Review Article

# Hair management for transgender genital surgery: A comparative review of techniques and implications for neovaginal and urethral health

**ABSTRACT**

Permanent genital hair removal constitutes a critical prerequisite in gender-affirming genital reconstruction, as the transposition of hair-bearing flaps into neovaginal or neourethral structures predisposes to infection, encrustation, lithogenesis, and functional impairment. Despite decades of clinical experience, hair eradication protocols remain heterogenous, with substantial variability in technique, accessibility, and insurance coverage. Electrolysis, historically regarded as the gold standard, achieves definitive follicular destruction but is protracted, painful, and operator-dependent. Conversely, laser hair removal (LHR), based on selective photothermolysis, offers greater procedural efficiency, improved tolerability, and reduced overall costs, particularly with alexandrite, diode, and Nd:YAG platforms. Recent comparative studies have demonstrated that LHR requires fewer sessions, shorter treatment times, and less analgesic support than electrolysis, while providing equivalent or superior clearance rates in patients with dark pigmented hair. Nevertheless, limitations include incomplete efficacy in light or nonpigmented hair and the absence of robust long-term outcomes. Psychosocial evidence underscores the role of hair removal in reducing gender dysphoria, enhancing sexual function, and improving overall satisfaction following vaginoplasty or phalloplasty. Access inequities persist, as many insurers categorize hair removal as cosmetic despite its recognized surgical necessity. Within the neovagina, residual hair correlates with stenosis, odor, and infection, while intra-urethral hair following phalloplasty has been implicated in calculi and obstructive syndromes. Experimental intraoperative strategies, such as cautery or follicular scraping, have been reported but remain anecdotal. Taken together, electrolysis and LHR represent indispensable preparatory interventions for transgender genital surgery, with lasers emerging as the preferential modality where feasible. Future research should focus on optimizing protocols, integrating hospital-based services, and evaluating long-term functional outcomes.

**Keywords:** Electrolysis, hair removal techniques, laser hair removal, transgender genital surgery

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## INTRODUCTION

### Context of gender-affirming surgery

Hair removal as a gender-affirming procedure may involve permanent elimination of hair on the face, chest, and genitals. It can also be an important preoperative step in gender-affirming surgery (GAS). Genital GAS alleviates gender dysphoria and can enhance psychological well-being and overall quality of life.[1,2] These surgeries often require tissue flaps or grafts that are, at the donor site, hair-bearing

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and, consequently, there is a potential for undesirable hair regrowth and increased morbidity at the recipient site in the neovagina or neophallus. Hair regrowth may result in intravaginal or intraurethral hair, potentially causing recurrent infections, folliculitis, stone formation, dyspareunia, and visible hair at the neointroitus. Each of these outcomes may compromise both functional results and patient satisfaction.[3,4] Therefore, permanent hair removal from donor sites is considered an important component of preoperative planning. The two most commonly employed techniques of permanent hair removal, laser hair removal (LHR) and electrolysis, differ significantly in their mechanisms of action, clinical applications, treatment duration, pain profile, and cost.[1,5] Despite increasing clinical demand for hair removal, inconsistencies in practice guidelines and limited provider availability contribute to disparities in treatment access and overall success across healthcare systems.[2,6] Furthermore, the retention of hair within surgically constructed epithelial cavities such as the neovagina or the neourethra remains a clinically relevant yet often underreported issue, with significant implications for postoperative infection risk and long-term patient-reported outcomes.[7,8] This narrative review aims to synthesize current evidence on permanent hair removal in transgender patients undergoing genital reconstruction. It will explore the comparative advantages and limitations of LHR and electrolysis, evaluate their indications in the preparation of neovaginal and neourethral tissues, and examine current international guidelines, including those issued by the World Professional Association for Transgender Health (WPATH).[9] In addition, the review will consider the psychosocial and logistical barriers that impact treatment accessibility, and propose a multidisciplinary and patient-centered framework for integrating hair removal into standardized surgical care pathways.

### Importance of preoperative hair removal to prevent complications

The removal of hair from skin regions designated for genital reconstruction is a fundamental yet sometimes underestimated aspect of surgical planning in gender-affirming procedures. When hair-bearing donor sites, such as the penile shaft, scrotum, or forearm, are utilized in neovaginal or neourethral construction, residual hair follicles can lead to a cascade of postoperative complications. These include chronic irritation, folliculitis, malodor, urinary tract infections (UTIs), hairball formation, and, in some cases, the need for surgical revision.[4,8] Hair regrowth within enclosed or moist environments, such as the neovaginal canal or the neourethra, creates an ideal substrate for bacterial proliferation and chronic inflammation, which not only may compromise surgical outcomes but also contribute to long-term patient discomfort. Preoperative hair removal has thus evolved from a cosmetic concern to a clinical necessity. Both the WPATH Standards of Care Version 8 (SOC-8) and expert consensus recommend hair removal from surgical donor sites before genital GAS, particularly when those areas will form internal structures exposed to secretions or urine. WPATH explicitly emphasizes the role of early multidisciplinary counseling to ensure timely and complete epilation before surgery, as inadequate removal has been associated with preventable complications that significantly impact quality of life.[9] Despite its clinical importance, consistent implementation of hair removal protocols remains uneven across institutions. Patients often face delays due to cost, access to trained providers, or limited awareness about the necessity of the procedure. Studies comparing LHR to electrolysis suggest that LHR, when appropriate based on hair type and skin tone, is not only more tolerable and time-efficient but also associated with greater patient satisfaction and better long-term surgical results.[1,3] However, electrolysis remains the only Food and Drug Administration (FDA)-recognized permanent hair removal method for all hair colors, underscoring the importance of individualized treatment planning. Ultimately, early, comprehensive, and patient-centered epilation is not an optional preoperative step but a preventive measure integral to the safety and efficacy of gender-affirming genital surgery. Recognizing this imperative, surgical teams should embed hair removal strategies into preoperative counseling and timelines, thus reducing avoidable risks and enhancing the durability of functional and aesthetic outcomes.

