Melvin A. Shiffman
Alberto Di Giuseppe
Editors

Advanced Aesthetic Rhinoplasty

Art, Science, and New Clinical Techniques

Springer

Advanced Aesthetic Rhinoplasty

Melvin A. Shiffman • Alberto Di Giuseppe
Editors

Advanced Aesthetic Rhinoplasty

Art, Science, and New Clinical Techniques

Springer

Editors
Melvin A. Shiffman, M.D., J.D.
Section of Surgery
Newport Specialty Hospital
Tustin
CA
USA

Alberto Di Giuseppe, M.D.
Department of Plastic
and Reconstructive surgery
Torrette hospital
Ancona
Italy

ISBN 978-3-642-28052-8 ISBN 978-3-642-28053-5 (eBook)
DOI 10.1007/978-3-642-28053-5
Springer Heidelberg New York Dordrecht London

Library of Congress Control Number: 2013936437

Printed on acid-free paper

Springer is part of Springer Science+Business Media (www.springer.com)

This book is dedicated to the memory of Dr. Antonella Belligolli M.D., Plastic Surgeon, aged 48, who died after a long struggle with breast cancer, which affected her 15 year back.

She was part of the staff of the Department of Plastic and Reconstructive Surgery of the University of Ancona, since its foundation.

She worked since 1991 in the Ancona General Regional Hospital, and she was a prominent Breast Plastic Surgeon.

But mostly, she was a real doctor: she came to learn plastic surgery, but finally she taught and showed us how a doctor should be.

Honesty, humanity, tenderness and firmness were her principles, which she applied to her life and her work.

We had the great privilege to work closely with her, and to learn from her.

To her dear husband Massimo, to her lovely daughter Ilaria and to her son Pietro, the tough job of continuing their lives, inspired by the great heart of this splendid woman.

Ciao Antonella

Alberto, Giovanni, Alessandro, Antonello, Marina, and all the Medical and Paramedical Staff of the Plastic Surgery Department 1991–2012

Foreword

Head Professor of the Post-Graduate Courses in Plastic Surgery of the Pontifical Catholic University of Rio de Janeiro and the Carlos Chagas Post-Graduate Medical Institute. Visiting professor, I.S.A.P.S.

For many years, I have been involved in the teaching of plastic surgery, having trained many generations of young surgeons eager to learn the practice of our specialty. Among the diverse anatomical regions that fall under our care, I believe the nose presents – even to the experienced surgeon – one of our greatest challenges. Placed in the fulcrum of the face, this complex structure commands our full attention. A slight defect, a minimal asymmetry, and harmony is unbalanced. The nasal pyramid must be approached with a perfect understanding of anatomy and function, through many different options of tissue manipulation, with an aesthetic result that is pleasing and in equilibrium with the patient's physiognomy. To operate a primary case, and especially a secondary nose, requires our utmost skill. The editors of this book have excelled in bringing together a large team of experts in the art and science of rhinoplasty. All aspects of this fascinating area of plastic surgery are covered, starting with the fundamental principles, moving on to the clinical evaluation and planning, and including a rich description of surgical techniques, elaborated by authors of large practice. Novel concepts and nonsurgical approaches are introduced, expanding the scope of a traditional textbook on rhinoplasty. I congratulate Dr. Shiffman and his collaborators for this important book, as it will prove to be a valuable contribution to the literature of plastic surgery.

Rio de Janeiro, Brazil — Ivo Pitanguy

Preface

There are many books on rhinoplasty, but most are limited to the editor's techniques or those of a few contributors. These give restricted information on the variety of procedures that are available and are mainly for teaching the inexperienced and somewhat experienced surgeons how to do rhinoplasty and possibly stay out of trouble.

This book on Advanced Aesthetic Rhinoplasty: Art, Science, and New Clinical Techniques gives a detailed analysis of the newer techniques that are available in primary and secondary rhinoplasty. This allows the presentation by international experts of the very newest procedures available with subjects covering nasal anatomy, psychological aspects of rhinoplasty, surgical techniques of primary rhinoplasty and secondary rhinoplasty, the use of fillers in rhinoplasty, and the possible risks and complications of rhinoplasty. This concept of gathering new techniques from international experts is not present in any other book on rhinoplasty, and the information is extensive and quite different from even recent books on rhinoplasty. The book is for the inexperienced, experienced, and the very experienced surgeon doing rhinoplasties.

The editors wish to present advanced technology and clinical techniques in rhinoplasty from unique contributors experienced with these procedures that are modified or original procedures. The contributors are inventive and eloquent in presenting to the reader a way to progress from inexperienced or experienced surgeons in rhinoplasty to better understanding that there is more than following simplified techniques as a template to performing a procedure that is fraught with possible risks and complications. Understanding the patient through psychological profiling will make it easier for the surgeon to stay out of trouble with patients who are not really candidates for rhinoplasty.

All cosmetic surgeries are potential problems if the patient is not properly evaluated preoperatively, not only physically but also mentally. This is most true with the patient considering rhinoplasty. However, the satisfaction of the patient who has a good result is inestimable.

Tustin, CA, USA — Melvin A. Shiffman, M.D., J.D.

Contents

Part IV Primary Rhinoplasty

Part I

Anatomy

1 Muscles, SMAS, and Vascular Anatomy of the Nose

Yves Saban, Chiara Andretto Amodeo,
and Roberto Polselli

1.1 Nasal Muscles and Concept of Nasal SMAS

Multiple layers form the soft tissues overlying the nasal bony and cartilaginous framework: skin, subcutaneous fat tissue, fibromuscular, deep areolar, and perichondral/periosteal layers.

The fibromuscular layer can be described following three different approaches: anatomical, physiological, and surgical.

1.1.1 Classical Descriptive Anatomy of Nasal Muscles

Classic anatomy treatises [1] describe several constant nasal muscles, even if some variations can be present, especially in the tip area and over the lateral wall of the bony pyramid (Figs. 1.1 and 1.2) (Table 1.1):

Y. Saban, M.D. (✉)
Head and neck- Facial Plastic Surgery
Institute of the French Riviera,
25 av. Jean Médecin, Nice 06000, France
e-mail: yves.saban@gmail.com

C.A. Amodeo, M.D.
Department of Plastic and Reconstructive Surgery,
University of Pavia, “Salvatore Maugeri” Foundation
Research and Care Institute Pavia, Italy

R. Polselli
Head and neck- Facial Plastic Surgery,
Marina di Carrara, Italy

1. The procerus (Figs. 1.1 and 1.3) covers the nasion lying between the frontalis muscle cephalically to aponeurosis of the transversus nasalis muscle caudally. In some cases, it can be considered as a muscular link between the frontalis muscle and the nose. It gets adherences to the periosteum of the nasal bones and to the perichondrium of ULC, close to the midline of the dorsum.
2. The transversus nasalis (Figs. 1.1 and 1.4) is adherent on the midline over ULC, forming a common aponeurosis which is part of both symmetric muscles. They are composed by two expansions: the caudal one inserts onto the deep aspect of the skin, and the cranial one intermingles with the lateral part of the myrtiformis muscle, covered by levator labii alaeque nasi.
3. The levator labii superioris alaeque nasi (Figs. 1.1 and 1.4) inserts on the frontal process of the maxilla and splits into two chiefs: one goes to the philtrum of the upper lip, the other one to the ala of the LLC.
4. The dilator naris (Fig. 1.1) forms the lateral framework of the nostril. It is located between LLC, nostrils margin, and pyriform aperture in an anatomic area absolutely free of any cartilage. It has also been sometimes described as part of the levator labii superioris muscle, so forming the deep levator labii superioris.
5. The compressor naris major and minor (Fig. 1.1) are accessory and inconstant muscles which lay in the subcutaneous tissue over the tip area; especially when LLC lateral crura are concave, these muscles are located in the

M.A. Shiffman, A. Di Giuseppe (eds.), *Advanced Aesthetic Rhinoplasty*,
DOI 10.1007/978-3-642-28053-5_1, © Springer-Verlag Berlin Heidelberg 2013

