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Review Article

Complication Rates and Anatomic Considerations in Gender-Affirming Surgery Among Transgender Patients

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Abstract

Gender-affirming surgery (GAS) encompasses a range of complex reconstructive procedures tailored to the anatomical and gender identity needs of transgender patients, yet complication rates remain highly variable and are shaped by anatomic, hormonal, surgical, and systemic factors. Across procedures such as vaginoplasty, phalloplasty, metoidioplasty, and chest reconstruction, postoperative complications ranging from urethral stricture, fistula formation, and tissue necrosis to hematoma, wound dehiscence, and sensory loss have been reported with significant frequency, particularly in the context of multistage or microsurgical approaches. Patient-specific anatomical characteristics, including pelvic architecture, vascular supply, skin pliability, and the presence or absence of prior surgical or hormonal interventions, exert considerable influence on intraoperative decision-making and postoperative tissue integration. Hormone therapy introduces further physiologic complexity: estrogen exposure has been associated with altered dermal collagen deposition, decreased skin thickness, and impaired neovascularization, while testosterone may increase hematocrit, vascular fragility, and the density of subcutaneous tissue, complicating mastectomy and genital reconstruction. The creation of neourethras and neo-genital structures introduces distinct biomechanical and immunologic challenges, as donor site characteristics and local wound environments modulate graft take, epithelialization, and long-term structural durability. Moreover, disparities in surgical training, preoperative counseling, access to multidisciplinary care, and insurance coverage contribute to inequities in complication rates and outcomes across demographic groups. High revision and reoperation rates, particularly in urethral lengthening and vaginal depth restoration, reflect ongoing technical and physiologic constraints that remain insufficiently addressed in current practice. Standardizing outcome reporting through integration of anatomical characteristics, hormonal context, surgical technique, and patient-reported outcomes advances the precision, safety, and equity of gender-affirming surgery, ensuring success reflects complication profiles and long-term functional outcomes and alignment with gender identity.

Keywords: food and drug administration; physicians

Introduction

Gender-affirming surgery (GAS) includes facial, chest, and genital procedures which are performed to align an individual's physical anatomy with their affirmed gender, serving as a medically necessary intervention for gender dysphoria and significantly improving quality of life. Common transfeminine (male-to-female) procedures include vaginoplasty, breast augmentation, and facial feminization, while transmasculine (female-to-male) procedures include chest masculinization, phalloplasty, metoidioplasty, and brow augmentation [1]. GAS rates have been increasing, with one study reporting a rise from 4,552 in 2016 to 13,011 in 2019, and another showing a 500% increase from 2010 to 2021 with no signs of

plateauing [2,3]. The sharp rise emphasizes the urgent need for standardized outcome data to ensure quality care as demand accelerates. The U.S. market was valued at roughly $2.1 billion in 2022, with projected 11.25% annual growth through 2030 [4]. This escalating demand highlights the need to optimize outcome reporting frameworks to support safer and more effective care for the rising number of patients seeking GAS.

While gender-affirming surgery is generally safe, complication rates vary based on procedure type and anatomical complexity [1]. In a study assessing penile inversion vaginoplasty (PIV) among 3,388 patients, which is the most common transfeminine procedure, Ding et al. reported that poor/splayed stream (11.7%), meatal stenosis (6.9%), and irritation (11.5%) were the most frequent urinary issues, with no serious complications [5]. Similarly, breast augmentation has low complication rates, with capsular contracture (3.6%), implant asymmetry (3.89%), and hematoma (0.63%) being most reported [6]. While these rates are low, a lack of standardized reporting limits consistent comparisons between centers, reducing the generalizability and clinical utility of these results

In contrast, transmasculine procedures have higher complication rates. A 2022 review of 1,731 phalloplasties reported a 76.5% overall complication rate, with urethral fistulas in 34% and strictures in 25% [7]. This highlights the substantial technical challenges inherent to urethral construction in phalloplasty. Schuettfort et al. reported similar findings, with 88% of 25 patients developing fistulas and 48% developing strictures, though most were low-grade and patients were still satisfied with the results [8]. These findings further emphasize that urethral lengthening remains a technically challenging component of neophallus construction. Chest masculinization also presents risks, particularly graft viability, with nipple graft necrosis seen in up to 18.5% of cases [9]. This data underscores the need for unified outcome tracking to better quantify risks and improve techniques.

Beyond procedural complexity, anatomical and hormonal factors significantly influence surgical outcomes. For transfeminine patients, the amount of penile and scrotal tissue is essential for PIV, where a study by Smith et al. found neovaginal depth was about 87% of pre-op penile skin length [10]. This indicates that adequate tissue length must be present as some amount is lost in the construction of new anatomical structures. Similarly, estrogen aids breast development and improves skin elasticity, hydration, and scarring [11,12]. These effects can enhance healing and aesthetic outcomes in transfeminine procedures. For transmasculine patients, donor site choice for phalloplasty depends on tissue availability and scarring preferences [13]. Individual goals and anatomical factors often guide this decision-making**.** Hormones such as testosterone promote clitoral elongation for metoidioplasty, but may lead to erythrocytosis and increase risk of thrombosis, potentially affecting flap survival [14,15]. These factors must be optimized for safe and functional outcomes.

