INTRODUCTION

The forehead flap is a staple of nasal reconstruction and a historical cornerstone of plastic and reconstructive surgery. In his seminal work, "Plastic Surgery of the Face," Sir Harold Gillies discussed nasal reconstruction stating, "The tint of the forehead skin so exactly matches that of the face and the nose that it must be first choice." Indeed, to this day the paramedian forehead flap remains a popular option for reconstruction of large, multi-subunit defects. Owing to this popularity, several permutations of the forehead flap have been described. Although initially described as a 2-stage reconstruction, in 1974, Millard proposed the addition of a third, intermediate stage. This 3-stage technique was expanded upon by Burget and Menick, who suggested a 3-stage approach would improve perfusion of the flap, expand options for nasal lining and graft support, and provide superior aesthetic and functional outcomes. Although both the 2- and 3-staged approaches are well described in the current literature, the comparative indications and outcomes of each remain unclear. In this article, the authors provide an overview of the history, relevant anatomy, and technical details of the paramedian forehead flap, as well as a review of the current literature comparing the indications and outcomes of the 2- and 3-stage approaches.

History

The history of the forehead flap and its utility in nasal reconstruction dates back to 600 BC. Mutilation of the nose and other prominent facial structures was a common form of corporal punishment in ancient India, leading to significant facial deformities. The ancient Indian text Shushruta Samhita describes several primitive techniques for reconstructing these defects, including the first description of the pedicled forehead flap as well as its subsequent division at a second stage. Although initially described as a 2-stage reconstruction, in 1974, Millard proposed the addition of a third, intermediate stage. This 3-stage technique was expanded upon by Burget and Menick, who suggested a 3-stage approach would improve perfusion of the flap, expand options for nasal lining and graft support, and provide superior aesthetic and functional outcomes. Although both the 2- and 3-staged approaches are well described in the current literature, the comparative indications and outcomes of each remain unclear.

Two or Three? Approaches to Staging of the Paramedian Forehead Flap for Nasal Reconstruction

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Summary: The paramedian forehead flap is a historic cornerstone of plastic surgery and a mainstay of complex nasal reconstruction. Although initially described as a 2-stage procedure, several procedural advancements and modifications have been proposed, with the most notable being the addition of a third, intermediate stage. Proponents of this 3-stage approach argue that the addition of an intermediate stage improves flap perfusion, expands lining and structural support options, and provides superior aesthetic outcomes. Although this technique has grown in popularity, studies comparing the 2- versus 3-stage approach are relatively scarce in the literature. Existing comparative studies seem to suggest that the 3-stage paramedian forehead flap may have advantages in large, complex nasal defects and patients at high risk for vascular compromise. Additionally, comparative analyses with respect to aesthetic outcome were found to be largely equivocal, suggesting that surgeon comfort and preference should guide flap selection. (Plast Reconstr Surg Glob Open 2021;9:e3591; doi: 10.1097/GOX.0000000000003591; Published online 13 May 2021.)
primary closure of the forehead donor site. Additional advancements by Millard and Menick led to a more narrow pedicle based solely on the supratrochlear artery, allowing the exclusion of the glabellar skin. In 1985 Burget and Menick published *Aesthetic Reconstruction of the Nose*, which is still considered the gold standard in nasal reconstruction.

The forehead flap was traditionally described as a 2-staged procedure. The first stage consisted of flap elevation, thinning, and inset, with division of the pedicle during a second stage approximately 3 weeks later. In 1992, Burget and Menick described the addition of an intermediate stage between flap transfer and division during which the flap is re-elevated from the recipient site, thinned, and contoured as needed. Menick proposed that this intermediate stage maximized blood supply to all nasal layers, expanded options for nasal lining, and enhanced overall aesthetic outcome.

**Anatomy**

The blood supply of the paramedian forehead flap is primarily based unilaterally off the supratrochlear artery and segmental perforators of the supraorbital artery proximally. Distally, the flap is often described to derive its blood supply in a random pattern fashion. Key to the dissection of this flap is the origin and course of the supratrochlear artery. The supratrochlear artery is a terminal branch of the ophthalmic artery, itself a branch of the internal carotid artery, which travels anteriorly over the periosteum as it emerges from the superomedial aspect of the orbit. After exiting the orbit, the supratrochlear artery courses medial to the supraorbital artery and pierces the corrugator muscles as it travels superiorly, where it then passes through the frontalis muscle approximately 2 cm superior to the orbital rim. Once passing through the frontalis, the vessel then continues to superficialize and invests within the subcutaneous fat, where it is considered to almost be contiguous with the skin of the scalp. The supratrochlear nerve has a similar course as its paired artery but is often disrupted during dissection. For preoperative identification and initial flap design, the supratrochlear artery can be traced running vertically 2 cm from the midline and 1 cm superior to the brow.