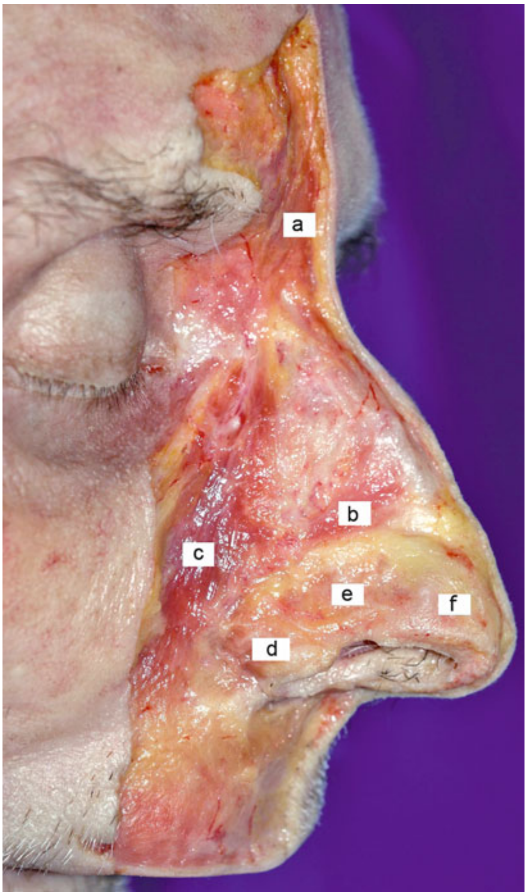

Fig. 1.1 Anatomical dissection showing nasal muscles: nasal-labial area after skin resection. Note the bony insertion of the medial canthal tendon on the frontal process of the maxilla just beneath the radix. Nasal muscles can be identified following their topography, shape, and color. This is the anatomical basis of the so-called medical rhinoplasty. All these muscles form a unique musculoaponeurotic layer, so-called nasal SMAS; this layer is separated from the bony cartilaginous framework by connective tissue which is the right plane for undermining during rhinoplasty. Note also the yellowish band of soft tissue overlying the ULC and LLC cartilaginous junction (*a*) procerus muscle (*b*) transversus nasalis. (*c*) levator labii superioris alaeque nasi (*d*) dilator naris (*e–f*) compressor naris major and minor

concavity of these cartilages and get insertion on the nostril margin.

6. The myrtiformis (Figs. 1.5 and 1.6) from the myrtiform fossa splits into an anterior chief which goes to the upper lip (Fig. 1.7) and a posterior chief which inserts on the nostril's floor.
7. The depressor septi nasi muscle (Fig. 1.6) goes from the orbicularis oris muscle to the skin of the columella and inserts on the feet of LLC medial crura after having split into anterior and posterior chiefs.

Micheli-Pellegrini (personal communication, 2005) has proposed a classification of facial muscles dividing them into three groups depending on their bony insertion: inserted, semi-inserted, and not inserted; on the nose, only semi-inserted and not inserted muscles can be identified (Table 1.1).

1.1.2 Surgical Applications

Aesthetically, many nasal muscles are involved in determining the aspect of the profile, affecting the nasal frontal and nasal-labial angles. In particular, ancillary surgical procedures performed on the myrtiformis or the depressor septi nasi muscles can be useful to open the nasolabial angle, to rotate the nasal tip, or to lengthen the upper lip. In the same way, to deepen the frontonasal angle, muscular resection of hypertrophic procerus muscle has been proposed [2].

Depending on anatomic variations of frontal process of the maxilla, in some anatomical situations, levator labii superioris alaeque nasi muscle may insert very high onto this bone; in these cases, lateral osteotomies carried “low to low” from pyriform aperture, without periosteal elevation, can cause hematomas and partial postoperatively upper lip ptosis due to direct muscle trauma.

Laterally, there is no dissection plane between the dilator naris muscle and the external nostrils skin; on the contrary, during alar base resection, it is possible to remove only the nostril skin, leaving the muscle intact in depth.

1.1.3 Physiologic Anatomy

From a physiological point of view, among the nasal muscles, we can identify those involved in respiratory function and those involved in mimic function. Some muscles have both mimic and respiratory functions. Many may have synergistic

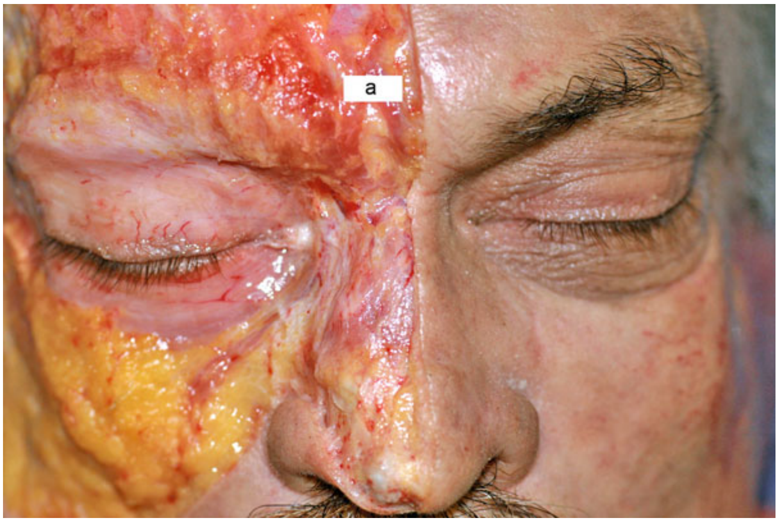

Fig. 1.2 Anatomical dissection showing procerus muscles: radix after skin resection. (*a*) The medial borders of procerus muscles have been dissected to facilitate their identification. Note the bony insertion on frontal nasal suture and the direction of muscle fibers cephalically toward frontalis muscles. Corrugator muscle is not visible at this step of dissection as it lays deeper and is covered by superficial muscles: frontalis, procerus, and orbicularis oculi muscles

Table 1.1 Nasal muscles

Muscle	Insertion	Function	Morpho-aesthetic implications
Transversus nasalis	Not inserted	Constrictor of the nasal valve	Vertical wrinkles over nasal dorsum
Procerus	Semi-inserted	Nasal and frontal mimic	Horizontal wrinkles over nasal radix and glabella
Levator labii superioris alaeque nasi	Semi-inserted	Dilating	Bunny lines
Dilator naris	Not inserted	Dilating	Flaring nostrils
Depressor septi nasi	Not inserted	Nasal mimic	Tip ptosis
Myrtiformis	Semi-inserted	Dilating	Displacement of nostrils lower margins
			Horizontal philtral wrinkles
Compressor naris major	Not inserted	Constrictor	Alar margin retraction
			Dome depression
Compressor naris minor	Not inserted	Constrictor	Alar margin retraction
			Dome depression

or antagonistic actions with others, depending on muscles insertion and topography.

1.1.4 Medical Applications: Use of Botulinum Toxin

Botulinum toxin, which produces a chemical denervation of muscles, has been used during recent past years to open the nasolabial angle during medical rhinoplasties and to correct nasal wrinkles in medical facial rejuvenation procedures according to muscles actions [3].

1.1.5 Medical Rhinoplasties

To open the nasolabial angle, botulinum toxin could be injected in the depressor septi nasi as this muscle has a strong action on lowering nasal tip. The dilator naris can be injected to correct the "flaring nostrils" effect. Botulinum toxin injections can also be useful on:

1. Procerus for the horizontal lines over the radix
2. Levator labii superioris alaeque nasi whose contractions create bunny lines
3. Transversus nasalis in case of vertical wrinkles over the lateral wall

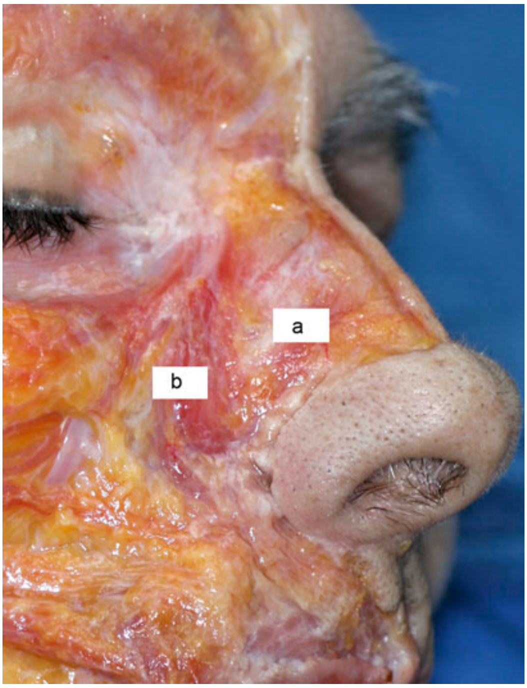

Fig. 1.3 Anatomical dissection showing nasal muscles: nasal pyramid after skin resection. (*a*) Transversus nasalis. (*b*) Levator labii alaeque nasi muscles. Note how the levator labii alaeque nasi muscle splits into two separate chiefs: the upper one, which disappears under the nostril skin, corresponds to the ala portion; the lower one turns around the alar-facial groove and goes to the philtrum, crossing superficially the upper lip

