The Paramedian Forehead Flap for Nasal Reconstruction: From Antiquity to Present

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Abstract: Nasal reconstruction is considered the historic foundation of facial plastic surgery, and the forehead flap remains the workhorse of repair. To recreate both the aesthetic contour and function of the nose, all anatomic layers must be addressed—covering, lining, and structural support. This article reviews the noteworthy history underlying the development of the paramedian forehead flap as the primary tool in reconstruction of large nasal defects while highlighting its implications on modern nasal repair. Current developments in the use of 2-staged paramedian forehead flap reconstruction are examined and a modern technique is presented.

Key Words: History, nasal reconstruction, paramedian forehead flap, rhinoplasty


The nose is the central, and therefore most prominent, feature of the human face. Its overall appearance including shape, size, and proportionality defines both facial symmetry and the relative facial attractiveness of an individual.1 Due to its prominent location within the face, its anterior plane of projection, and the delicacy of the skin and soft tissue envelope, the nose is also particularly vulnerable to injury with resulting injuries that are readily noticeable. Given its prominence within the facial subunits, the nose has been considered the “organ of reputation” since ancient times. Consequently, rhinopia, or nasal amputation, was implemented as a form of punishment to disgrace an individual, effectively stripping them of their honor. When the healing is complete and the skin and soft tissue envelope fuse, the nose is also particularly vulnerable to injury with resulting injuries that are readily noticeable. Given its prominence within the facial subunits, the nose has been considered the “organ of reputation” since ancient times. Consequently, rhinopia, or nasal amputation, was implemented as a form of punishment to disgrace an individual, effectively stripping them of their honor. When the healing is complete and the nose is restored, the physician takes the leaf of a plane [and] places it on the patient’s cheek or forehead and cuts out of this a piece of skin of the same size in such a manner that the skin at one end remains attached [...] Then he freshens with his scalpel the edges of the stump of the nose and wraps the piece of skin from the cheek or forehead carefully around it and sews it at all the edges. The he inserts two thin pipes in the nose (in the position of the nostrils) to facilitate respiration and prevent flesh from collapsing. When the healing is complete and parts united, the connection is removed.”1,4,6

Although this method of nasal reconstruction proved effective, it was not adopted on an international level for several centuries, likely due to lack of communication or maritime commerce.7 In the 10th century, the Islamic conquest of India facilitated the spread of medical knowledge from India to Arabia, and subsequently to Italy following the occupation of Sicily during the ninth to twelfth centuries.8 Pope Innocent III however prohibited surgical procedures in the early thirteenth century, resulting in a period of stagnation in science and medicine. However, early reconstructive surgical principles were kept alive, passed from 1 generation to another, and the renaissance of the fourteenth century brought with it a rebirth of scientific advancement. Sushruta forehead flap technique was first documented in Europe by Branca de’Branca of Sicily in 1442. The technique was passed from Branca to his son, Antonio, and observers, outside of their family, were prohibited from viewing the procedure due to fear that the technique may be stolen. Antonio Branca made significant modifications to the procedure, using a delayed skin flap from the upper extremity tissue donor site. This method came to be known as “the Italian Method.”1,5-8

The first documented account of the Indian midline forehead rhinoplasty technique in English literature appeared in the Madras Gazette in 1793, chronicling a description of the procedure performed in Poona, India. The technique was again published, 1 year later, in the Gentleman’s Magazine of London by a British Surgeon named Lucas after observing an Indian surgeon reconstruct the amputated nose of a bullock driver.12 This account encouraged
Joseph Carpue, a British Surgeon at York Hospital in Chelsea England, to attempt the procedure. He initially experimented with the technique on cadavers for over 20 years until finding appropriate candidates for the procedure. In 1814, Carpue successfully implemented the procedure on 2 patients: the first, a military officer who had lost his nose due to the toxicity attributable to mercury treatments and the second, an officer whose nose was mutilated by a sword injury. He reported that the reconstructive procedures he observed in India were performed in over 90 minutes. However, Carpue described a total procedure time of 15 minutes, including 9 minutes for flap harvesting and 6 minutes for suturing. He documented that the application of postoperative dressings, however, took 22 minutes. Following his publication, the forehead flap gained wide use throughout Europe. In 1818, a German surgeon, Carl Van Graefe, published a large volume detailing his techniques in nasal reconstruction entitled Rhinoplastik. Within this text he described “the German method” of nasal reconstruction in which he modified the Italian method by using a skin graft from the arm in place of the pedicled flap described previously. Warren then performed the first nasal reconstruction in America in the late 1830s. Modifications of the forehead flap began to develop in the 1840s as more surgeons began to adopt this technique. Pierre August Labat, a French surgeon, described the use of an inwardly folded tri-lobed flap in 1834. Von Graefe’s successor, Friedrich Dieffenbach, published a comprehensive text regarding rhinoplasty, Operative Chirurgie, in 1845 and is credited with popularizing secondary revision procedures to improve the aesthetic appearance of the reconstructed nose. Dieffenbach was also an early adopter of anesthesia, thereby allowing reconstructive procedures to be more tolerable for patients allowing for increasing interest in further procedures.