**Comparison of Surgical Techniques**

**Two-stage Approach**

The initial surgical approach (including flap design and elevation) is similar between the 2- and 3-stage forehead flaps. After examining the nasal defect, a template is constructed based on the corresponding nasal subunit of the contralateral side. The supratrochlear artery is identified via Doppler as it exits the superomedial orbit, approximately 2 cm lateral to the midline, coursing under the medial brow. The paramedian forehead flap may be based off either the ipsilateral or contralateral supratrochlear artery. The ipsilateral approach requires a shorter flap length to reach a lateral nasal defect; however, the pedicle may be subject to torsion during flap rotation. Precise identification of the pedicle allows the surgeon to taper the flap and achieve a narrow pedicle width (1.0–1.7 cm) minimizing any clinically significant pedicle torsion. Menick suggests that regardless of whether a contralateral or ipsilateral flap is designed, rotational torsion is best avoided by incising the flap lower on its medial edge than its lateral edge.

After the flap is designed and marked, local anesthetic is infiltrated for plane hydrodissection, the distal portion of the flap is incised, and elevation commences in a distal to proximal fashion. The distal portion of the flap may be harvested in a plane superficial to the frontalis muscle, or alternatively, the frontalis may be included initially and thinned before inset. As elevation progresses toward the supraorbital rim, the dissection plane deepens as the pedicle descends from its subcutaneous plane to course between the orbicularis oculi and corrugator. The supratrochlear artery is identified as it passes over the corrugator muscle. Elevation continues until sufficient flap length for defect coverage without undue tension is achieved. In our experience, transitioning to a sub-periosteal plane approximately 1 cm superior to the orbital rim is helpful to ensure the pedicle is protected. If a 2-stage procedure is planned, flap thinning typically occurs during the initial stage, with thinning of the subcutaneous tissue and frontalis underlying the distal 1–2 cm of the flap. Although considered safe, the disruption of the myocutaneous blood supply may pose a risk in vascularly compromised patients, such as current smokers, diabetics, or elderly patients. Support grafts are then placed and contoured as necessary. Unlike the 3-stage approach, the flap is not re-elevated for additional contouring or shaping.

**Three-stage Approach**

In contrast to the 2-stage approach, dissection during the initial stage of the 3-stage forehead flap begins by elevating a full-thickness flap, including the skin, subcutaneous tissue, and the underlying frontalis muscle. Menick advocates for this technique, cautioning that removal of the underlying myocutaneous tissue at this stage may partially devitalize the distal tip of the flap and expose raw dermal tissue that is prone to fibrosis. Cartilage support grafts may be placed at this stage or during the following intermediate stage. After 3–4 weeks, the skin of the flap is re-elevated from its distal inset with the now-healed underlying frontalis and subcutaneous tissue remaining adherent to the wound bed. This flap skin has now been effectively surgically delayed. The underlying tissue and cartilage grafts can either be contoured or the addition of delayed grafts may be employed. The supratrochlear pedicle remains intact during this intermediate stage operation.

The 3-stage forehead flap also expands options for nasal lining reconstruction. In a 2-stage approach, this historically consisted of skin grafts, local flaps, mucosal flaps, and intranasal lining flaps based on axial vessels. The 3-stage “folded” forehead flap offers a unique approach to nasal lining deficiencies. A full thickness extension is designed at the distal border of the flap, matching the lining defect. During inset, this distal segment is then folded back on itself and secured to the remaining native lining. In 3–4 weeks during the intermediate stage, the folded
portion is no longer dependent on the perfusion of the proximal flap and may be divided, allowing access for contouring and delayed graft placement if desired.\textsuperscript{4,19}

In the experience of the senior author, indocyanine green (ICG) angiography has proved a useful adjunct in the assessment of flap perfusion, particularly during inset. This technology allows the surgeon to assess perfusion during preliminarily inset, identify potential pedicle kinking, and modify the inset as necessary. ICG angiography may also aid the decision-making process when selecting a 2- versus 3-stage forehead flap.