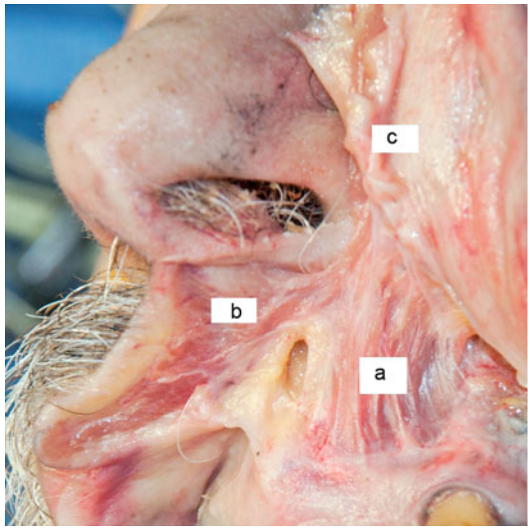

Fig. 1.4 Anatomical dissection showing myrtiformis and depressor septi nasi muscles: nasal-labial area after upper lip, separation of inferior nostril rim, section of buccal mucosa, and lifting of the left upper lip. (*a*) Main portion of myrtiformis muscle is exposed as it inserts onto myrtiformis fossa delimitated laterally by the canine tooth. Note the vertical direction of muscular fibers. The anterior nasal spine, where the (*b*) depressor septi nasi muscle inserts, is visible. One can notice the (*c*) subnasal artery sectioned and elevated in the lip flap; this artery lies between two muscular layers, myrtiformis in depth and orbicularis oris superficially

Botulinum toxin is very effective in pathological situations like hemifacial spasm and blepharospasm when nasal muscles are concerned in the pathology.

1.1.6 Surgical Anatomy, Nasal SMAS, and Nasal Ligaments

1.1.6.1 Nasal SMAS

From a surgical point of view, the fibromuscular layer covering the nasal skeleton can be considered as a continuous anatomical layer, so-called nasal SMAS (Fig. 1.2). Composed by muscular and aponeurotic anatomical structures, it extends from the nasofrontal angle (radix) to nostril margin, continuing medially onto the columella down to the nasolabial angle. Laterally, it is connected to facial SMAS [4–6].

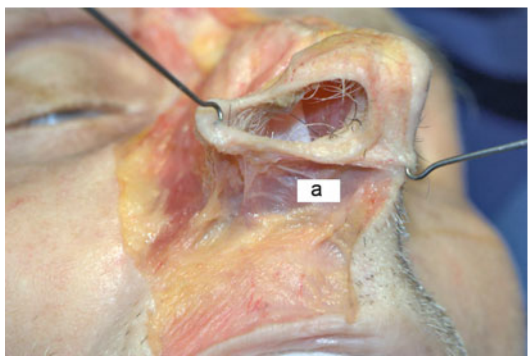

Fig. 1.5 Anatomical dissection showing myrtiformis muscle nostril expansion: labial nasal area. Hooks elevate the nostril floor. Note the orbicularis oris muscle covering myrtiformis muscle main chief; the (*a*) expansion of myrtiformis muscle fibers to nostril floor is identified

1.1.6.2 The SMAS as the Vessels Carrying Layer

It is important to notice that all nasal vessels run inside the nasal SMAS, and from this fibromuscular layer, the arteries give off perforating branches, which form the subdermal plexus and reach the skin (Fig. 1.8). Forming a unique layer on the nasal dorsum, it can also be considered a protective layer in between the skin and the nasal framework.

1.1.6.3 Composition of Nasal SMAS

At the level of the intercartilaginous junction (i.e., internal nasal valve), the nasal SMAS splits into superficial and deep layers; each layer is composed of two wings (medial and lateral):

1. The superficial layer gives two wings: the lateral wing (alar wing) passes over the LLC to insert into the skin of the alar margin; medially, the medial wing (columellar wing) runs over nasal tip then into the columella, between the skin and cartilage, to reach the depressor septi nasi muscle.
2. The deep layer divides into lateral and medial wings: the lateral wing (valve wing) is composed of yellowish tissue and inserts onto the cartilaginous junction between ULC and LLC in the scroll, forming the internal nasal valve. The medial wing (septal wing) runs inside the membranous septum, between the anterior septal angle and the interdomal ligament, down to the anterior nasal spine (Figs. 1.9 and 1.10) The septal wing may correspond to the Pitanguy's ligament as it can connect the deep aspect of the dorsal skin to the anterior septal angle [7].

According to these statements, the nasal SMAS can be described as a unique layer overlying the whole nasal pyramid from the forehead to the nostrils margins, getting intermediate insertions onto the nasal valve.

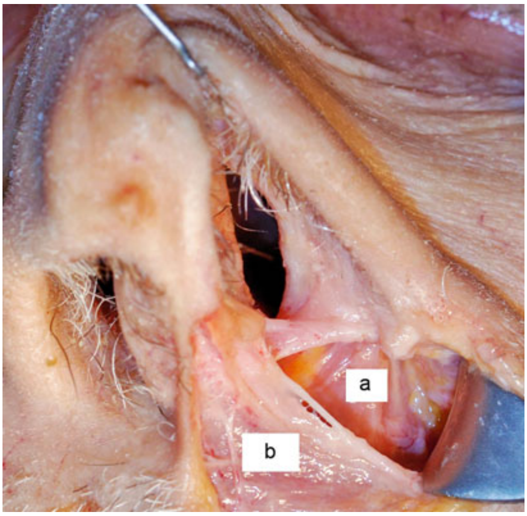

Fig. 1.6 Anatomical dissection showing depressor septi and myrtiformis muscles: left nostril inferior view after skin resection, separation of nostril floor expansions of myrtiformis muscle retracted laterally. (*a*) Lateral expansion of myrtiformis muscle, visible in depth, goes upward, and intermingles with transversus nasalis muscle. (*b*) Anteriorly above anterior nasal spine, muscular fibers of depressor septi nasi muscle goes into the columella

1.1.6.4 Nasal Ligaments

Besides the interdomal ligament that connects together the domes of LLC, the nasal SMAS is connected to the perichondral and periosteal layers by expansions containing perforating vessels, so-called nasal ligaments.

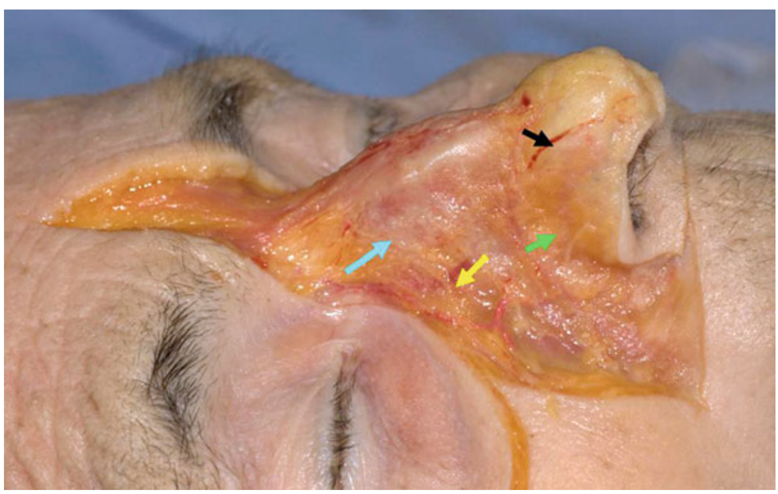

Fig. 1.7 Nasal SMAS anatomical dissection: skin has been removed exposing the SMAS layer which covers the whole nasal pyramid from radix to tip and nasolabial angle. Nasal muscles and vessels running in the SMAS layer can be identified: *black arrow*, constrictor naris muscle; *green arrow*, dilator naris muscle; *yellow arrow*, levator labial alaeque nasi muscle; *light blue arrow*, transversus nasalis muscle

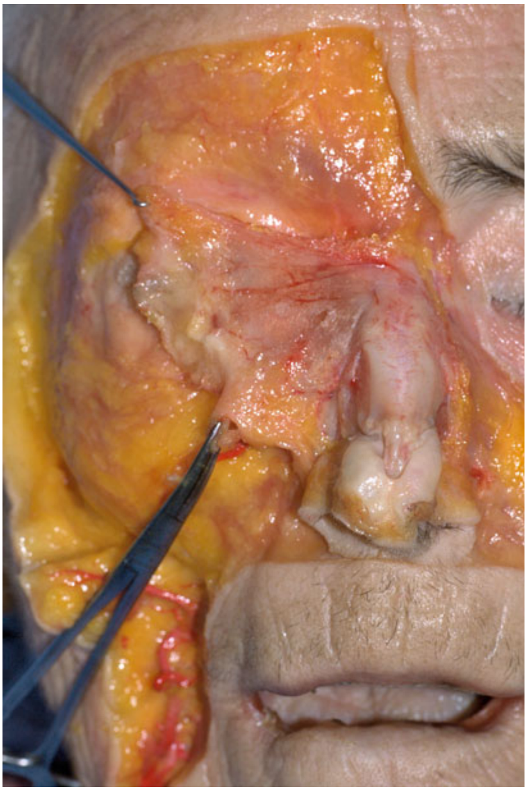

Fig. 1.8 Nasal SMAS anatomic dissection: note that in the SMAS layer run all the main vessels

