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REVIEW

# Paramedian Forehead Flap Hair Removal: A Comprehensive Review of Techniques, Timing, Challenges, and Future Directions

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**Abstract:** The paramedian forehead flap (PFF) is a widely used and versatile reconstructive technique, highly valued for its reliable vascularity, close tissue match, and integration of both functional and aesthetic outcomes. Despite its versatility and broad applicability in reconstructive surgery, inclusion of hair-bearing scalp can compromise cosmetic results and patient satisfaction, making hair management a critical but often underappreciated aspect of flap-based reconstruction. Traditional depilation techniques provide only temporary results, whereas contemporary methods such as laser hair removal, intense pulsed light (IPL), electrolysis, and follicular unit extraction (FUE) enable durable or permanent hair reduction in transferred flaps. The timing of intervention, including preoperative, during tissue expansion, intraoperative, or postoperative treatment, significantly influences both efficacy and patient tolerance. FUE is particularly advantageous for patients with low hairlines or extensive donor sites, while laser hair removal remains the primary method for most flap applications. This review systematically summarizes current hair removal strategies in PFF reconstruction, evaluating their underlying mechanisms, clinical effectiveness, advantages, limitations, and optimal timing considerations. This review draws on clinical experience and published evidence to provide practical recommendations for hair management in paramedian forehead flaps. It focuses on improving aesthetic outcomes, guiding timing and technique selection, and supporting decisions in flap-based reconstruction.

**Keywords:** hair removal, paramedian forehead flap, nasal defects, techniques, timing

## Introduction

Nasal defects, particularly in distal subunits such as the tip and columella, represent some of the most challenging problems in dermatologic reconstructive surgery. Forehead flap techniques have a long history, from early descriptions in the Sushruta Samhita to the paramedian forehead flap popularized by Millard.[1,2] The paramedian forehead flap (PFF) is highly valued for its reliable vascularity, excellent tissue match, and ability to restore both functional and aesthetic outcomes. Modern approaches emphasize not only defect closure but also preservation of tissue quality, adnexal structures, and three-dimensional nasal contour.[3] A systematic review and overview of flap reconstructive techniques for nasal skin defects, including 176 studies and 11,370 patients, demonstrated that most nasal defects arise after cutaneous malignancy resection, underscoring the clinical burden and diversity of nasal wounds requiring reconstruction.[4]

Management of hair-bearing tissue is a critical consideration in PFF reconstruction, as extension into scalp regions may result in persistent hair growth on the reconstructed area, compromising cosmetic outcomes and patient satisfaction. Traditional depilation methods such as shaving, chemical depilation, waxing, and plucking provide only temporary results and may cause discomfort. Although modern laser- and light-based techniques enable more durable hair

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reduction, clinical guidance regarding method selection, timing, and expected outcomes remains limited.[5–7] These gaps justify a comprehensive review summarizing current strategies for hair management in PFF reconstruction.

Current strategies include both conventional and contemporary approaches, including laser hair removal (LHR), intense pulsed light (IPL), electrolysis, and follicular unit extraction (FUE). Each method is evaluated in terms of mechanism, clinical efficacy, advantages, limitations, and optimal timing. Particular emphasis is placed on individualized approaches that optimize aesthetic outcomes, minimize complications, and expand reconstructive options for patients with varying hairline positions or donor tissue availability.

Hair removal interventions are discussed according to timing, including preoperative, intra-expansion, intraoperative, and postoperative phases. Comparative analysis highlights differences in clinical applicability, durability, and patient tolerability. By integrating clinical experience with published evidence, this review provides practical guidance for hair management in PFF reconstruction and supports evidence-based planning and decision-making in flap-based reconstructive procedures.

# Paramedian Forehead Flap in Nasal Defect Repair

## Overview of the Paramedian Forehead Flap

The paramedian forehead flap remains a workhorse for reconstructing major nasal defects.[8,9] It delivers superior reliability in full-thickness losses or defects involving multiple nasal subunits compared to alternative flaps. Forehead skin closely matches nasal skin in color and texture, providing ample tissue with excellent functional and aesthetic integration. Based on the supratrochlear artery, the flap ensures robust vascularity and low complication rates, manageable typically with antibiotics or minor revision. It demonstrates consistent survival and outcomes even in high-risk patients, including elderly individuals or those with comorbidities or smoking history.