In both the 2- and 3-stage approaches, the donor site is widely undermined in the subgaleal plane and closed primarily if the defect is <3.5 cm in diameter. Due to the forgiving nature of the forehead as a donor site (secondary to the area’s high vascularity), large defects may be partially closed and left to heal by secondary intent. The final stage is pedicle division, occurring at approximately 3–4 and 8 weeks in the 2- and 3-stage approach, respectively.\textsuperscript{2}

### Comparing the 2- and 3-stage Approaches

Head-to-head analyses of the 2- and 3-stage approaches to the paramedian forehead flap are relatively scarce in the current literature; however, few comparative studies do exist (Table 1).\textsuperscript{5,6,7,17-19} These studies help shed light on the indications and outcomes of each approach. In describing the 3-stage forehead flap, Burget and Menick offer 9 specific benefits of this approach.\textsuperscript{3} More recently, several authors have attempted to further clarify the precise indications for the 3-stage forehead flap, commonly citing defect size, complexity, and patients at high risk for vascular compromise.

One of the proposed advantages of the 3-stage forehead flap is risk mitigation in patients with a predisposition for surgical complications due to comorbid medical conditions. The elevation and inset of a full-thickness flap maximizes distal perfusion, which may be beneficial in this patient population. In a 2019 retrospective review, Lo Torto et al compared the outcomes of 2- and 3-stage forehead flaps in patients whom they considered to be “high vascular risk,” including patients with 1 of the following characteristics: smokers, elderly patients (>65 years old), diabetes, ASA class < 3, and defects > 1.5 cm. Flap necrosis was documented in 13% of patients in the 2-stage group, and zero patients in the 3-stage group. Although these findings were not found to be statistically significant, the authors suggest that the 3-stage approach may reduce the risk of flap complications in smokers, elderly, and diabetic patients.\textsuperscript{17}

In addition to comorbid medical conditions, defect size and complexity are often cited as potential indications for a 3-stage paramedian forehead flap. In the largest comparative study to date, Stahl et al hypothesized that in large, complex defects, the 3-stage forehead flap would be associated with lower rates of flap necrosis and overall complications.\textsuperscript{1} The authors retrospectively reviewed 187 cases of nasal reconstruction with the paramedian forehead flap in 2 (n = 87) and 3 (n = 100) stages. Of note, specific indications for a 3-stage approach were cited as “preexisting systemic risk factors, medium to large defects, and the need for cartilage framework for inner lining.” The authors propose a severity index incorporating defect depth, tissue layers involved, number of nasal subunits, and need for internal lining or cartilage grafts. Overall defect complexity—as well as the number of full thickness defects, need for

### Table 1. Summary of Key Findings of Studies Directly Comparing 2- versus 3-stage Forehead Flaps

| Study          | Patients | Primary Outcome | Findings                                                                                           | Notes                                                                                           |
|----------------|----------|-----------------|----------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|
| Santos Stahl et al\textsuperscript{1} | Two stage (n = 87) | Complication rate | Significantly higher defect complexity scores in patients undergoing 3- versus 2-stage paramedian forehead flap. | Regression analysis controlling for defect complexity found no significant difference in flap necrosis rates. |
|                | Three stage (n = 100) | | No significant difference in rates of flap necrosis, epidermolysis, infection between 2- and 3-stage group. | Visual analog scale (1-10) used to assess aesthetic satisfaction. |
| Ribuffo et al\textsuperscript{15} | Two stage (n = 20) | Aesthetic outcome | Aesthetic satisfaction significantly greater in 3-stage group when assessed by both patient and surgeon at 1 and 6 months. | High vascular risk patients included those with defects larger than 1.5 cm, ASA < 3, smoking habit (>20 cigarettes a day), diabetes, elderly patients (>65 years). |
|                | Three stage (n = 11) | | | |
|                | Two stage (n = 30) | Complication rate, aesthetic outcome | No significant difference in rates of wound dehiscence, partial or complete flap necrosis in 2 versus 3-stage group in high vascular risk patients. | |
|                | Three stage (n = 16) | | Aesthetic satisfaction significant greater in 3-stage group when assessed by both patient and surgeon at 1 and 6 months postoperatively. | |
| Noel et al\textsuperscript{16} | Two stage (n = 16) | Aesthetic outcome | Aesthetic satisfaction with total flap thickness significantly greater in 3-stage group. No significant difference in aesthetic satisfaction with respect to total nasal appearance, or individual subunit appearance. | Aesthetic satisfaction assessed via 35-question self-assessment questionnaire developed by a multidisciplinary team, including both surgeons and psychiatrists. |
|                | Three stage (n = 15) | | | |
| Stahl et al\textsuperscript{1} | Two stage (n = 25) | Aesthetic outcome | No significant difference in overall satisfaction with aesthetic outcome between groups. | |
|                | Three stage (n = 35) | | Significantly higher satisfaction with reconstructed nasal ala in 2-stage group. | |
lining or cartilage grafts, and prior nasal operations—were significantly greater in the 3-stage cohort. Despite differential complexity scores, complication rates were not statistically different between the cohorts. Although not statistically significant, additional subgroup analyses controlling for defect complexity identified lower rates of flap necrosis in the 3-stage cohort. An additional proposed advantage of the 3-stage paramedian forehead flap is enhanced aesthetic outcome. The skin of the forehead is significantly thicker than that of the nose, requiring some degree of flap “thinning” when utilized for nasal reconstruction. In the 2-stage approach, this flap thinning occurs during the index operation, as the distal end of the flap will not be re-elevated once inset. By comparison, during the initial stage of the 3-stage approach, a full-thickness flap is transferred to the nasal defect, including skin, subcutaneous tissue, and underlying frontalis muscle. Thinning occurs during the second or intermediate stage, when the flap has been effectively physiologically delayed and can tolerate significantly more aggressive thinning. Proponents of the 3-stage technique argue that this allows for more precise 3-dimensional contouring and fine adjustments of cartilage grafts, leading to an overall enhanced aesthetic outcome.