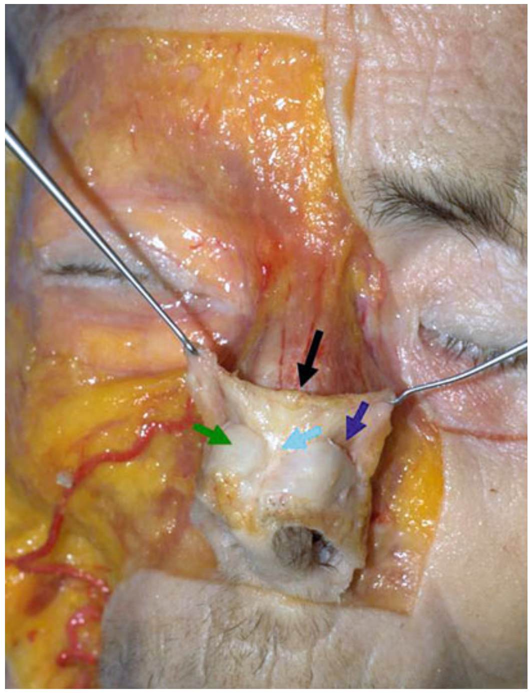

Fig. 1.9 Nasal SMAS deep layer: the deep wings of the nasal SMAS are exposed. The columellar wing has been transected and nasal SMAS flap elevated. *Black arrow*, columellar wing; *green arrow*, LLC; *blue arrow*, valve wing; *light blue arrow*, septal wing

Two nasal ligaments can be identified onto the lateral portion of the nasal pyramid:

1. The superior one is halfway over the lateral aspect of the upper lateral cartilages, at the osteocartilaginous junction between the nasal bones and the ULC (Fig. 1.11).
2. The inferior one is located laterally at the level of the pyriform aperture in the fibrous triangle (Fig. 1.11).

1.1.6.5 Medial Canthal Tendon

The medial canthal tendon is a fibrous band formed by the junction of the superior and inferior tarsal lamellae. It runs medially toward the medial orbital wall and splits into two chiefs: the superficial one inserts onto the anterior lachrymal crest, on the frontal process of the maxilla, as the deep one, called also the Horner's muscle formed by pretarsal portions of orbicularis oculi muscle, inserts onto the posterior lachrymal crest. Both chiefs surround the lachrymal sac.

1.1.6.6 Surgical Applications

Nasal SMAS divides subcutaneous plane into two planes of dissection: subcutaneous and sub-SMAS [8]. While performing rhinoplasty, the right surgical plane of dissection is always sub-SMAS, even if the dissection above the nasal SMAS in the subcutaneous fatty plane is feasible. But especially in supratip area, this superficial plane is crossed by perforating vessels running from the nasal SMAS to dermis. So, superficial dissection which interrupts these small vessels in this subcutaneous plane is not recommended.

1.1.7 Open Rhinoplasty and SMAS Undermining

Transcolumellar incision and SMAS columellar wing section: when performing open rhinoplasties, it is necessary to cut the columellar wing of the nasal SMAS in which small columellar arteries run. Then sub-SMAS dissection of the columella can be performed in close contact of the caudal edge of LLC medial crura, staying in the same surgical plane medially up to supratip area without cutting any other anatomical structure. At this point, a vertical fibrous band running from superficial soft tissues toward the nasal spine is present, and it is impossible to reach the nasal dorsum without cutting this structures which is actually the septal wing of the nasal SMAS. Sub-SMAS undermining will not cross any other obstacle up to frontonasal angle, except on nasal bones where procerus muscles take insertion.

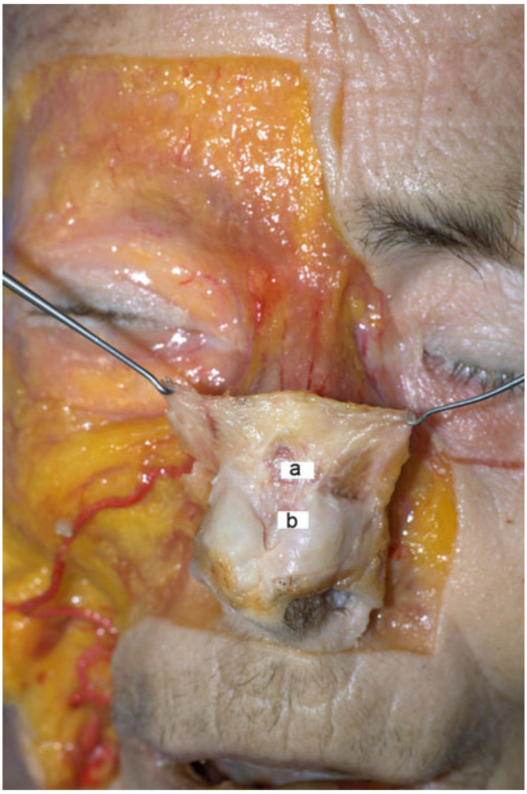

Fig. 1.10 Nasal SMAS deep layer: (*a*) the transection of septal wing and (*b*) allows exposition of anterior septal angle and surgical access to the cartilaginous dorsum

During the same procedure, or while performing marginal extended approach, the nasal SMAS is elevated laterally from nostril margins until the cranial border of the LLC. At this point, to reach the dorsum, it is mandatory either to transect or, better, to elevate the yellowish tissue (which is in fact the valve wing of nasal SMAS) which inserts onto the internal nasal valve and where lateral nasal artery lies (Fig. 1.12).

1.1.8 Rhinoplasty and Nasal Ligaments

Nasal ligaments can be considered as lateral limits for the lateral sub-SMAS dissection; Joseph's elevator is blocked by these ligaments and vessels during both external and endonasal rhinoplasty. When performing low to low lateral osteotomies, the superficial chief of the medial canthal tendon can be damaged. Furthermore, several muscles of the nasal area insert either onto or below the superficial chief of the medial canthal tendon: preseptal portion of orbicularis oculi, levator labii

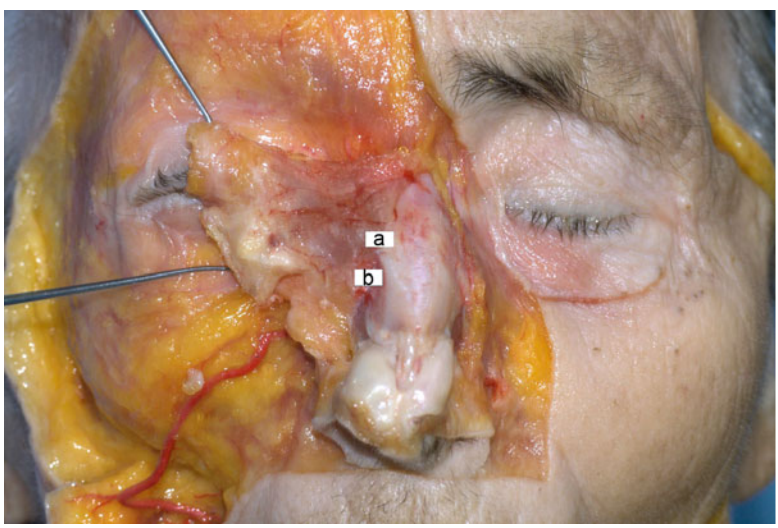

Fig. 1.11 Nasal SMAS ligaments: the SMAS layer has been elevated and transacted on the midline, then laid laterally on right side. Note that over the lateral wall of the nasal pyramid, deep vertical fibrous structures (*a*–*b*) connect the SMAS to the nasal skeleton. In these bands run vessels. To perform sub-SMAS dissection laterally, it is necessary to cut these ligaments, and this can expose to intraoperative bleeding

Fig. 1.12 Nasal SMAS deep layer: valve wings have been transacted allowing elevation of the entire SMAS overlying nasal dorsum. The dissection has been performed above the perichondrial and periosteal layer. Note the vessels running in this layer

superioris alaeque nasi, depressor supercilii, and levator genae. Injuries to these structures can lead to major swelling, hematoma, palpebral ecchymosis, temporary medial dystopia, and upper lip ptosis (Fig. 1.13).