## HAIR REMOVAL TECHNIQUES

### Hair growth stages and the target stage for epilation

The human hair follicle is a dynamic mini-organ that perpetually remodels through anagen, catagen, and telogen stages. This biology is directly relevant to permanent epilation modalities such as LHR and electrolysis, both of which are indispensable in the preparatory phases of gender-affirming genital surgery. Anagen represents the growth phase, characterized by vigorous mitotic activity of matrix keratinocytes, robust melanogenesis, and intimate contact between the bulb and the dermal papilla. In the early anagen stage, the bulb is relatively superficial and pigment content is maximal, conditions that render the follicle exquisitely susceptible to photothermal injury in LHR and to electrochemical or thermolytic destruction in electrolysis.[5,10] By contrast, late anagen follicles are positioned deeper in the dermis or subcutis, reducing accessibility and requiring higher fluences that increase the risk of collateral epidermal injury during LHR; electrolysis remains possible but technically more challenging.[8] Catagen is a brief involutional phase characterized by apoptosis of the lower follicle and cessation of melanogenesis, rendering follicles essentially unresponsive to LHR and poor targets for electrolysis.[10] Telogen, in which the follicle rests with a club hair devoid of pigment, is similarly refractory to LHR due to the absence of chromophores and only marginally responsive to electrolysis because the key target structures are dormant.[5] Given that follicles cycle asynchronously, only a minority are in early anagen at any one time. For this reason, serial treatment sessions every 4–6 weeks are required to repeatedly intersect susceptible cohorts, balancing epidermal recovery with optimal capture of early anagen follicles. Regional variability further dictates treatment timelines: facial hair completes anagen in about 6 months, pelvic hair in about 7 months, and thigh hair in up to 12 months.[1,7] Durable clearance in genital donor sites destined for vaginoplasty or urethroplasty thus requires protracted courses extending over many months, with clinical completion defined as the absence of regrowth for at least 2 months before surgery.[4] The clinical implications for GAS are substantial. Inadequate synchronization with the hair cycle results in the incorporation of untreated hair-bearing skin into the neovaginal or neourethral lumen, with postoperative sequelae including chronic infections, folliculitis, trichobezoar or calculus formation, malodor, dyspareunia, and persistent gender dysphoria.[4,8,11] Both LHR and electrolysis, despite their mechanistic differences, achieve maximal efficiency during anagen. While LHR is strictly dependent on melanogenesis and therefore phase specific, electrolysis, although theoretically independent of pigment, remains more effective in anagen due to the integrity of follicular architecture that guides probe placement to the dermal papilla. For this reason, careful treatment planning harmonized with follicular kinetics is indispensable to surgical readiness and postoperative satisfaction.

### Laser epilation: Mechanism, efficacy, and limitations

Laser epilation is grounded in the principle of *selective photothermolysis*, whereby light energy of specific wavelengths is selectively absorbed by melanin within the hair follicle, resulting in localized thermal damage while sparing the surrounding epidermis. This thermal injury leads to follicular destruction and long-term hair reduction, provided that the hair is in its active growth (anagen) phase at the time of treatment.[5,10] The choice of laser system plays a pivotal role in determining both efficacy and safety. The most widely utilized systems include the following:

- Alexandrite lasers (755 nm), ideal for light to olive skin with dark hair.
- Diode lasers (800–810 nm), effective across a broader range of skin phototypes.
- Neodymium-doped (Nd): yttrium aluminum garnet (YAG) lasers (1064 nm), preferred for darker skin due to deeper penetration and lower melanin absorption in the epidermis.[10,12]

Therapeutic success is contingent upon the correct balance of key parameters, notably wavelength, fluence, and pulse duration, which must be shorter than the thermal relaxation time of the follicle to confine damage to the target chromophore. The use of integrated contact cooling and dynamic cryogen spray systems has improved patient comfort and reduced epidermal side effects, particularly in high-fluence regimens.[10] Multiple treatment sessions are required due to asynchronous hair cycling. Optimal results are generally obtained after six to eight sessions spaced at 4–8 week intervals. The interval permits regrowth of the hair and aids in the identification of the region to be treated in subsequent sessions. In the context of GAS, hair-bearing areas such as the scrotum, perineum, and penile shaft (in phalloplasty), or the scrotal and perineal skin (in vaginoplasty) require precise and complete depilation to avoid postoperative complications.[13] The overall efficacy of LHR is well-documented, with durable reductions of 60%–90% in terminal hair density. However, its effectiveness is significantly reduced in nonpigmented hair, such as blonde, red, or gray follicles, where the absence of melanin precludes adequate energy absorption.[5] Despite its efficacy, laser epilation carries inherent limitations, which are as follows:

- Restricted efficacy in light-colored or telogen-phase hairs.
- Need for long-term maintenance therapy.
- Potential adverse events, including burns, dyspigmentation, paradoxical hypertrichosis, and scarring, especially in darker skin types or when incorrect parameters are applied.[14]

From a sociomedical perspective, access remains limited, particularly for transgender individuals. LHR is frequently classified as a cosmetic procedure and excluded from insurance reimbursement, despite its role in preventing significant surgical complications such as hair-bearing neovaginal cavities or intraurethral hair growth following phalloplasty.[9,13] Given these considerations, LHR in transgender surgical candidates should be regarded as a preoperative medical necessity, requiring appropriate planning, qualified personnel, and early initiation well before the date of surgery [Table 1].