PFF is particularly indicated for defects larger than 1.5–2 cm across the tip, dorsum, alae, columella, or soft tissue triangles.[10] It is advantageous when over half a subunit is lost or multiple subunits are involved, optimizing contour and coverage.[7,11] The flap can be folded over structural supports (cartilage, bone, or titanium) and adapted to complex post-resection defects.[10] Modifications such as frontalis muscle preservation reduce donor-site morbidity.[12–14] Staged execution allows customization according to defect morphology and patient factors.[7,10,15,16]

## Role of Hair Removal in Paramedian Forehead Flap

Achieving optimal outcomes in nasal reconstruction requires minimizing the transfer of hair-bearing skin into non-hair-bearing regions.[17] Unwanted hair can cause cosmetic issues, patient discomfort, and complicate clinical monitoring.[18] Although forehead skin typically lacks terminal hair,[15] patients with low hairlines, limited forehead height, or distal defects may require flap extension into the scalp,[19,20] increasing the risk of hair transfer.[5,21–24] Even with modifications such as oblique design, visible hair remains a documented concern, occurring in 23% of patients in one series.[25] Alternatives like tissue expansion, cross-paramedian flaps, or subfollicular harvesting are often limited by donor-site tension, eyebrow asymmetry, or compromised perfusion.[5,20]

Menick emphasizes that reliable nasal coverage should remain the priority and that the PFF should not be avoided solely due to hair-bearing potential.[19] Flap extension, though potentially increasing scarring or incorporating scalp, enables tension-free closure and avoids more complex donor sites. Many patients tolerate post-repair hair removal well, indicating that hair transfer is manageable. Effective depilatory or epilatory techniques can address most cosmetic and practical concerns,[19,26] and preoperative or intraoperative hair removal may facilitate suturing and dressing.[27]

# Hair Removal Techniques in Nasal Defect Repair with PFF

Hair removal in PFF repair can be classified as depilation or epilation, each with distinct advantages. Depilation removes only the hair shaft, providing short-term results of up to two weeks, using methods such as shaving or chemical depilatories. Epilation removes both shaft and follicular bulb, yielding longer-lasting effects of 6–8 weeks, via waxing, plucking/threading, laser hair removal, intense pulsed light, or electrolysis.[9,28,29] Epilation offers sustained results but often requires multiple sessions and may involve more complexity and discomfort. Tables 1 and 2 compare the mechanisms, efficacy, suitability, advantages, and limitations of current hair removal techniques.

**Table 1** Comparison of Conventional Hair Removal Techniques

| Technique | Mechanism | Effect Duration | Indication (Age/Area) | Advantages | Limitations & Adverse Events | Refs |
|---|---|---|---|---|---|---|
| Shaving | Mechanical hair removal | Days | Any age/Whole body | • Fast<br>• Low cost<br>• Useful for larger area | • Folliculitis<br>• Pseudofolliculitis<br>• Scarring<br>• Pigmentation | [9,23,29,30] |
| Chemical Depilatories | Chemical keratin dissolution | Days to weeks | Any age/Whole body | • Fast<br>• Low cost<br>• Painless<br>• Convenient | • Less effective on coarse hair<br>• Dermatitis | [9,23,29,30] |
| Plucking/ Threading | Mechanical extraction | Days to weeks | Any age/Eyebrows, upper lip, chin | • Low cost<br>• Minimal trauma<br>• Precise | • Time-consuming<br>• Painful<br>• Erythema<br>• Folliculitis | [9,23,29,30] |
| Waxing | Adhesive removal from root | Days to weeks | Not suitable for young children/ Whole body | • Longer interval between regrowth | • Scarring<br>• Painful<br>• Folliculitis<br>• Scarring | [9,23,29,30] |

**Table 2** Comparison of Advanced Hair Removal Techniques

| Technique | Mechanism | Effect Duration | Indication (Age/Area) | Advantages | Limitations & Adverse Events | Refs |
|---|---|---|---|---|---|---|
| IPL | Selective photothermolysis | Months to years | Any age/Whole body | • Safe for light hair | • Costly<br>• Multiple sessions needed | [31–34] |
| Electrolysis | Electrical follicle destruction | Permanent | Not suitable for young children/Whole body | • Permanent<br>• Effective on light hair | • Costly<br>• Inefficiency<br>• Painful | [9,35] |
| FUE | Surgical follicle extraction | Permanent | Any age/Whole body | • Fast<br>• Permanent<br>• Effective on light hair | • Costly<br>• Anesthesia required<br>• Less effective on curly hair | [36–38] |
| Laser | Selective photothermolysis | Months to years | Any age/Whole body | • Fast<br>• Potential permanence | • Costly<br>• Ineffective on light hair<br>• Multiple sessions needed | [33,39–41] |