Fig. 1.13 Muscular injuries due to low to low osteotomies. Note the path of low to low osteotomies which can cause muscles injury

1.1.9 Nasal SMAS Injury During Rhinoplasty

Partial or total accidental loss of nasal SMAS during hump removal can lead to adherences between dermis and cartilaginous/bony framework. If it happens many consequences can occur:

1. From an aesthetic point of view, the cartilaginous and bony framework become visible under the skin as they are not anymore hidden by the fibromuscular soft tissue layer.
2. Open roof syndrome can occur due to adherences between the internal nasal mucosa and the external dermis through the hiatus of the open roof. This syndrome leads to pain and vasomotor problems.
3. Adherences between skin and nasal framework are extremely difficult to dissect if a revision is needed; skin injuries, perforations, scars, and retractions can occur. In this situation, it is necessary to insert a connective layer between skin and bony/cartilaginous framework.
4. Neoangiogenesis and telangiectasia of skin over the nasal dorsum can be observed.

1.1.10 Nasal SMAS Surgery and Rhinoplasty

1.1.10.1 Rhinoplasty Access and Nasal SMAS

When performing marginal incision, the surgeon has to transect muscular insertions of compressor narium muscles which appear as brown pink tissue that is very adherent onto LLC lateral crura surface. The alar wing is firmly adherent to cartilage from which it has to be undermined in order to give proper access to the dorsum, avoiding bleeding due to vessels running in this layer and allowing better appreciation of the cartilage shape.

1.1.10.2 Tip Rotation and Valve Improvement

To allow easier tip rotation during endonasal rhinoplasty, it is recommended to transect the septal wing of the nasal SMAS. In some cases, the depressor septi nasi muscle inserts on the feet of LLC medial crura. Its action may produce tip drooping and nasolabial angle deepening. Section or resection of these insertions may be necessary to allow tip rotation and to maintain surgical result in good position.

1.2 External Nasal Vascularization

1.2.1 Primary Nasal Blood Supply

Blood supply to the external nose is provided both by facial and ophthalmic arteries, the branches of the external and internal carotid arteries. During the anatomic dissections, the author has noticed several variations in nasal blood supply, and this is confirmed by many different anatomical variations of nasal arteries described in literature. For example, angular artery may be considered in some cases the terminal branch of either facial or ophthalmic arteries. In usual practice and to make it simple, one can consider four main arteries – two facial and two ophthalmic – and their branches forming a unique anastomotic system which guarantees nasal vascularization in any physiological or pathological situations. The entire arterial system is located within the nasal SMAS.

1.2.2 Description of Nasal Arteries

The facial artery gives rise to the superior labial artery which meets the contralateral artery over the upper lip. At this level, a vertical branch runs cephalically into the philtrum to columella. This small branch runs upward, meets the columellar branch of the subnasal artery forming the columellar artery which lies in the columella, and gives rise to its terminal branches over the tip area.

The lateral nasal artery branches off from facial artery at the level of the alar-facial groove and gives off two or three branches which form little arteries over the lateral crura, the dorsum, and the lobule area. The small distal branches of lateral nasal artery form several anastomoses with contralateral branch and with columellar arteries. More recent studies focused on nasal blood supply have shown that the lateral nasal artery, one of the three major blood supplies to the nasal tip, can branch off either from the facial artery or from the superior labial artery [9]. Toriumi has reported that lateral nasal artery runs along the cephalic margin of lateral crura of the lower lateral cartilages, giving off little branches which pass over the lateral crura toward the nostril rim. These little vessels reach the tip and meet the columellar arteries over the domal area to form the alar arcade, which lies over the alar lobule [10].

The last branch of the facial artery is the angular artery which runs over the medial canthal area to meet the nasal artery branch of ophthalmic artery. Another blood supply to the nasal area comes from the dorsal nasal artery which, at its origin at the level of the medial canthus, is considered a terminal branch of the ophthalmic artery (Fig. 1.14).

1.2.3 Variations of Nasal Blood Supply

A recent study has classified the distribution of the arteries that form the primary blood supply of nasal tip in Asians into four types, depending on their origins: in type I, vessels to nasal tip come from ipsilateral lateral nasal artery (62.7%), in type II from ipsilateral dorsal nasal artery (15.7%), in type III from contralateral lateral

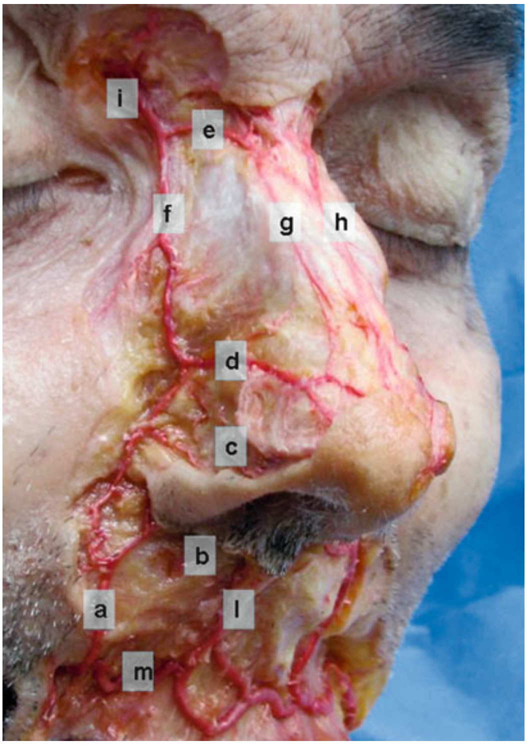

Fig. 1.14 External arterial vascularization of the nose: facial arteries have been injected bilaterally with red-dyed liquid. Cadaver dissection was performed following the arteries after skin resection. Nasal blood supply is provided by a transfacial polygonal arterial anastomotic system that connects the internal and external carotid systems. Note the vessels which form this system: (*a*) right facial artery, (*b*) subnasal artery, (*c*) marginal artery, (*d*) lateral artery, (*e*) radix artery, (*f*) angular artery, (*g*) right dorsal artery, (*h*) left dorsal artery, (*i*) nasal artery, (*l*) philtrum artery, and (*m*) superior labial artery

nasal artery (15.7%), and type IV from contralateral dorsal nasal artery (5.9%) [11].

When regarding nasal tip blood supply, in the majority of cases lateral nasal artery is the main blood supply to the tip, then dorsal nasal artery and variable contributions come from columellar artery.

1.2.4 The Concept of Anastomosis Between Internal and External Carotid

Lassau and Mitz in 1973 [12] stated that blood supply to the whole face is always preserved by the presence of many anastomosis. They have shown that the main arteries run in or under the SMAS layer, giving off perforating branches to dermis which form the subdermal plexus (superficial anastomosis). These vascular anastomoses are also present at the level of the nasal area, mainly at the level of the radix and the tip. Authors call these anastomosis superior nasal arcades and inferior nasal arcade.

Following Salmon's work, Taylor has introduced the concept of angiosome which are three-dimensional composite anatomic structures whose blood supply is provided by a single vascular pedicle. This concept is of great surgical interest especially for composite flaps used in postoncological defects corrections. Concerning the nose, Houseman and Taylor have described two angiosomes which correspond to external and internal carotid systems. It is impossible to identify specific nasal angiosomes because four arteries (the facial and the ophthalmic arteries on both sides) are responsible for the vascularization of the same area, depending on blood pressure and on patient's anatomy [13–15].

1.2.5 Nasal Anastomotic Polygonal Blood Supply Concept

According to our anatomical and physiological experience, we consider nasal blood supply as a polygonal arterial anastomotic system. This mesh-pattern multidirectional system connects both external and internal carotid systems, and it works like a transfacial anastomosis (Fig. 1.15).

This arterial system is composed of three horizontal vessels:

1. Lateral nasal artery, running over the cephalic margin of the lateral crura
2. Marginal alar artery branching off either from the facial artery or sometimes from the lateral nasal artery, prior to and more caudally than the lateral nasal artery
3. Radix artery branching off from the angular artery and running transversally at the level of the radix of the nose

All the vessels running transversally meet the contralateral homologue artery over the midline.