### *Laser platforms for permanent hair removal*

#### Ruby laser (694 nm)

The ruby laser was the first platform systematically studied for hair removal.[5,10,12] Its wavelength (694 nm) lies at the lower edge of the therapeutic window (600–1100 nm), where

**Table 1: Fitzpatrick skin types and recommended lasers**

| Fitzpatrick type | Characteristics | Recommended laser |
|---|---|---|
| I—Very fair | Always burns, never tans | Ruby (694 nm), alexandrite (755 nm), and diode (810 nm) |
| II—Fair | Usually burns, tans minimally | Alexandrite (755 nm) and diode (810 nm) |
| III—Medium | Sometimes burns, tans uniformly | Alexandrite (755 nm) and diode (810 nm) |
| IV—Olive | Rarely burns, tans easily | Nd:YAG (1064 nm) and diode (810 nm, low fluence) |
| V—Brown | Very rarely burns, tans darkly | Nd:YAG (1064 nm, long-pulse with cooling) |
| VI—Dark brown/black | Never burns, deeply pigmented | Nd:YAG (1064 nm, reduced fluence + cooling) |

melanin absorption is maximal but penetration depth is limited (~1–2 mm). This allows efficient energy deposition in superficial follicles but fails to adequately target deeper structures such as coarse terminal hairs. Therefore, clinical effectiveness is limited to fine, dark hairs in patients with Fitzpatrick I–II skin types. Because epidermal melanin competes strongly at this wavelength, adverse events such as blistering, dyspigmentation, and scarring are common in darker phototypes, precluding its use beyond very fair skin. In the context of GAS, ruby lasers are practically obsolete, as they cannot safely or effectively clear the dense, coarse follicles in genital, forearm, or thigh donor sites.

### Alexandrite laser (755 nm)

The long-pulse alexandrite laser (755 nm) offers deeper penetration (~2–3 mm) with high melanin absorption, making it one of the most effective systems for rapid clearance of large body areas. Its efficacy is maximized in Fitzpatrick I–III patients with dark terminal hair. The alexandrite laser is widely used for genital depilation in light-skinned transfeminine patients preparing for penile inversion vaginoplasty (PIV). However, in Fitzpatrick IV–VI, its high melanin affinity increases epidermal injury risk. Standard pulse durations are in the millisecond range, and effective epidermal cooling (contact or cryogen spray) is mandatory. In gender-affirming protocols, alexandrite is considered a first-line option for light-skinned patients requiring extensive preoperative clearance.

### Diode laser (800–810 nm)

The diode laser operates at 800–810 nm, a near-infrared wavelength that penetrates more deeply (~3–4 mm) than alexandrite while maintaining relatively high melanin affinity. This balance allows efficient targeting of medium-to-coarse follicles across Fitzpatrick I–IV skin types. Diode systems are versatile and effective for depilation of the penile shaft and scrotal skin, as well as forearm or thigh donor sites in transmasculine patients. Compared with alexandrite, diode lasers present lower risks in darker phototypes, though still less safe than Nd:YAG. With appropriate cooling, diode lasers provide a favorable efficacy-to-safety profile, making them a mainstay for preoperative clearance in both transfeminine and transmasculine patients.

### Nd:YAG laser (1064 nm)

The long-pulse Nd:YAG laser (1064 nm) has the lowest melanin absorption of the major platforms but penetrates most deeply (~4–6 mm). This makes it uniquely suited for coarse, deeply seated follicles and for patients with Fitzpatrick IV–VI phototypes. Because epidermal melanin competes less at this wavelength, the risk of burns and pigmentary changes is significantly reduced. The trade-off is lower efficiency per pulse, requiring higher fluences, larger spot sizes, and more sessions to achieve equivalent follicular destruction compared to alexandrite or diode. In the transgender surgical setting, Nd:YAG is indispensable for patients with darker skin or tanned skin, where other lasers are unsafe. It is the preferred modality for depilation of donor sites in patients of Mediterranean, Hispanic, African, or Asian ancestry.

### Dual-wavelength and hybrid systems

Recent devices combine alexandrite (755 nm) with Nd:YAG (1064 nm) or diode (810 nm) with Nd:YAG in sequential or blended emission modes. These platforms aim to extend safety and efficacy across a wider range of phototypes. Preliminary evidence suggests that dual systems may reduce the number of sessions required and optimize tolerance, particularly in mixed skin-type populations; however, robust long-term data remain limited.

### Electrolysis: Mechanism, efficacy, and limitations

Electrolysis remains the foundational technique for permanent hair removal, distinguished by its pigment-independent mechanism of action. Unlike laser modalities, which rely on selective photothermolysis of melanin, electrolysis achieves follicular destruction via direct electrical current delivered through an ultrafine probe inserted into individual follicles. Three main modalities are recognized: galvanic electrolysis, based on chemical lysis via sodium hydroxide formation; thermolysis, which employs high-frequency alternating current to induce thermal coagulation; and the blend method, combining both principles to maximize cytotoxic efficacy[15] Theoretically, the universality of electrolysis makes it indispensable in gender-affirming surgical planning, particularly in cases where the donor skin includes a substantial proportion of lightly pigmented, white, red, or gray hair—phenotypes that respond poorly or not at all to laser depilation.[9,16] The ability to treat all hair types irrespective of skin phototype is critically important for ensuring the complete epilation of sites destined for internal placement, such as the penile shaft or scrotal skin in vaginoplasty, and the radial forearm in phalloplasty urethral reconstructions.[1] From an efficacy standpoint, electrolysis can yield complete and permanent follicular ablation, but its success is intimately linked to operator expertise, anatomical accessibility, and patient compliance. Numerous sessions are typically required, often exceeding 20–30 in the genital region, with variable spacing to account for follicular.[17] The procedural tempo is inherently slow: each follicle must be treated individually, rendering electrolysis a labor-intensive and time-prohibitive choice for large surfaces. Nonetheless, it remains unmatched in terms of permanence, particularly in areas with sparse or mixed hair pigmentation.[15] The literature consistently highlights electrolysis as more painful than laser therapy, frequently requiring topical anesthetics or tumescent anesthesia, especially in perineal or penile areas where nerve density is high.[2,18] Adverse events, while often transient, include post-inflammatory hyperpigmentation, crusting, folliculitis, and rare hypertrophic scarring, with darker Fitzpatrick skin types at higher risk if energy levels are excessive or follicle depth is misjudged.[16,18] Electrolysis is profoundly operator-dependent. Its effectiveness hinges on precise needle insertion depth and angle, appropriate energy delivery, and meticulous mapping of treatment areas. Variability in technique contributes to disparities in outcomes, prompting calls for formalized training and certification for practitioners involved in transgender surgical pathways.[11] Despite its drawbacks, including discomfort, cost, and time investment, electrolysis remains irreplaceable for patients with nonpigmented or laser-resistant hair and must be regarded not as a cosmetic adjunct, but as a core medical intervention in the perioperative optimization of gender-affirming genital surgery.