Several small comparative studies have attempted to objectively compare the aesthetic outcomes of 2- and 3-stage paramedian forehead flaps. In 2012, Ribuffo et al utilized a visual analog scale (scored 1–10) to assess aesthetic and functional outcomes of 2-versus 3-stage flaps. Assessing flap thickness, the authors found that 3-stage flaps were significantly thinner at the nasal tip (1.62 versus 3.26 mm), dorsum (1.84 versus 3.63 mm), and sidewall (1.86 versus 3.6 mm). Both patients and independent plastic surgeons reported greater satisfaction with overall aesthetic appearance in the 3-stage group at 1 and 6 months postoperatively, with each of these comparisons found to be statistically significant.

Conversely, subsequent studies have found no significant difference between aesthetic or functional outcomes in the 2 versus 3-stage approach. Stahl et al utilized a 35-question self-assessment questionnaire developed by a multidisciplinary team, including both surgeons and psychiatrists. No significant difference in overall satisfaction with aesthetic outcome was identified between groups. Interestingly, subgroup analysis of individual nasal subunits found that patients in the 2-stage group were more satisfied with the appearance of the reconstructed nasal ala than those who underwent 3-stage reconstruction; however, no difference was identified with the remaining subunits. The authors hypothesized that the additional surgical procedure may lead to increased risk of fibrosis at the nasal ala, which could contribute to differential thickness and satisfaction rates.

The findings of these comparative studies seem to suggest—albeit, preliminarily—that the 3-stage paramedian forehead flap may be advantageous in large, full-thickness nasal defects and in patients with significant medical comorbidities. However, there are unique risks to a 3-versus 2-stage approach. By definition, a 3-stage approach involves an additional operative procedure, further exposing patients to the inherent risks of anesthesia and surgery, including surgical site infection. Additionally, one must consider the additional recovery time and absence from work/school associated with an additional procedure. In terms of differences in aesthetic outcomes, the available comparative studies are relatively limited due to their retrospective nature and small sample size. Although objective metrics such as flap thickness were assessed, reported outcomes were largely subjective, making them difficult to quantify and compare across studies. Additional large-scale investigations—preferably in a prospective manner, with validated patient questionnaires—are necessary to determine if there is a true differential in aesthetic outcome or patient satisfaction.

CONCLUSIONS

The paramedian forehead flap is a workhorse flap for distal nasal third reconstruction and may be approached in either 2 or 3 stages. Existing comparative analyses, although limited, suggest that the 3-stage approach may be beneficial in large, complex nasal defects and in patients at high risk for vascular compromise. Aesthetic results are largely equivocal between the 2 approaches, and flap selection should be based on surgeon comfort, rather than on dogmatic principle. The paramedian forehead flap—in both its 2-stage and 3-stage versions—is a safe, reliable, and useful flap for the reconstruction of large nasal defects and will continue to be a staple in the field of reconstructive plastic surgery for years to come.

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