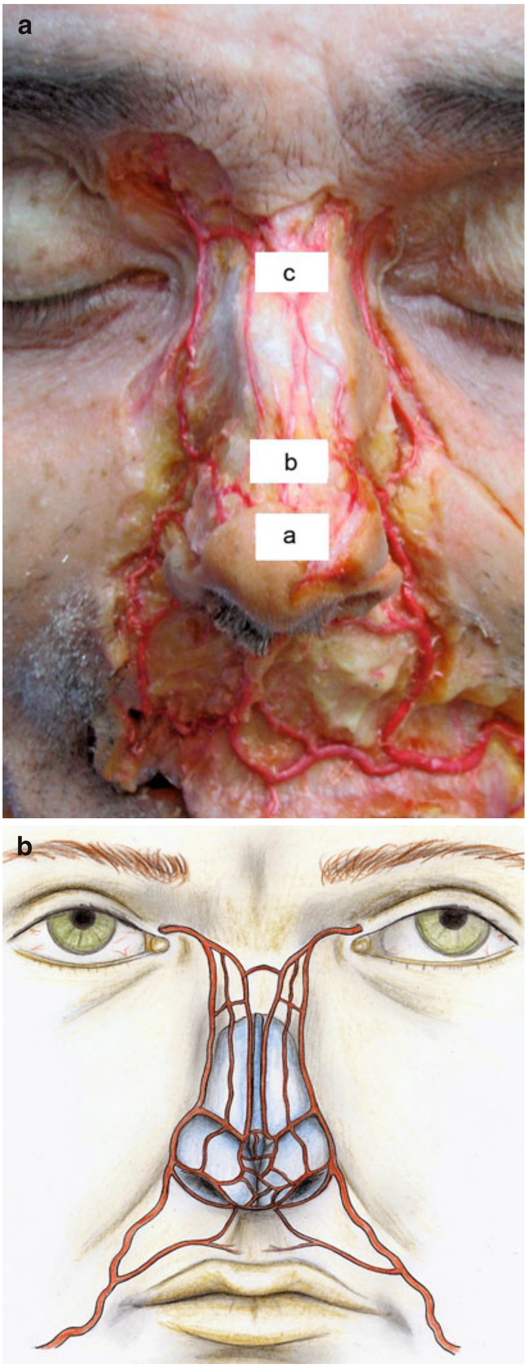

Fig. 1.15 External arterial vascularization of the nose: (**a**) the skin of the tip has not been resected. (*a*) Marginal arcade, (*b*) nasal valve arcade, and (*c*) radix arcade. (**b**) Note the transfacial anastomosis formed by the arcades

These vessels are connected by three longitudinal vessels:

1. Columellar artery, which runs upward from subnasal artery toward the tip
2. Angular artery, running laterally and longitudinally from alar-facial groove to medial canthal tendon
3. Dorsal nasal artery running over the nasal dorsum

Sometimes, a longitudinal inconstant intermediate artery can be observed, running longitudinally over the lateral nasal wall, from the lateral nasal artery to the radix artery.

So, one can consider the horizontal vessels (marginal, lateral nasal, and radix artery) forming three arterial arcades: the marginal, the nasal valve, and the radix arcades which are connected by the anastomotic longitudinal arteries. Furthermore, the marginal arcade forms with the columellar arteries and the subnasal artery, an arterial circle around the nostrils.

In this system, the major blood flow can be provided both by the internal and the external carotid arteries of both sides depending on the patient's anatomy (absence of some vessels), physical features (higher blood pressure in internal or external carotid artery), and blood can run from nasal tip to radix and vice versa.

This polygonal system explains the physiological blood supply to the nose and the possible inversion of the flow, depending on the blood pressure in internal and external carotid arteries.

This has been confirmed by our ultrasound Doppler work showing inversion of arterial nasal blood flow. In physiological situation, the main nasal flow is provided by facial artery. Compression of facial artery causes inversion of the blood flow direction. Then compression of ipsilateral ophthalmic artery may cause either complete interruption or lowering of the flow registered by echo Doppler (Figs. 1.16 and 1.17).

1.2.6 Surgical Applications

During external rhinoplasty approach, dissection in sub-SMAS plane is absolutely safe because blood supply to nasal tip is extremely rich, and

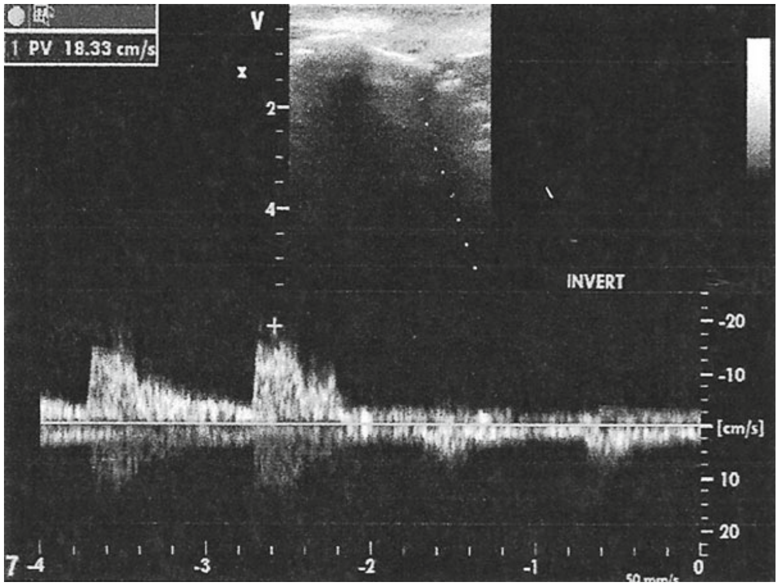

Fig. 1.16 Doppler ultrasound of facial artery showing intercarotid anastomosis: The two first spikes correspond to physiological flow coming from the facial artery. After facial artery compression, an inversion of the blood flow occurs, and it comes from the ophthalmic artery

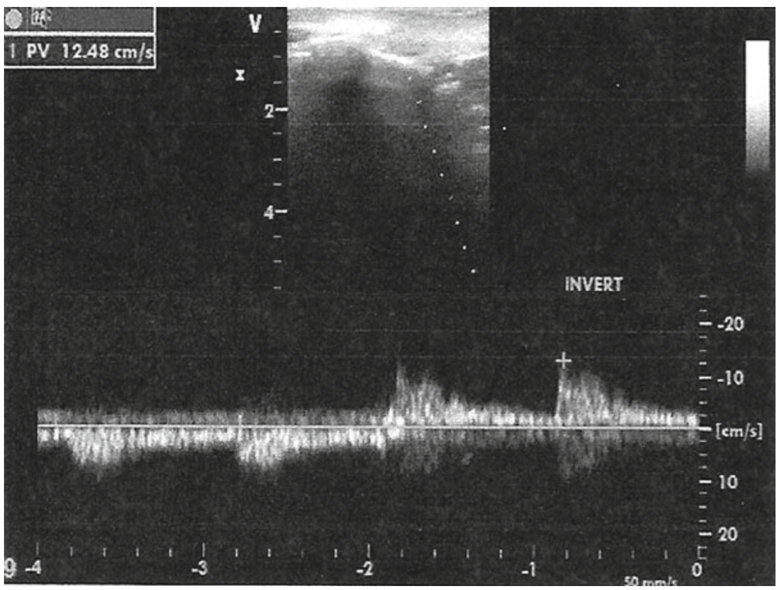

Fig. 1.17 Doppler ultrasound of facial artery showing intercarotid anastomosis: after releasing of the compression on facial artery, the blood flow returns to the previous physiological situation

even closure of a major vessel does not cause necrosis. While performing rhinoplasties, precise and careful elevation of soft tissues in sub-SMAS plane allows protection of nasal arteries. In reconstructive procedures, the presence of this multidirectional polygonal flow system allows the use of flaps with longitudinal or transverse pedicles to reconstruct nasal defects in order to respect the nasal subunits as described by Burget [16].

While performing medical primary rhinoplasties using fillers, if intravascular injections are performed, presence of so many anastomoses forming this system limits the risk of necrosis. On the contrary, sometimes it may create (1) a real risk of antegrade arterial embolism, which anyway in the majority of cases does not cause tissue necrosis, thanks to blood supply coming from other vessels, and (2) a risk of retrograde arteriolar microembolism into ophthalmic artery, which can lead to temporary or permanent visual loss [17, 18].

In revision rhinoplasties, prior to filler injections, it is mandatory especially in tip area to evaluate the presence of (1) any adherence between dermis and bony/cartilaginous framework (in this case, the main nasal vascularization is compromised) and (2) subcutaneous grafts (i.e., shield graft, umbrella graft; in this area, the space between LLC and dermis is very thin, and the grafts placed there compress the subdermal vessels). In our opinion, injections performed in this area after placement of tip grafts can lead to skin necrosis, especially after using external rhinoplasty approach, which interrupts de facto blood supply from columellar arteries.

When blood supply to the tip is compromised, every filler injection performed in this area may cause a further compression on vessels, even if the injection is performed correctly.