## Comparison of both techniques

The comparative analysis of LHR and electrolysis reveals two fundamentally distinct technologies with overlapping but noninterchangeable clinical roles, particularly in the context of genital GAS. LHR functions via selective photothermolysis of melanin, effectively targeting pigmented hair within the anagen phase. By contrast, electrolysis relies on direct energy delivery to the follicle, making it universally applicable regardless of hair pigmentation or skin type. In terms of efficacy, LHR demonstrates superior performance for dark terminal hairs on Fitzpatrick skin types I–IV, with average reduction rates ranging from 60% to 90% after six to eight sessions [Table 2].[18] However, this efficacy drops significantly in lighter or nonpigmented hair. Electrolysis maintains its effectiveness across all hair types but requires a substantially higher number of sessions (20–30+) and a more prolonged treatment course, particularly in hair-dense genital zones.[1,17] Pain perception differs markedly: LHR is generally well tolerated with contact cooling and optional topical anesthetic, whereas electrolysis often elicits moderate to severe discomfort and mandates routine anesthetic support, especially in highly innervated anatomical zones.[2,16] The risk profile for both procedures includes dyspigmentation, erythema, and folliculitis; however, electrolysis carries a higher scarring potential when performed by inexperienced practitioners.[16] Operator dependency further distinguishes these techniques. LHR devices are increasingly automated and standardized, offering reproducibility and reduced interoperator variability. Conversely, electrolysis remains a manually intensive procedure where success hinges on individual skill, experience, and anatomical familiarity. Consequently, institutional disparities in outcomes are more common with electrolysis than with laser-based systems.[11] Cost and accessibility are also pivotal considerations. Both techniques are often excluded from insurance coverage and may pose substantial economic burdens. However, while individual LHR sessions are more expensive, the cumulative cost of electrolysis, given its longer duration and higher

**Table 2: Laser hair removal versus electrolysis**

| Aspect | Laser hair removal | Electrolysis |
|---|---|---|
| Principle | Selective photothermolysis (melanin absorption) | Electric current destroys each follicle individually |
| Efficacy | 70%–90% permanent reduction (depends on hair/skin type) | Only Food and Drug Administration-recognized 100% permanent method |
| Number of sessions | 6–10 | 20–40 (often >100 h total) |
| Session duration | 15–40 min | 30–120 min |
| Pain | Moderate (lower than electrolysis) | High (more painful) |
| Average cost | ≈ $800–1500 per cycle | ≈ $4000–6000 for full cycle |
| Hair types | Dark, pigmented hair only | All colors and types (including blond, gray, and red) |
| Areas | Large areas, rapid coverage | Small, detailed areas |
| Complications | Erythema, hyperpigmentation, rare burns | Scarring, hypopigmentation, folliculitis |
| Main advantages | Fast, less painful, and treats large areas | Definitive, effective on all hair types |
| Main limitations | Ineffective on light/gray hair, not 100% permanent | Very slow, costly, operator-dependent |

session count, often exceeds that of laser treatments.[1] In conclusion, the decision between electrolysis and LHR should not be framed in oppositional terms but rather as complementary strategies. Electrolysis remains the gold standard for nonpigmented hair and small, high-risk areas, while LHR offers rapid, efficient, and cost-effective reduction in areas with dense, pigmented hair. Optimal preoperative planning for transgender patients should integrate both modalities in a staged, anatomically tailored manner to maximize surgical outcomes and minimize postoperative complications.

### Experimental and nonconventional hair removal modalities

Beyond electrolysis and LHR, several alternative technologies have been explored in the context of hair reduction, although their role in the preparation for gender-affirming genital surgery remains limited. Intense pulsed light (IPL) devices emit broad-spectrum, noncoherent light in the 590–1200 nm range, filtered to target follicular melanin. Unlike true lasers, IPL systems deliver energy across multiple wavelengths, resulting in less selective photothermolysis and a higher variability in efficacy. Clinical trials have shown that IPL can achieve a reduction in hair density, but outcomes are generally inferior to those obtained with laser platforms, often requiring more sessions and being associated with higher recurrence rates.[14,15] IPL treatment is also associated with a narrower safety margin in darker Fitzpatrick skin types, where the risk of postinflammatory hyperpigmentation and burns is increased. In addition to IPL, a growing market of home-use hair removal devices has emerged, many of which are miniaturized IPL systems. These devices offer the advantage of convenience and lower cost, but their effectiveness is considerably lower than that of clinical-grade equipment. Studies demonstrate that while home devices may achieve temporary hair reduction and can prolong hair-free intervals, they do not achieve permanent follicular destruction, and their safety profile is heavily dependent on user compliance and correct application.[13] Reported complications include erythema, blistering, paradoxical hypertrichosis at field margins, and ocular injury when protective measures are not observed. From a surgical perspective, these modalities are inadequate substitutes for clinical laser or electrolysis in preoperative planning for vaginoplasty or phalloplasty. Their limited penetration, inconsistent follicular targeting, and lack of standardized treatment protocols preclude reliable eradication of donor-site follicles. Nevertheless, they may play a supplementary role in the general population for cosmetic depilation or as interim measures while awaiting definitive clearance with electrolysis or LHR. For patients undergoing GAS, however, professional, clinic-based modalities remain the only acceptable standard for achieving the hair-free fields required to prevent intra-neovaginal or intra-urethral complications.