The turn of the twentieth century served as a catalyst for facial reconstructive surgery. Prior to this period, reconstructive or aesthetic surgery was only a secondary thought, limited to adjunctive surgeries, and few reputable physicians devoted their practice primarily to facial reconstruction. However, World War I, and trench warfare, brought with it a necessity for reconstructive surgeons; inspiring young academic surgeons of the time, such as Harold Delf Gillies, to adopt the forehead flap as the preferred method of nasal reconstruction. Following his wartime experiences, Gillies documented various procedures which he had either adopted or developed in his textbook, Plastic Surgery of the Face. Gillies was a strong proponent of the forehead flap writing: “The tint of the forehead skin so exactly matches that of the face and the nose that it must be first choice […]the forehead makes far and away the best nose [and] with some plastic juggling, the forehead defect can be camouflaged effectively.”

Following Gillies publication several modifications of the forehead flap were described throughout the twentieth century. The median forehead flap, which implemented a vertical flap along the midline of the forehead, was introduced in the United States by Kazanjian in 1946. The flap received its blood supply from both supratrochlear vessels with a base that rotated 180 degrees at or above the eyebrows. Forehead donor sites in these early operations were continued to allow to heal by secondary intention. Results following these procedures were poor as wound contracture along the underlying surface of the flap often led to distortion of the external nasal anatomy. Furthermore, the residual intranasal lining was inadequate. It was through these suboptimal results and resultant modifications that the basic tenets of nasal reconstruction, in which the nasal framework is established with both a properly lateral and appropriate viable cutaneous covering, were developed. Midline forehead flaps were unable to provide both adequate tissue for reconstruction of the columella and permit in-folding for nasal lining without compromising flap viability with added tension along the pedicle. In order to provide additional flap length, several modifications were attempted including Gilles’ “up-and-down flap,” which was pedicled over 1 supraorbital vessel, passed into the hair-bearing scalp and then back into forehead. Converse modified the up-and-down flap, constructing a flap with a vascular pedicle which included the major vascular supply of the scalp. Regrettably, these flap designs, while providing added length, resulted in forehead donor sites that were difficult to close. In order to address the need for lining, many surgeons turned their attention toward addressing the raw undersurface of the flap rather than folding it. Gillies popularized the use of composite chondrocutaneous grafts for structural support and lining. Converse alternatively used a septomucoperichondrial graft as an alternative.

The need for structural framework support became evident with the popularization of the forehead flap. The transferred soft tissue and lining would otherwise collapse following reconstruction resulting in both poor functional and aesthetic outcomes. Restoration of nasal contouring often requires a single procedure with the use of large bulky cantilever grafts. As the intranasal lining flaps became increasingly used, their thin and highly vascular nature allowed for the use of primary cartilage graft placement from the native septum, auricle, or rib. Placement of delicate grafts facilitated the reconstruction of the normal cartilaginous framework of the nose. Cartilage grafts augment projection while providing support and enable recreation of the three-dimensional natural nasal contour. Similarly, delayed primary cartilage grafts were used to support lining provided from a skin graft or a folded flap during an intermediate stage procedure prior to division and inset of the forehead, resulting in a 3-stage procedure. These progressive refinements set the stage for modern nasal reconstruction and established the forehead flap as the workhorse of repair.

ANATOMY

An appreciation for both nasal and forehead anatomy is crucial in successful nasal reconstruction, particularly when implementing the forehead flap. The supratrochlear artery, arising from the ophthalmic artery, is the primary blood supply for the forehead flap. The supratrochlear artery arises as a single trunk from the maxillary artery serves as a single trunk from the maxillary artery. Identification of the arteries exit from the orbit, approximately 1.7 to 2.2 cm from the midline. As the supratrochlear ascends along the forehead it lies superficial to the corrugator supercilii and deep to the orbicularis oculi. The artery then traverses the orbicularis oculi and frontalis at approximately 1.5 cm above the orbital rim, corresponding to the level of the medial eyebrow in a Caucasian patient. This segment of the artery is fairly superficial and continues in the subcutaneous plane anastomosing with the ipsilateral supraorbital and angular arteries as well as the contralateral supratrochlear. This network of arteries provides the adequate perfusion pressure and blood supply to the distal aspect of the flap. Prior studies have further identified a supraorbital plexus, an anastomotic network of arteries from branches of the supratrochlear, supraorbital and dorsal nasal vessels. A modification in which a 3 cm cuff of peristomeum at the pedicle base is preserved allows for added perfusion and flap stability and is able to adequately perfuse not only a forehead flap but also a transverse limb, or cross paramedian forehead flap.