References

1. Testut L (1900) Traité d'Anatomie Humaine, 4th edn. Octave Dom, Paris
2. Meyer R (2002) Residual bony deformity. Nasofrontal angle. In: Meyer R (ed) Secondary rhinoplasty: including reconstruction of the nose, 2nd edn. Springer, New York, p 68 (Chapter 11)
3. Redaelli A, Braccini F (2010) Medical rhinoplasty. Basic principles and clinical practice. OEO, Firenze
4. Saban Y, Andretto AC, Hammou JC, Polselli R (2008) An anatomical study of the nasal superficial musculoaponeurotic system: surgical applications in rhinoplasty. Arch Facial Plast Surg 10(2):109–115
5. Saban Y, Polselli R (1994) Atlas of surgical anatomy of the face and neck. Masson, Paris
6. Saban Y, Polselli R (2009) Atlas d'Anatomie Chirurgicale de la Face et du Cou. SEE, Firenze
7. Pitanguy I, Salgado F, Radwanski HN, Bushkin SC (1995) The surgical importance of the dermocartilaginous ligament of the nose. Plast Reconstr Surg 95(5): 790–794
8. Sterzi G (1910) Il Tessuto Sottocutaneo (Tela Subcutanea). Niccolai, Firenze
9. Nakajima H, Imanishi N, Aiso S (2002) Facial artery in the upper lip and nose: anatomy and clinical application. Plast Reconstr Surg 109(3):855–861
10. Toriumi DM, Mueller RA, Grosch T, Bhattacharyya TK, Larrabee WF Jr (1996) Vascular anatomy of the nose and the external rhinoplasty approach. Arch Otolaryngol Head Neck Surg 122(1):24–34
11. Jung DH, Kim HJ, Koh KS, Oh CS, Kim KS, Yoon JH, Chung IH (2000) Arterial supply of the nasal tip in Asians. Laryngoscope 110(Pt 2):308–311
12. Lassau JB, Mitz V, Ricbourg B (1975) Les branches faciales de l'artère faciale. In: Memoires du Laboratoire d' Anatomie de la Faculté de Paris, Paris
13. Salmon M (1936) Artères des muscles de la tête et du cou. Ed Masson, Paris, pp 9–75
14. Taylor GI, Palmer JH (1987) The vascular territories (angiosomes) of the body: experimental study and clinical applications. Br J Plast Surg 40(2):113–141
15. Houseman ND, Taylor GI, Pan WR (2000) The angiosomes of the head and neck: anatomic study and clinical applications. Plast Reconstr Surg 105(7): 2287–2313
16. Burget GC, Mehick FJ (1985) The subunit principle in nasal reconstruction. Plast Reconstr Surg 76(2): 239–347
17. Mc Cleve DE, Goldstein JC (1995) Blindness secondary to injections in the nose, mouth and face: cause and prevention. Ear Nose Throat J 74(3):182–188
18. Sung MS, Kim HG (2010) Ocular Ischemia and ischemic oculomotor nerve palsy after vascular embolization of injectable calcium hydroxyhapatite filler. Ophthal Plast Reconstr Surg 26(4):289–291

2 Neurologic Anatomy of the Nose

Peter M. Prendergast

2.1 Introduction

The external nose and nasal cavity receive a rich sensory innervation through branches of the first and second divisions of the trigeminal nerve (Fig. 2.1). Autonomic nervous supply to the nose arises from the superior salivatory nucleus in the brain stem (parasympathetic) and superior cervical ganglion (sympathetic) via the pterygopalatine ganglion. Knowledge of the neurologic anatomy of the nose is important for the facial and rhinoplasty surgeon who must place incisions strategically to avoid inadvertent injury to sensory nerves. Regional nerve blocks also require a detailed knowledge of the sensory innervation of the nose and the locations of the foramina from which they emerge.

The soft tissues and skin of the external nose are innervated by the infratrochlear and external nasal nerves. These are branches of the ophthalmic division of the trigeminal nerve. Nasal branches of the infraorbital and anterior superior alveolar nerves, both terminal branches of the maxillary nerve, provide further sensory innervation to the sides and part of the tip and columella (Fig. 2.2).

Within the nasal cavity, special sensory innervation relating to olfaction is provided by the first cranial nerve. General sensation in the nasal cavity is relayed through branches of the ophthalmic and maxillary nerves. These include the anterior ethmoidal, infraorbital, and posterior superior alveolar nerves. Further innervation is provided indirectly through the pterygopalatine ganglion by the posterior superior nasal, greater palatine, and nasopalatine nerves (Fig. 2.3).

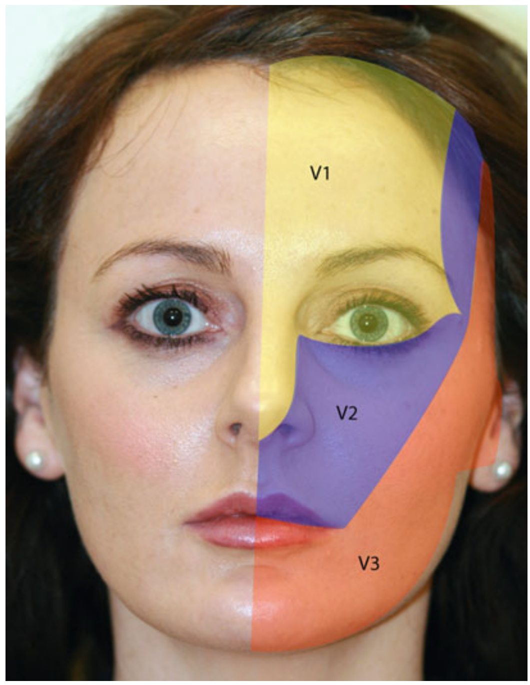

Fig. 2.1 Sensory innervation of the face. The nose is supplied by branches of the first (V1 ophthalmic), second (V2 maxillary), and third (V3 mandibular) divisions of the trigeminal nerve

P.M. Prendergast, M.D., MBBCh, MRCSI
Venus Medical, Heritage House, Dundrum
Office Park, Dundrum, Dublin 14, Ireland
e-mail: peter@venusmed.com

M.A. Shiffman, A. Di Giuseppe (eds.), *Advanced Aesthetic Rhinoplasty*,
DOI 10.1007/978-3-642-28053-5_2, © Springer-Verlag Berlin Heidelberg 2013