## GUIDELINES AND RECOMMENDATIONS

### Recommendations from the World Professional Association for Transgender Health

The WPATH formally recognizes permanent hair removal as an essential medical intervention within the broader framework of gender-affirming care. According to the latest Standards of Care for the Health of Transgender and Gender Diverse People, Version 8 (SOC-8), permanent hair removal—via laser epilation or electrolysis—is classified not as a cosmetic procedure but as a medically indicated component of both gender affirmation and surgical preparation for genital reconstruction. Statement 15.14 of the SOC-8 explicitly recommends the removal of hair from any skin surface that will be used to form internal genital structures. This includes penile, scrotal, perineal, or forearm skin employed in vaginoplasty or phalloplasty. The guidance is supported by strong clinical evidence demonstrating that retained hair in neovaginas or neourethras is associated with considerable morbidity: recurrent UTIs, calculi, chronic inflammation, fistula formation, and patient dissatisfaction with both aesthetic and functional outcomes.[9] The guidelines emphasize that permanent epilation should be integrated into the multidisciplinary preoperative pathway. Dermatologists, surgeons, endocrinologists, and mental health providers must collaborate to assess epilation needs during early surgical counseling. WPATH recommends that treatment initiation occur 6–12 months before surgery to allow sufficient time for full follicular clearance, particularly in anatomical areas with dense or slow-growing hair. Patients must be educated on the realistic duration of treatment, the number of sessions required, and the method most suited to their hair and skin characteristics. WPATH does not promote a one-size-fits-all approach: it endorses an individualized technique selection, guided by hair pigmentation, anatomical location, and patient tolerance. LHR is generally more efficient for dark terminal hair in patients with lighter skin (Fitzpatrick I–III), whereas electrolysis is the preferred method for nonpigmented or mixed-color hair, particularly in areas where complete clearance is critical (e.g., neovaginal vault and neourethra). Furthermore, WPATH underscores the ethical and logistical need for health system support: it strongly advocates for insurance coverage of hair removal procedures as part of reconstructive and not merely aesthetic care. The association calls on both public and private insurers to eliminate policy exclusions that frame epilation as elective. Failure to do so, the SOC-8 notes, contributes to inequities in surgical access and outcomes. Finally, the document highlights the educational responsibility of clinicians, asserting that inadequate epilation of donor sites before genital reconstruction constitutes a preventable medical error. Providers must be trained to identify anatomical regions requiring treatment, guide patients in technique selection, and ensure that hair removal is complete before surgery. This framework ensures that hair management is not an ancillary consideration; however, a core element of safe and effective gender-affirming surgical care.

### Preoperative hair removal protocols and mapping of epilation zones

Preoperative hair removal protocols constitute a critical component in preparing transgender patients for gender-affirming genital surgery.[7-9] Systematic and effective preoperative hair removal significantly reduces postoperative complications and enhances overall surgical outcomes. Current protocols, aligned with international standards such as the WPATH SOC-8, provide a structured approach emphasizing appropriate timing, technique selection, and multidisciplinary collaboration. The primary clinical indication for preoperative hair removal is the utilization of hair-bearing skin in genital reconstructive procedures. Specifically, in PIV, complete hair removal from the penile shaft and scrotal skin is required when these tissues are incorporated to create the vaginal canal, whereas in phalloplasty procedures involving urethral lengthening, hair clearance of the radial forearm or thigh donor sites is essential to prevent urethral obstruction and recurrent infections. The exact templates of hair removal are determined by the surgeon's choice of donor site and reconstructive technique. An equally important aspect of these protocols is the accurate preoperative mapping of the epilation zones. Mapping ensures that only the skin destined to line the neovagina or neourethra is cleared of hair, thereby avoiding unnecessary procedures in external regions and minimizing the risk of intraluminal follicle persistence. In PIV, this generally corresponds to the penile shaft and the anterior and lateral portions of the scrotum, which are mobilized to augment depth and introitus, whereas the posterior scrotum and perineum are usually spared unless specifically required by the operative plan. For radial forearm flaps, depilation must be directed to the medial and ventral aspects of the forearm skin that will be tubularized into the urethra, whereas in anterolateral thigh flaps, only the medial segment requires clearance, since the lateral surface is reserved for shaft coverage. The provision of diagrams, photographic documentation, and skin markings during preoperative consultation has been shown to facilitate communication between surgeons and dermatologic teams, improve patient adherence, and ensure that depilation is both accurate and efficient. Ultimately, systematic mapping represents a simple but crucial measure to prevent intraluminal hair growth, a complication that may otherwise undermine long-term functional and psychosocial outcomes. Timing remains another cornerstone of protocol design. Initiating hair removal 6–12 months before surgery allows sufficient time for comprehensive follicular clearance, taking into account the cyclical nature of hair growth. LHR sessions are usually scheduled every 4–6 weeks, while electrolysis, because of its follicle-by-follicle approach, often requires more frequent and prolonged treatment, with patients commonly undergoing 20–30 or more sessions. The choice of technique is tailored to hair pigmentation and anatomical considerations: LHR is favored for large areas with dark, pigmented hair, due to its efficiency and speed, whereas electrolysis is indispensable for mixed or lightly pigmented hair, despite its greater time and cost burden. Provider competence and standardized training are crucial to protocol effectiveness. The technically demanding nature of electrolysis, in particular, necessitates specialist expertise and ideally formal certification to ensure safety and consistency. Equally vital are preoperative counseling and patient education, which should cover expected session numbers, treatment duration, potential complications such as erythema, crusting, scarring, or pigmentary changes, and realistic outcome expectations. Financial planning and transparent discussion of the resource-intensive nature of hair removal are integral to informed consent. Multidisciplinary collaboration among dermatologists, surgeons, primary care providers, social workers, and mental health professionals ensures coordinated care and optimizes preparation. Detailed documentation and regular communication among team members further guarantee that hair clearance is complete before surgery, thereby minimizing postoperative risks. Taken together, rigorous adherence to structured protocols, accurate mapping of epilation zones, and effective patient counseling substantially enhance surgical outcomes, reduce complications, and improve overall satisfaction in gender-affirming care.