Traditional approaches are effective temporarily but frequent repetition can cause physical and psychological discomfort.[9,19,23,24,28,29,35,42–44] Light-based techniques target melanin, enabling rapid treatment of larger areas, with several FDA-approved devices for permanent hair reduction.[45] Electrolysis, independent of pigmentation, is limited to small areas but remains the only FDA-recognized permanent method.[29,45] Radiofrequency-assisted epilation is effective but technically demanding and costly.[46] FUE, adapted from hair transplantation, achieves permanent removal by excising follicles, while topical eflornithine can delay regrowth adjunctively.

Due to cyclical hair growth, multiple sessions and often multimodal strategies are needed.[9,28] Permanent methods generally offer superior durability. Laser hair removal, with proven efficacy and safety, is considered the gold standard,[9] and is most commonly applied in flap-based repairs.[8,17,26] Chemical depilation,[8] electrolysis,[25,43,47] and increasingly FUE[20] may be used as complementary options in flap design and postoperative management.

## Laser Hair Removal

Laser technology entered dermatology in the 1960s under Dr. Leon Goldman.[48] Anderson and Parrish's theory of selective photothermolysis in the 1980s established that chromophores absorb specific wavelengths preferentially, enabling targeted thermal damage with optimized wavelength, fluence, and pulse duration.[49] Grossman later applied this to hair follicles, demonstrating melanin-mediated photothermal effects (600–1100 nm) that significantly delay hair regrowth.[50] Laser hair removal has since been widely applied to hirsutism, hidradenitis suppurativa, and unwanted hair

on skin grafts and flaps, including reconstructive procedures of the ear, face, and oral cavity, facilitating vertical extension of PFF in nasal reconstruction.

Cheng-I Yen et al first applied the Alexandrite laser (755 nm, 14–18 J/cm$^2$, 10–20 ms, 18 mm) to PFFs post-nasal reconstruction, achieving durable hair reduction with high patient satisfaction and minimal complications.[5] Some fine or depigmented hairs persisted, yet aesthetic outcomes remained favorable. Ding Feixue et al reported diode laser (810 nm, 36–44 J/cm$^2$) treatment two weeks post-flap transfer in six cases, achieving flaps closely matching adjacent skin.[3] Rodriguez described six postoperative Alexandrite sessions for a nasal arteriovenous malformation with satisfactory results.[51] These studies confirm laser hair removal in nasal reconstruction is safe, effective, and permits reliable vertical flap extension while minimizing patient discomfort.[3,5,51]

Adverse effects are generally mild and transient, including pain, erythema, perifollicular edema, and temporary pigment changes.[52,53] Rare complications, including blisters, burns, persistent hypopigmentation, scarring, retinal injury, or paradoxical hypertrichosis, are minimized with appropriate precautions.[9,39,53–56] Permanent hair reduction, as defined by the FDA, requires stable hair regrowth decrease after a full cycle (4–12 months).[57,58] Laser achieves significant long-term reduction but not complete follicular destruction.[52,59] True permanence requires targeting stem cells in the follicular bulge and papilla; untreated follicles enter prolonged telogen.[53] Single sessions eliminate 15–30% of hairs, mostly anagen-phase, while catagen and telogen hairs require 2–3 month-spaced sessions.[18,39] Hypopigmented hairs respond poorly.[18,24,39,53]

Efficacy and safety depend on laser type and skin phototype.[59] Diode, Alexandrite, and Nd:YAG lasers are widely used,[3,9,18,40,60] while the ruby laser (694 nm) is largely obsolete.[39,52,61] Diode and Alexandrite offer comparable long-term reduction, though diode may be less comfortable.[39,52,61–64] For darker skin (Fitzpatrick IV–VI), Nd:YAG is preferred to reduce epidermal melanin absorption and adverse effects.[8,53,64] Forehead and scalp flap experience favors Alexandrite and diode lasers as primary options, with conservative initial settings adjusted to perifollicular edema or mild erythema.[3,5,51,65–70]

Clinical considerations include:[41] (1) comprehensive history and contraindication screening; (2) photoprotection; (3) avoidance of depilation/epilation for $\geq$ 4 weeks; (4) protective eyewear; (5) assessment of skin and hair type for laser selection; (6) post-treatment cooling to reduce pain and edema.