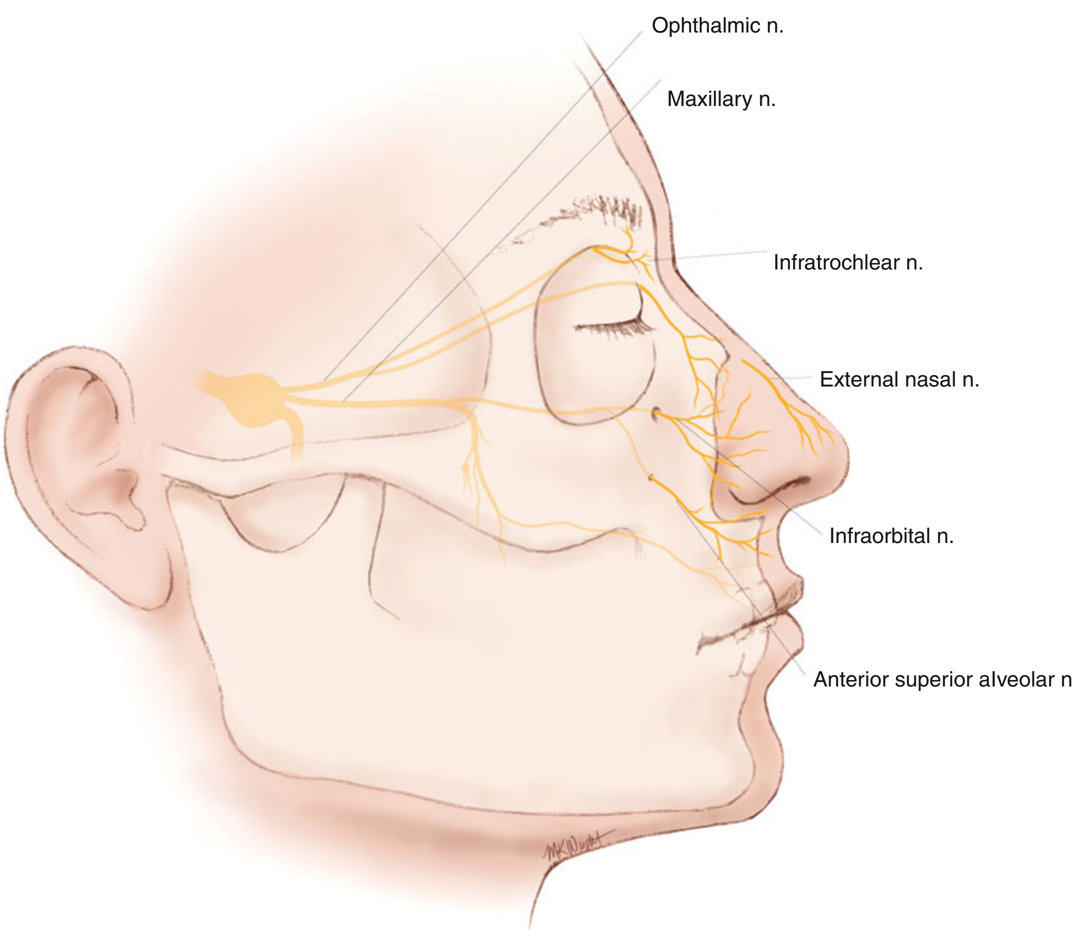

Fig. 2.2 Nerves to the external nose

2.2 Olfactory Nerves

The olfactory nerves transmit the special sense of smell and arise from olfactory cells that lie in the mucosa of the superior conchae and superior part of the nasal septum. From the neural plexus that lies in the nasal mucosa arise about 20 branches of unmyelinated nerves. These branches are ensheathed in dura, pia, and arachnoid mater and pass through the cribriform plate to reach the olfactory bulb in the anterior cranial fossa. The extension of the meningeal layers from the brain to the nasal cavity is a potential avenue for the transmission of infection through the subarachnoid space to the intracranial cavity.

2.3 Sensory Nerves

2.3.1 Anterior Ethmoidal Nerve

The anterior ethmoidal nerve is a direct continuation of the nasociliary nerve when the latter arrives at the medial orbital wall after crossing the optic nerve and running below the superior rectus and superior oblique muscles. After traversing the anterior ethmoidal foramen and canal, the anterior ethmoidal nerve runs along the cribriform plate before passing through a slit lateral to the crista galli to enter the nasal cavity. Medial and lateral branches supply the mucosa of the nasal septum and lateral nasal wall, respectively. At the caudal end of the nasal bone, the nasociliary nerve

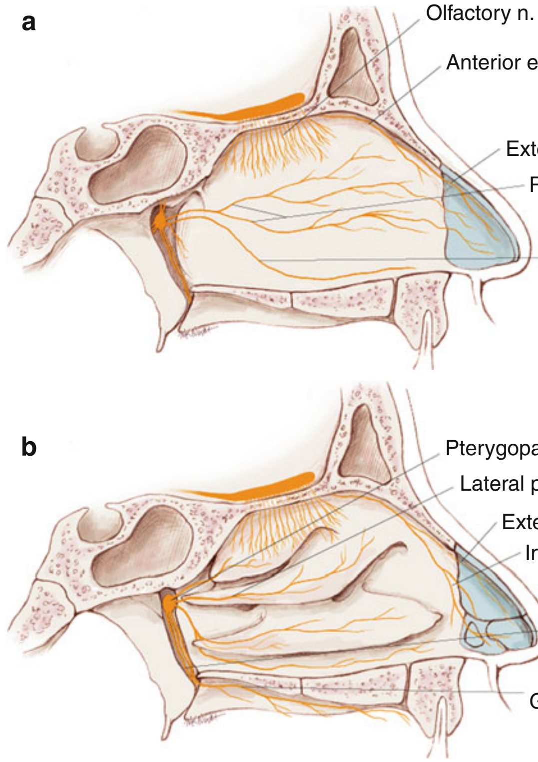

Fig. 2.3 Innervation of the nasal cavity. (**a**) Medial branches supply the septum. (**b**) Lateral branches supply the lateral walls and conchae

appears 6.5–8.5 mm from the midline as the external nasal nerve. From this position between the nasal bone and the upper lateral cartilage, it runs parallel to the midline toward the nasal tip. Variations in the external nasal nerve exist [1]. The nerve may appear as two branches superiorly, branch as it approaches the apex of the nose, or remain as a single branch along its course. The external nasal nerve passes deep to the nasalis and superficial musculoaponeurotic layer of the nose, through the deep fatty layer, to the alar cartilages. The nerve supplies sensation to the distal aspect of the nasal dorsum and tip of the nose, as well as the skin of the nasal ala. Injudicious endonasal incisions or dissection during rhinoplasty surgery can easily lead to transection of the external nasal nerve resulting in nasal tip dysesthesias. Nerve injuries may be minimized by avoiding deep intercartilaginous or intracartilaginous incisions, restricting the dissection to within 6.5 mm of the midline, and limiting dorsal nasal onlay grafts to 13 mm at the rhinion [1].

2.3.2 Infratrochlear Nerve

The infratrochlear nerve, a branch of the nasociliary nerve, arises near the anterior ethmoidal foramen and runs along the medial wall of the orbit before exiting above the medial canthus. The nerve runs inferiorly and supplies sensation to the medial eyelid, lateral part of the nose above the medial canthus, medial conjunctiva, and lacrimal apparatus. The infratrochlear nerve also receives a branch from the supratrochlear nerve lateral to it.

2.3.3 Infraorbital Nerve

The infraorbital nerve is the largest terminal branch of the maxillary nerve. The latter arises between the first and third divisions of the trigeminal nerve as a broad band, passes through the foramen rotundum, and becomes more cord-like as it enters the pterygopalatine fossa. It sends two ganglionic branches to the pterygopalatine ganglion before continuing anteriorly to give off its sensory branches that innervate the midface. Nasal sensory nerves arise from both the anterior superior alveolar nerve and the larger infraorbital nerve. The anterior superior alveolar nerve arises in the infraorbital canal and traverses the canalis sinuosus, passes below the infraorbital foramen on the maxilla, and then turns inferiorly lateral to the nose before sending branches to the central lip, incisors, columella, and tip of the nose. The infraorbital nerve traverses the infraorbital canal in the floor of the orbit. It emerges as five branches at the infraorbital foramen about 6–8 mm below the inferior orbital rim in line vertically with the pupil. These sensory branches consist of the inferior palpebral, external, and internal nasal branches and medial and lateral subbranches of the superior labial branch of the infraorbital nerve [2]. The infraorbital nerve branches emerge into the infraorbital space over the maxilla, where they are amenable to nerve block or susceptible to both traumatic and iatrogenic injuries. This space is bounded superiorly by the origin of levator labii superioris, laterally by levator anguli oris, medially by levator labii superioris alaeque nasi, and inferiorly by orbicularis oris. Hu [2] describes four branching patterns of the infraorbital nerve as it appears from its foramen (excluding the inferior palpebral branch): type I, where all four branches are separated; type II, where the two nasal branches are separated but the superior labial branches are fused; type III, where the superior labial branches are separated but the nasal branches are merged; and type IV, where the two nasal branches and the two labial branches are fused. The external nasal branch of the infraorbital nerve innervates the lateral part of the nose and ala. The internal nasal nerve arises from the lateral part of the infraorbital foramen and runs down along the nose and around the ala to innervate the nasal septum and vestibule.

2.3.4 Anterior Superior Alveolar Nerve

This branch of the infraorbital nerve arises before the latter reaches the infraorbital foramen. It supplies a small part of the external nose at the tip and columella (Fig. 2.2).

2.3.5 Posterior Superior Nasal Nerves

These branches of the maxillary nerve innervate the nasal cavity through a number of smaller medial and lateral branches. Lateral branches supply the mucosa of the superior and middle nasal conchae, whereas medial branches send fibers to the nasal septum (Fig. 2.3). The nasopalatine nerve represents the largest of the medial posterior superior nasal nerves. It passes anteroinferiorly in a groove on the vomer to reach the floor of the nasal cavity. From here, it passes through the incisive fossa of the hard palate and communicates with the greater palatine nerve to supply the mucosa of the hard palate. The posterior superior nasal nerves pass through the pterygopalatine ganglion without synapsing and onto the maxillary nerve via its ganglionic branches.

2.3.6 Palatine Nerves

The greater and lesser palatine nerves are also sensory branches of the maxillary nerve, via the pterygopalatine ganglion. From the ganglion, they pass inferiorly through the greater palatine canal. In the canal, the larger greater palatine nerve gives off branches that perforate the perpendicular plate of the palatine bone to enter the nasal cavity. These posterior inferior branches supply sensation to the mucosa over the inferior nasal concha and the inferior and middle meatuses. The greater palatine nerve emerges from its canal through the greater palatine foramen and passes anteriorly in the roof of the palate, innervating the mucosa and gingivae and communicating with the nasopalatine nerve anteriorly. The lesser palatine nerve runs with the greater palatine nerve, emerging through the lesser palatine foramen to send sensory fibers to the tonsils, uvula, and soft palate. It does not contribute to the innervation of the nose or nasal cavity.