## PSYCHOSOCIAL AND ECONOMIC ASPECTS

Access to permanent hair removal remains deeply inequitable due to systemic, financial, and logistical barriers. High out-of-pocket costs often exceeding several thousand dollars or euros for complete genital area clearance are a major obstacle, particularly as insurance providers frequently categorize electrolysis and LHR as elective cosmetic treatments. This classification undermines their clinical relevance, despite strong evidence of medical necessity in the context of GAS. Medicaid and private insurance plans vary widely in terms of inclusion, with only a minority of transgender patients successfully securing reimbursement, typically after prolonged and bureaucratically burdensome appeals. For example, Downing *et al*.[19] reported that only 12.2% of Medicaid recipients in Oregon obtained reimbursement for hair removal, whereas Nguyen, Heilberger, Hartjen, *et al*. found that even after appeal, coverage approval was achieved in just 34.5% of cases. Moreover, broader policy analyses underscore the extent of systemic variability. Thoreson *et al*.[20] documented that only 26% of U.S. insurance plans offered any coverage for preoperative hair removal, and a mere 5% provided unrestricted benefits, while Peloza *et al*.[21] found that approximately 40% of policies included some form of coverage but with substantial restrictions and frequent exclusions of facial hair removal. Almazan *et al.*[22] further demonstrated that states with nondiscrimination laws were significantly more likely to provide coverage, with rates approaching 50% compared with only 30% in states without such protections. These findings illustrate not only the rarity of initial approval but also the profound geographic and legislative disparities that shape access. By contrast, certain institutions such as Mount Sinai in New York have reported greater success in securing insurance coverage through active advocacy and direct negotiation with insurers, highlighting the critical role of institutional commitment in overcoming systemic barriers. These figures highlight both the rarity of initial approval and the heavy reliance on time-consuming appeal processes to secure access.[23,24] The financial burden is further compounded by the extended nature of treatment cycles, which can last over a year and require 20–40 sessions depending on the technique and treatment area. Geographic disparities in provider availability further restrict access. Electrologists and laser technicians with experience in treating genital regions are often located in urban or academic centers, leaving rural or underserved areas without qualified personnel. Patients must often travel long distances for care, incurring additional costs for transportation, lodging, and missed workdays. These barriers are amplified by long waitlists reported up to 4–6 months in some referral centers and by provider refusal, with documented instances of practitioners declining care due to lack of training, transphobia, or administrative limitations. Experiences of stigmatization in dermatologic and aesthetic medical settings further deter many transgender individuals from seeking or completing treatment. Beyond logistical and economic constraints, prolonged and incomplete hair removal exerts a significant psychological toll. Anecdotally, transfeminine individuals frequently report heightened gender dysphoria associated with the presence of hair in genital regions, especially when it contradicts their affirmed gender identity. The inability to access or complete hair removal intensifies emotional distress and may delay or compromise surgical outcomes. Psychological studies have demonstrated that dissatisfaction with hair-related features is strongly associated with elevated levels of anxiety, depressive symptoms, and body image discomfort. Conversely, satisfaction with depilation has been shown to correlate positively with reductions in distress and improvements in gender congruence, emotional stability, and social confidence. Importantly, successful depilation is not only associated with alleviation of dysphoria but also with the emergence of gender euphoria, a psychological state marked by heightened positive affect, body satisfaction, and affirmation of identity. These benefits have significant implications for mental health and quality of life, as they foster social integration, reduce avoidance behaviors, and contribute to an overall sense of authenticity and well-being during the transition process. For many, the act of clearing genital hair is not merely preparatory to surgery but central to embodiment and gender coherence. The systemic failure to classify hair removal as a medically necessary intervention imposes a cumulative burden: financial, geographic, and emotional. Addressing these gaps requires not only reforming insurance coverage and increasing provider training, but also acknowledging the integral psychosocial role of hair removal in the broader context of transgender health.[6,9]

## MANAGEMENT OF HAIR IN NEOVAGINA

### Complication due to hair in the neovagina

The presence of hair in the neovaginal cavity following PIV may pose clinical risks. Utilizing hair-bearing skin from the penile shaft and scrotum in constructing the neovagina can lead to postoperative intravaginal hair growth. This condition may result in chronic mucosal irritation, recurrent infections, folliculitis, intravaginal hair bezoars, and calculi formation, which might necessitate additional medical or surgical interventions.[7,8] Residual hair may impact patients' quality of life by causing persistent discomfort, interfering with sexual activity, reducing sexual satisfaction, and negatively affecting psychological well-being and overall satisfaction with surgical outcomes. One study demonstrated that inadequate or incomplete preoperative hair removal was strongly associated with increased postoperative complications. Patients presenting residual intravaginal hair frequently experience recurrent mucosal inflammation, pain, infections, and extended postoperative recovery periods, often necessitating subsequent corrective procedures and thus increasing healthcare costs and patient morbidity.[7] However, there is a general paucity of data on the long-term effects of residual hair in the vagina. Anecdotally, we have found that during routine examination of the neovagina, recurrent small amounts of hair regrowth can be present but are rarely symptomatic. Even when more significant growth occurs, patients may still be asymptomatic.[7,8]

### Management of hair in the neovagina

The occurrence of residual hair within the neovaginal canal, though infrequent, has been associated with distressing complications including malodor, chronic discharge, recurrent infections, dyspareunia, and, in rare cases, trichobezoar formation. Once hair-bearing epithelium has been inset, eradication of follicular units is extremely challenging. The literature studies describe a number of salvage strategies, predominantly in the form of case reports. Endoscopic resection of intraluminal hair conglomerates or trichobezoars has been performed with or without concomitant electrocautery to ablate the follicular base.[25,26] Attempts at transvaginal or vaginoscopic laser ablation using Nd:YAG devices have also been reported, although results are variable and recurrence is possible.[27] Mechanical approaches, including curettage or scraping of mucosa containing follicular remnants, have been applied in selected cases, and marsupialization of chronically infected hair-bearing tracts has been described as a salvage measure to reduce persistent discharge and infection. Chemical instillation with thioglycolate or trichloroacetic acid was historically attempted but has been abandoned because of poor tolerability and risk of mucosal injury.[28] Although these approaches may provide symptomatic relief, none ensure definitive clearance, highlighting the importance of complete preoperative hair removal of donor sites.