## IPL Hair Removal

Intense Pulsed Light emits broad-spectrum light (400–1400 nm), unlike lasers, which are monochromatic, coherent, and collimated. Its wide range allows versatile use across skin types and conditions.[31]

Clinical outcomes for IPL in hair removal are mixed. Some studies suggest diode and alexandrite lasers provide superior long-term reduction in lighter skin, while others report no significant difference. IPL often causes less pain and fewer side effects than alexandrite. In darker skin, Nd:YAG lasers are generally more effective, offering higher satisfaction and fewer pigmentary issues, though some reports note comparable results with IPL, which carries a higher risk of pigmentation changes.[39,52,55,63,65,66]

Advantages of IPL include lower cost, reduced discomfort, and faster coverage of larger areas. Limitations include bulky handpieces, limited visualization of tissue endpoints, and increased burn risk in inexperienced hands.[39,67] Adverse effects include burning, post-inflammatory hyperpigmentation, and scarring, particularly in darker skin, which can be mitigated with wavelength-specific filters, lower fluences, and longer pulses.[1]

Both IPL and lasers have unique strengths. Lasers remain the primary choice for hair removal on transferred flaps in nasal and facial repair, while IPL may be useful when cost, pain tolerance, or large treatment areas are considerations. Comparative efficacy requires further study, and device selection should be individualized.

## Electrolysis Hair Removal

Electrolysis remains the only FDA-approved permanent hair removal technique, available in three modalities: galvanic electrolysis, thermolysis, and the blend method. Each requires insertion of a fine needle into the follicle to deliver current directly to the germinative bulb, permanently destroying proliferative structures.[29,35] Operator expertise and magnification are essential to ensure accurate targeting and minimize collateral tissue injury. Among the available modalities, the

blend method is most frequently used due to its balance of treatment efficiency and reduced patient discomfort, combining the rapid heating of thermolysis with the galvanic current's neuromodulatory effect.

Electrolysis is best suited for small or anatomically complex regions with coarse or resistant hairs, but its slow speed and painful, repetitive nature limit its practicality for large treatment fields.[23,29,35,71] Outcomes are heavily dependent on technique; proper application avoids scarring, whereas incorrect current delivery may cause pigmentary alterations or cicatricial changes.[40,45,47,71] Typical side effects include transient edema, erythema, or minor crusting, resolving within hours to days. Post-inflammatory pigmentation is more frequent in darker skin phototypes.[23,29,35,71]

Comparative studies highlight these limitations. Laser hair removal, for example, demonstrates greater efficiency, requiring fewer and shorter sessions, with reduced costs, pain, and higher patient satisfaction compared to electrolysis in gender-affirming surgery.[40] Similarly, IPL has shown superior efficacy and tolerability, while electrolysis was associated with higher rates of persistent erythema, blistering, and crusting.[5] Despite these disadvantages, electrolysis retains value for patients with blonde, red, or white hairs, which lack melanin and respond poorly to light-based modalities. In such cases, electrolysis may be performed alone or in combination with laser treatment for optimal outcomes.

In the context of nasal and flap surgery, electrolysis is generally reserved for limited areas of persistent hair growth where light-based devices are ineffective or contraindicated. Although unlikely to replace laser as a first-line modality, electrolysis remains a clinically important adjunctive technique for achieving long-term aesthetic refinement in selected patients.

## FUE Hair Removal

Follicular Unit Extraction, introduced by Rassman et al in the early 21st century, is a minimally invasive hair transplantation technique initially developed for androgenetic alopecia.[72] FUE involves no suturing and leaves no linear scars, with micro-wounds typically healing within one week. The International Society of Hair Restoration Surgery (ISHRS) defines FUE as a surgical technique involving circumferential incision around follicular unit bundles to extract full-thickness skin grafts containing hair follicles, dermis, epidermis, and intradermal fat.[36] Postoperative complications, including bleeding, infection, folliculitis, sensory disturbances, and scarring, are rare.[54] Visible scarring or pigmentary changes are minimized when punch sizes are $\leq 0.8$ mm. Experienced surgeons can harvest up to 2000 follicles per hour, including white hairs, with a single session yielding approximately 80% of donor follicles.[73]

FUE's versatility has expanded its application to both medical and cosmetic domains.[37] Gupta et al demonstrated effective, safe, and rapid removal of white hairs with FUE,[73] while Liu et al reported its precision in permanent removal of unwanted facial terminal hair (uFTH) in a multicenter retrospective study.[54] When applied to the paramedian forehead flap,[20] FUE requires only follicle extraction without transplantation, significantly reducing operative time, complexity, and complication risk. Residual follicles may be treated with laser or adjunctive modalities, improving efficiency, lowering costs, and enhancing patient compliance. FUE-assisted expanded PFFs allow customized flap design with increased hairless skin and flap length, enabling reconstruction of diverse facial defects with favorable aesthetic outcomes.[20]