MODERN OPERATIVE TECHNIQUE

The patient is placed supine on the operating table in 30° of reverse Trendelenburg position, facilitating reduction in venous return and a resultant decrease in intraoperative blood loss. The patient’s eyes are protected with either moistened eyepads or temporary tarsorrhaphy. Draping is wide with exposure of the full face, from midtrichion to the submental area, and sterilized in standard fashion (Fig. 1A).
Preparation for reconstruction is first performed by outlining the nasal subunits directly on the patient’s nose to better define the cutaneous defect. A template of the defect is designed, often using the aluminum suture packaging. The contralateral corresponding subunit may be used to verify or assist with outlining of the defect in order to counteract any soft tissue distortion along the defect site that may hinder symmetrical planning of the template. The defect site is then prepared by removing any devitalized or irregularly contoured bordering tissue. The adjacent skin is mildly undermined to reduce any possible trap door deformity following reconstruction. The template is then traced onto the donor forehead site along the midline above the medial brow (Fig. 1B). The flap is based above the medial canthus with its center approximately 1.25 to 1.50 cm lateral to midline corresponding to the vertical axis of the supratrochlear artery. The flap is typically based on the supratrochlear artery contralateral to the defect. This is due to the lower degree of rotation and torsion required to reach the defect resulting in decreased risk of occlusion to distal arterial supply and improved venous return. A flap width of 1.0 to 1.5 cm is designed, allowing for a margin of tissue surrounding the supratrochlear artery. The pedicle base is not flared in order to prevent restriction to the arc of rotation. The superior skin paddle may be thinned. After satisfactory delineation of the planned skin paddle and pedicle, incisions are made along the margins of the tracing, ensuring that all borders are angular, rather than curvilinear, in order to mitigate risk of future trap door deformity. The distal skin paddle is raised in the subcutaneous plane creating a thin pliable flap that will conform well with the native nasal topography. In patients with vascular disease, the skin paddle may require a more robust blood supply, and therefore the flap may be raised in a subgaleal plane and thinned in an intermediate staged procedure prior to division and inset. The proximal skin paddle and pedicle is raised in a subgaleal plane extending to a subperiosteal plane as the dissection proceeds proximally to preserve the vascular supply and further increase pedicle length (Fig. 1C). The flap is then inset after confirming thickness similar to that of the native nasal covering. Prior to inset, structural grafts are placed to address any functional deficits as needed. The flap is inset using interrupted vicryl suture followed by prolene superficial closure. The forehead donor site is undermined in a subgaleal plane and advanced to midline for closure (Fig. 1D). Forehead defects less than 3.5 cm are generally amenable to complete primary closure. Vertically based galeotomies may be performed, approximately 1.5 to 2 cm apart, to accommodate closure of more broadly based pedicle defects. Large superior skin paddle defects are closed to the extent possible and left to heal via secondary intention, leaving the frontalis intact will facilitate rapid healing along this area. The underside of the flap pedicle may be wrapped with petroleum impregnated gauze or acellular dermal matrix to promote retention of moisture and prevent bleeding.

Pedicle division is performed approximately 3 weeks following the initial procedure, allowing for an adequate amount of time for neovascularization. The distal segment of the pedicle is incised transversely to the subcutaneous plane, and the cutaneous segment is thinned. After undermining, the pedicle is completely divided and the surrounding scar edges are trimmed to allow for maximized eversion and subsequently inset. Attention is then turn to the proximal pedicle, and a blade is used to fashion a small triangle along the superior pedicle stump. This flap is then rotated and inset into the glabellar region of the forehead scar (Fig. 1E, F). Attention is paid to symmetry of the brow, as the medial aspect of the brow is displaced inferiorly during the first stage of the procedure and must be resuspended.

CONCLUSION
Nasal reconstruction is a difficult yet rewarding endeavor. The paramedian forehead flap has evolved as an important tool in the reconstructive surgeon’s armamentarium when approaching nasal reconstruction, particularly large defects. It has developed, from its origin in antiquity as a broad-based flap with considerable donor site morbidity and excessive bulk, to an elegant reconstructive procedure that achieves an aesthetically pleasing outcome for patients. Advances in understanding of the anatomic variation in blood supply have allowed surgeons to utilize it in a myriad of reconstructive approaches. The use of intranasal lining flaps, skin grafts, or modified folded forehead flaps has allowed for recreation of the thin delicately vascularized tissue of the nasal lining while the rigid structural support, recreated by primary or delayed cartilage and bone grafts, has further refined the reconstructive process.

REFERENCES

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16. Labat L. De la Rhinoplastie, Art de Restaurer ou de Refaire Complètement le Nez. Paris, France: Ducrosseis; 1834
23. Converse JM. Composite graft from septum for nasal reconstruction. Trans Am Cong Plast Surg 1956;8:281

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