## URETHRAL HAIR IN NEOPHALLUS

### Complication

In phalloplasty procedures, intraurethral hair growth within the neourethra may represent a significant clinical issue due to the frequent use of hair-bearing donor sites such as radial forearm, thigh, scrotal, or proximal penile skin.[6-9,15] This complication can manifest clinically through recurrent UTIs, chronic irritation, urethritis, and obstructive voiding symptoms. The most severe complications include urethral obstruction due to hairball (trichobezoar) formation and the development of calculi, which typically form around embedded hairs, complicating their removal and increasing morbidity [Figure 1a and b]. Such conditions may necessitate additional surgical interventions and negatively impact the patient's quality of life and satisfaction with surgical outcomes.[8,16,25] Data on optimal treatment for this condition are absent. In severe cases, we recommend marsupialization of the urethra, retreatment of the hair growth with laser or electrolysis, and then recanalization of the urethra. Fortunately, this staged surgical intervention is rarely necessary. Our most commonly employed technique is cystoscopic laser epilation.[8,16,23]

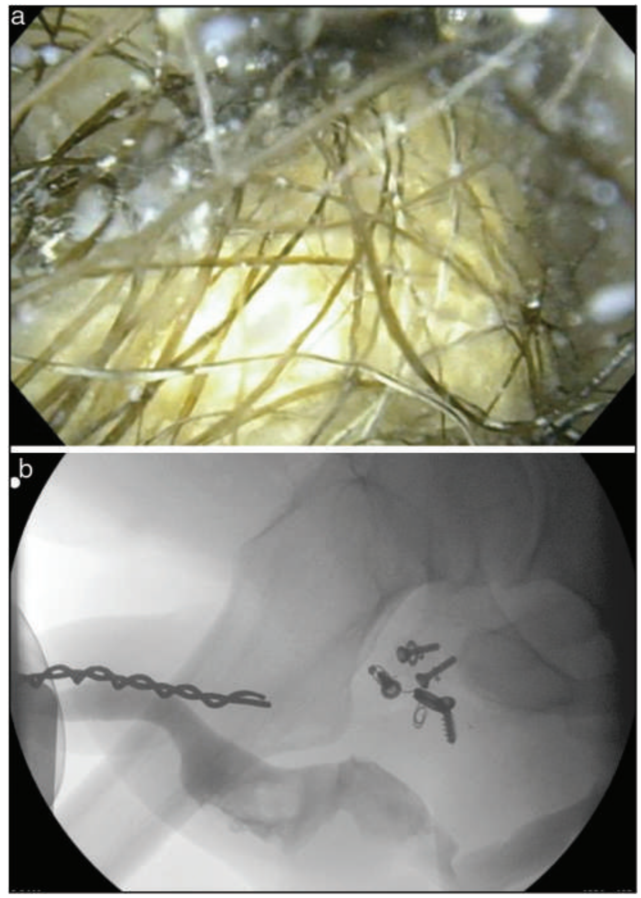


**Figure 1: (a and b) Trichobezoar in the urethra from incomplete hair resection seen on cystoscopy and retrograde urethrogram**

### Specific removal technique

Residual hair within the neourethra is an uncommon but well-documented complication of phalloplasty with urethral lengthening, and its clinical manifestations may include recurrent UTIs, stone formation, intraluminal trichobezoars, irritative voiding symptoms, and frank obstruction. Once hair-bearing donor skin from the forearm or thigh has been inset into the urethral tube, eradication of the follicular units becomes technically complex and rarely definitive. Several salvage strategies have been described, almost exclusively in case reports and small series. Singh and Hemal[26] and Xie *et al*.[25] reported the use of endoscopic resections of urethral trichobezoars, sometimes combined with fulguration of the follicular bases to reduce recurrence. Other authors attempted intraluminal Nd:YAG laser epilation, applying selective photothermolysis directly to the intraluminal follicles; however, the outcomes have been inconsistent, and durability remains uncertain. Mechanical approaches have also been described. Curettage or scraping of mucosal areas harboring follicular remnants has been applied in selected cases, with the rationale of physically removing the epithelialized follicles. Marsupialization of chronically infected hair-bearing tracts has similarly been reported as a salvage measure to alleviate persistent infection and discharge.[28] Historical methods included chemical ablation with topical thioglycolate or trichloroacetic acid, designed to dissolve hair or chemically destroy follicular structures, but these techniques were poorly tolerated and associated with mucosal injury, and have therefore been abandoned in contemporary practice. More complex cases, particularly those complicated by calculi or large trichobezoars, have sometimes required open or endoscopic urethrolithotomy. Reports have described combining stone removal with trimming of the mucosa and adjunctive laser epilation of residual hair to minimize recurrence, with success depending on meticulous dissection, careful incision planning, and stringent postoperative management to reduce sequelae such as urethrocutaneous fistula. Recent innovations in reconstructive surgery, such as the "tube-in-tube" stent method, have been proposed to improve urinary drainage and reduce the risk of infection and fistula formation, thereby promoting improved healing.[25] Despite these efforts, it must be emphasized that all such interventions are essentially palliative. Once hair-bearing skin has been incorporated into the urethral lumen, achieving complete eradication is exceedingly difficult, and recurrence is common.

