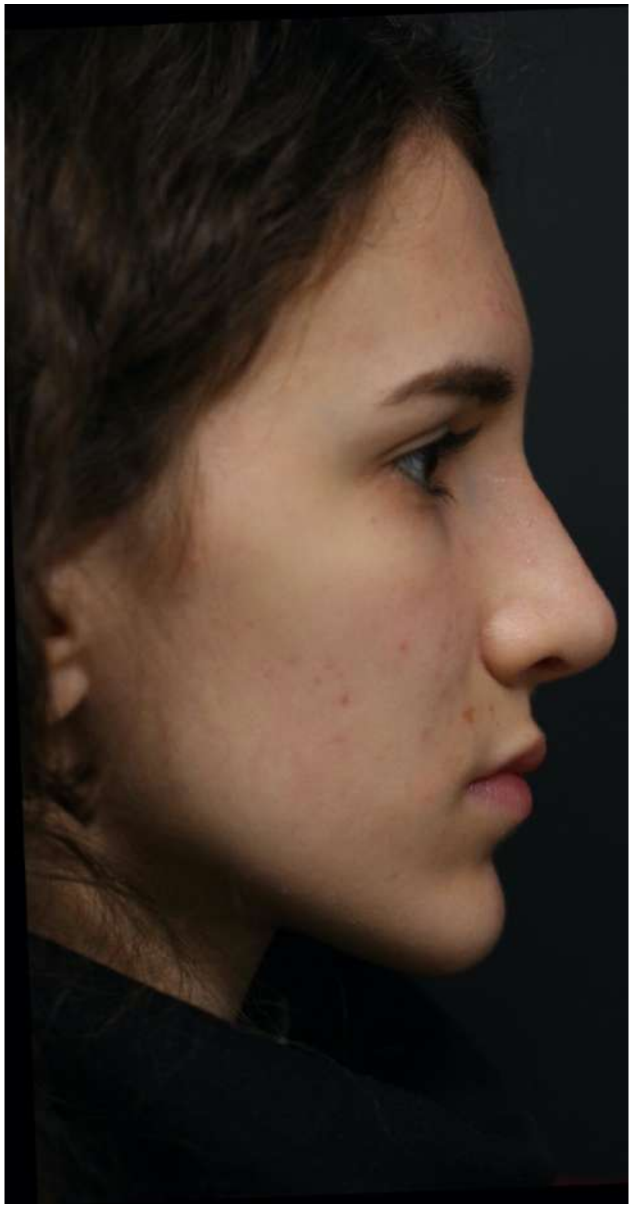

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