Limitations of FUE include subclinical scarring and potential trauma to dermal and subcutaneous structures, which may impact flap expansion and viability. To mitigate these risks, Le et al employed local tumescence anesthesia with smaller extraction needles, followed by early topical epidermal growth factor (EGF) and postoperative silicone ointments, resulting in minimal flap contracture and reliable survival.[20] The procedure is labor-intensive, requiring precise manual extraction and advanced hand-eye coordination to maintain low transection rates, making operator skill critical.[74] FDA-approved robotic systems such as ARTAS (Restoration Robotics) enhance efficiency and consistency, reducing operator dependence and shortening the learning curve.[54,75,76] Emerging technologies, including robotic assistance and trichoscopic imaging, are anticipated to further improve precision, safety, and outcomes.[76–78]

FUE offers permanent hair removal, minimal visible scarring, rapid healing, short downtime, high patient compliance, and suitability for diverse hair types and body areas.[37,54,76] In the context of paramedian forehead flaps, FUE is particularly advantageous for patients unwilling to undergo repeated procedures or prolonged waiting periods for therapeutic effect.[54] FUE is generally more efficient than electrolysis for hair removal, as each follicular unit typically contains multiple hairs, whereas electrolysis removes only one hair at a time. In paramedian forehead flap reconstruction for total nasal defects, around 100–200 follicular units are usually harvested from a donor area of 4–5 $cm^2$. For smaller defects, the donor area and the number of follicular units are proportionally reduced, depending on patient-specific

factors. Furthermore, FUE allows harvested follicles to be transplanted, whereas electrolysis destroys them, highlighting FUE's distinct clinical advantages when appropriately applied.[54]

# Timing of Hair Removal

## Timing of Laser Hair Removal

The optimal timing of LHR during PFF reconstruction is not standardized. While postoperative treatment remains most common, preoperative and intra-expansion LHR are gaining attention. Preoperative LHR offers technical ease: a flatter, more accessible field enables lower energy delivery, fewer sessions, and better efficacy,[18,30,68,78] while potentially reducing overlap-related complications.[67] However, unpredictable flap borders and possible surgical delays hinder its routine use.[24,79,80]

LHR during expansion achieves superior clearance with fewer sessions than postoperative regimens.[32,65] The thinned, stretched skin improves light penetration and follicle targeting, as demonstrated in scalp flaps,[32,66,67] without delaying repair and yielding good cosmesis. Postoperative LHR is still preferred when immediate repair is required. Though technically more challenging due to nasal topography, it enhances aesthetics and reduces patient concern. Management should be individualized: with expansion, begin LHR during expansion and supplement postoperatively; without expansion, use postoperative LHR; if surgery can be deferred and flap design is clear, preoperative LHR may streamline care and reduce cost. Further studies are needed to confirm safety and long-term outcomes.

## Timing of IPL in Hair Removal

The optimal timing of IPL hair removal in flap-based nasal repair is broadly similar to laser approaches. Preoperative IPL allows lower fluence, fewer sessions, and higher efficacy while reducing complications from overlapping postoperative treatments.[67] In auricular reconstruction, IPL during flap expansion achieved superior clearance and allowed most patients to complete therapy before reconstruction, shortening the timeline and lowering costs. Patients with a low anterior hairline may still require additional sessions before expander placement.[32] Despite these promising results, studies on IPL timing in paramedian forehead flaps are limited, and more evidence is needed to clarify its long-term safety, efficacy, and comparative role with laser therapy.

## Timing of Electrolysis in Hair Removal

Electrolysis has traditionally been applied in the postoperative period following flap transfer, but this approach is often limited by patient discomfort, the need for multiple sessions, poor compliance, and unsatisfactory outcomes.[81] Intraoperative electrolysis, performed under anesthesia during paramedian forehead flap transfer, avoids procedural pain and improves tolerability.[47] When executed with precision, a single intraoperative session has been shown to provide durable hair removal and superior aesthetic outcomes.[43] Nevertheless, hair regrowth occurs in approximately 15–40% of treated follicles, even in experienced hands.[28,40] To address this limitation, a dual-stage protocol performed at both the time of flap harvest and transfer has been advocated to enhance efficacy and reduce recurrence.[47]