## DISCUSSION

Permanent hair removal in genital gender-affirming surgeries is critical for enhancing clinical outcomes, patient satisfaction, and psychological well-being. Effective hair removal significantly reduces postoperative complications such as recurrent infections, folliculitis, obstructive symptoms, and calculus formation. This review comprehensively addresses the management of hair in neovaginal and neourethral reconstructions, focusing on technical nuances, clinical considerations, and comparative efficacy drawn from existing literature studies. LHR and electrolysis are the two primary preoperative hair removal modalities, each with distinct advantages and limitations. LHR utilizes selective photothermolysis and is effective for rapidly treating large areas with dark, pigmented hair. Zhang *et al*.[8] and Pigot *et al*.[16] highlighted LHR's effectiveness in significantly reducing hair density and subsequent complications when applied correctly. However, the main limitation of LHR remains its reduced efficacy on nonpigmented or lightly pigmented hair, frequently found in donor sites for neourethral and neovaginal reconstructions, underscoring the necessity of electrolysis for comprehensive results. Electrolysis provides definitive follicular destruction regardless of hair pigmentation, crucial for detailed depilation, especially in sensitive anatomical areas.[6,13] Specifically emphasized electrolysis's importance in reducing gender dysphoria and enhancing psychological well-being, despite its labor-intensive and time-consuming nature, often requiring 20–40 sessions or more. Notably, recent evidence has challenged the universal necessity of preoperative hair removal. Pigot *et al*.[16] reported that in transmasculine individuals undergoing phalloplasty, the presence of hair-bearing urethral segments did not correlate with higher rates of voiding dysfunction or symptomatic obstruction. This finding suggests that, at least in specific surgical contexts, residual hair may remain clinically silent and not inevitably lead to complications. However, these results must be interpreted with caution: the follow-up was limited, the endpoints focused on functional voiding symptoms rather than long-term sequelae such as stone formation or intraluminal trichobezoars, and the data may not be generalizable to transfeminine vaginoplasty. Nevertheless, this study underscores that the assumption of obligatory depilation before all genital reconstructive procedures is not absolute, and that the degree of risk attributable to residual hair may vary by technique, patient characteristics, and anatomic site. From a risk-assessment standpoint, residual hair is most frequently encountered when a single modality is used in isolation. LHR alone carries the greatest risk of incomplete clearance in patients with light-colored, fine, or nonpigmented hair, while electrolysis, though definitive, may leave untreated follicles if performed by less experienced operators or if sessions are prematurely discontinued. The anatomical source of donor tissue also influences the degree of risk: scrotal skin and radial forearm flaps, characterized by higher follicular density, are particularly prone to residual hair. Clinically, residual follicles in urethral reconstructions represent the most serious scenario, predisposing to stone formation, intraluminal hairball development, and recurrent urinary infections; in contrast, residual hair in neovaginal linings more often results in local irritation, discharge, or malodor. By comparison, sequential strategies typically initiate LHR followed by targeted electrolysis and are associated with the lowest rates of clinically relevant residual hair, underscoring the importance of multimodal protocols and operator expertise.[1,7] It should also be acknowledged that not all residual hair is clinically relevant. In some cases, limited follicular persistence remains entirely asymptomatic, without progression to infection, obstruction, or stone formation. This variability indicates that the clinical significance of residual hair is heterogeneous and context-dependent, and that minimal persistence does not necessarily compromise functional or psychosocial outcomes.[8] Additionally, Thoreson *et al*.[20] and Marks *et al*.[13] revealed substantial financial and insurance-related barriers limiting access to electrolysis, highlighting significant discrepancies in healthcare coverage across various regions and the need for systemic policy reform. Fernandez *et al*.[29] further corroborate electrolysis as the only FDA-recognized permanent method of hair removal, describing galvanic, thermolysis, and blend techniques. They note that while galvanic electrolysis offers superior permanence, it is slower and more painful, whereas thermolysis is faster but less consistently effective. Their overview of the evolution of depilatory technologies underscores the historical trajectory leading to today's clinical standards and highlights how the technological and cultural context shaped modern practices in transgender care. Given the complementary nature of these methods, a combined approach of initial LHR followed by targeted electrolysis is frequently recommended. Berger *et al*.[7] demonstrated that such a proactive combined approach significantly mitigates infections and calculus formation in surgically created neovagina. Similarly, Xie *et al*.[25] provided evidence that meticulous hair removal strategies combined with innovative surgical techniques significantly reduce complications in neourethral reconstruction, including calculus and hairball formation. The timing of hair removal, guided by WPATH recommendations, is another essential consideration. Hair removal initiated 6–12 months before surgery allows sufficient time for follicular clearance and minimizes side effects like erythema, hyperpigmentation, or scarring. Surgical innovations, such as the tube-in-tube stent method introduced by Xie *et al*.[25] further enhance postoperative outcomes by ensuring better drainage and reduced risks of urethrocutaneous fistulas. Comparative analysis between studies highlights significant variability in outcomes based on chosen hair removal protocols. Pigot *et al*.[16] emphasized that although preoperative LHR reduces hair density, complete hair elimination is rarely achieved, necessitating subsequent electrolysis. In contrast, Xie *et al*.[25] highlighted surgical refinements to address hair-related complications. Furthermore, Berger *et al*.[7] corroborated the clinical importance of complete preoperative hair removal by demonstrating its direct correlation with reduced infection rates and improved functional outcomes. A crucial dimension underscored by multiple studies is the economic burden of permanent hair removal. Electrolysis, while clinically superior for complete hair elimination, is significantly more expensive and time-intensive than LHR. Yuan *et al*.[1] quantified the mean cost per patient for electrolysis as exceeding $5000, compared with under $1000 for laser therapy. These differences in cost are amplified by inconsistent insurance coverage: while WPATH and dermatologic experts advocate for recognition of hair removal as medically necessary, insurance plans frequently classify it as cosmetic, leading to significant out-of-pocket costs for patients.[1,13,20] This economic disparity translates into clinical inequity. As Thoreson *et al*.[20,29] showed, patients from lower socioeconomic backgrounds or states with restrictive Medicaid policies face disproportionate barriers to accessing essential preoperative care. Consequently, these patients may proceed to surgery with inadequate hair removal, heightening their risk for complications and subsequent interventions. Fernandez *et al*.[29] support this notion by contextualizing the sociocultural evolution of hair removal, highlighting the historically gendered expectations that continue to shape both access and patient perceptions. Bradford *et al*.[6] highlighted another critical dimension: psychological outcomes. Effective hair removal notably reduces gender dysphoria, enhances positive affect, and improves overall emotional well-being, suggesting an expanded role for hair removal beyond medical necessity.[6] In summary, while current methods significantly improve postoperative outcomes and psychosocial well-being, persistent disparities remain in accessibility, economic feasibility, and protocol standardization. Future efforts should focus on validating optimized, patient-centered protocols; mandating uniform insurance coverage for medically necessary depilation; and strengthening interdisciplinary collaborations between surgeons, dermatologists, and policymakers to ensure equitable, effective care delivery for all transgender individuals.

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### Conflicts of interest

There are no conflicts of interest.

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