## Timing of FUE Hair Removal

For FUE, preoperative application appears most effective compared with intraoperative or postoperative approaches. Le et al[20] reported that removing scalp follicles before flap transfer in patients with low anterior hairlines created hair-free donor areas, minimizing scarring and contracture. Liu et al[54] further demonstrated precise and permanent removal of unwanted facial terminal hair, achieving a low transection rate of 6.2%, minimal regrowth, and 96.6% patient satisfaction, supporting selective follicle removal across multiple facial regions. These findings establish FUE as a reliable, minimally invasive option for both aesthetic hair removal and procedural preparation, complementing laser and electrolysis. Preliminary application of preoperative FUE in two cases of paramedian forehead flap nasal reconstruction resulted in smooth donor site healing and satisfactory cosmetic outcomes. Patients were typically followed up every 2 weeks to assess hair removal efficacy, with satisfactory results generally defined as marked reduction in hair density and minimal regrowth. Flap surgery was usually performed 4–6 weeks after FUE. For patients requiring additional hair reduction, the

preoperative interval was extended, with continued FUE sessions until the desired outcome was achieved before proceeding with surgery. These intervals represent suggested practice based on limited case experience and may be adjusted according to individual patient healing and treatment response.[82,83] Further studies are warranted to define its role in routine dermatologic practice.

# Challenges and Future Directions

## Clinical Conundrums and Surgical Challenges

Hair-bearing tissue remains a significant challenge in reconstructive procedures, particularly when flap design involves hair-bearing areas or tissue expansion. Patients with a high hairline can often achieve sufficient hair-free donor areas with minimal hair removal, which meets surgical requirements while limiting the hair removal area. In contrast, patients with a low hairline, dense scalp hair (especially females), or those requiring reconstruction of larger or more complex defects may need tissue expansion to obtain adequate skin. This approach extends the surgical timeline and increases the demands on preoperative hair removal, including the timing, choice of technique, and determination of the hair removal area. Over-removal may lead to donor-site hair thinning, whereas under-removal can result in residual hair growth in the transferred flap. Correctly balancing these factors requires extensive clinical experience and individualized judgment to optimize both flap survival and aesthetic outcomes.

Existing literature further emphasizes the importance of hair removal timing and method selection. In a prospective study, Ding et al showed that performing laser hair removal during tissue expansion required fewer sessions and achieved higher hair reduction rates than post-expansion treatment. The procedure was safe and effective across facial reconstruction cases.[65] Similarly, Le et al demonstrated that FUE can be successfully combined with expanded scalp flaps to remove follicular units thoroughly without compromising flap viability or causing noticeable scarring in patients with low hairlines.[20] From the patient perspective, FUE may be perceived as more invasive due to post-extraction micro-incisions, while laser hair removal is widely considered minimally invasive, associated with less pain and faster recovery. This difference contributes to higher patient satisfaction and adherence for laser treatment.

## Research Strategies and Future Directions

Future research should focus on individualized, multimodal hair removal strategies to optimize both functional and aesthetic outcomes across reconstructive procedures. Achieving this requires selecting appropriate hair removal methods and timing based on patient-specific factors such as hair characteristics, skin type, and defect location. Coordination of preoperative, intraoperative, and postoperative interventions is essential. Multi-center, large-sample studies are needed to systematically evaluate the long-term efficacy and complication rates of laser, IPL, FUE, and combination approaches in flap-based reconstructions. Emerging technologies, including robotic-assisted FUE, trichoscopic mapping, and three-dimensional flap planning, may improve procedural precision and reduce patient discomfort. Preoperative psychological assessment and patient education can further enhance treatment acceptance and adherence. By combining extensive clinical experience with evidence-based research, surgeons can optimize flap survival, donor-site aesthetics, and effective hair management. This approach ultimately improves surgical outcomes and patient satisfaction across a wide range of reconstructive procedures.

# Conclusion

The paramedian forehead flap remains the standard for large nasal defect reconstruction, but transferred hair-bearing tissue can compromise aesthetics and patient comfort. Careful selection and timing of hair removal methods, including laser, IPL, electrolysis, and FUE, are critical to optimize flap outcomes. Preoperative FUE is particularly valuable for patients with low hairlines or extensive donor sites, while laser remains the mainstay for most flap areas. Future studies should compare techniques, refine timing protocols, and explore emerging technologies to maximize durability, safety, and patient satisfaction. Evidence-based, individualized planning can streamline flap design, minimize hair-related complications, and enhance aesthetic and functional outcomes.

## Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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