Surgical technique and systemic barriers further affect outcomes and access. Flap choice in phalloplasty influences both graft viability and donor site morbidity. Radial forearm flaps may offer better sensation but drawbacks include limited girth and potential functional complications, while anterolateral thigh flaps preserve function but may be bulkier [13]. Systemic barriers like insurance coverage and regional disparities also present significant challenges. One study found half of patients traveled out of state for GAS, paying 50% more out-of-pocket compared to in-state residents [16]. Moreover, patients in the South had lower odds of receiving care despite national growth in access to GAS [17]. This paper aims to synthesize current complication data across major GAS procedures and to advocate for standardized outcome reporting frameworks that integrate anatomical, hormonal, surgical, and systemic factors to promote safer and more equitable care.

Review

Gender-affirming Surgery and Common Complications

Gender-affirming surgery refers to procedures that are either feminizing or masculinizing in order to help transgender patients align their physical appearance with their gender identity. Common feminizing surgeries include vaginoplasty and vulvoplasty, while common masculinizing surgeries are phalloplasty and metoidioplasty [18]. Vaginoplasty, the creation of a new vagina, is frequently completed using PIV an extensive procedure which involves orchiectomy, penile disassembly, urethral meatus and clitoris construction, and labia minora, labia majora and vaginal canal creation. Vulvoplasty, also referred to as minimal-depth vaginoplasty (MDV), is an option for individuals looking for the appearance of external female genitalia without the creation of a vaginal canal [19]. Phalloplasty utilizes extragenital tissue, commonly from the radial forearm or anterolateral thigh, to create a phallus. Metoidioplasty is rearrangement of existing gential tissue to create male genitalia. It requires lengthening and increasing the prominence of the phallus among other optional components decided by the goals of the patient [18]. Chest reconstructions are utilized for both feminization and masculinization purposes, augmentation mammaplasty and mastectomy respectively [20]. As with many types of surgery, GAS does not come without risks and each procedure has common complications.

Vaginoplasty is a common type of GAS for individuals undergoing male-to-female transition. A 2023 retrospective analysis, found that the complication rate for vaginoplasty was 46.3% at 30 days and 79.6% at 90 days with yeast infection and hematoma being most common at 30 days and granulation tissue most common at 90 days. The 30-day complication rate for vulvoplasty was 38.1% and the 90 day compilation rate was 47.6%; urinary tract infection and granulation were the most common complications at 30 and 90 days [21]. While these complications are not uncommon, they are generally minor and easily treatable with antibiotics, silver nitrate, and surgical evacuation. Transgender patients who undergo GAS require frequent follow up to monitor development of treatable complications. A 2021 systematic review and meta-analysis reported vaginoplasty complication rates to include 1% fistula, 11% stenosis/strictures, 4% tissue necrosis, and 3% prolapse. These results are combined from multiple surgical techniques; however, PIV was most commonly used. Overall patient satisfaction was 91% [22]. While these complications are more likely to impact function, patient satisfaction was still high. A substantial percentage of satisfied patients despite complications, illustrates the effectiveness of vaginoplasty in addressing gender dysphoria. This further indicates the need for continued training and development of GAS so transgender patients can receive high quality care.

Phalloplasty, utilized in female-to-male transitions, carries different complications than vaginoplasty or vulvoplasty. A 2022 retrospective study of phalloplasty complications reported a total complication rate of 49.5%. Complications included urethrocutaneous fistula, urethral stricture, partial flap loss, and stone or hair formation [23]. These complications vary in severity and treatment ability, with some directly affecting urinary function and others posing aesthetic or psychosocial challenges. Urethrocutaneous fistulas require conservative treatment with extended catheterization or revision surgery if non-healing, while urethral hair growth can be treated with laser therapy. Urethral hair growth may be a less serious complication; however, any complication after GAS is distressing to the patient and prolongs treatment time and increases associated costs. A retrospective study from 2024 focused on complications after metoidioplasty, and they found an overall complication rate of 57.1%. The most common complications were strictures and urethral fistulas. Necessary treatments included dilation procedures or endoscopic urethrotomy for strictures and direct anastomosis or urethroplasty with a free vaginal mucosa transplant or free buccal mucosa graft transplant for fistulas [24]. These complications require additional procedures for treatment which provides more evidence to the need for further research to decrease complications. Decreasing complications will have downstream effects of less financial and emotional strain for patients. A systematic review specifically investigated urethral outcomes in patients

undergoing metoidioplasty and phalloplasty post vaginectomy. Metoidioplasty complications included strictures (25%), fistulas (21%), and wound complications (63%). Phalloplasty with radial forearm flap complications included, urethral strictures (32%), urethral fistulas (36%), wound complications (8%), and flap necrosis (12%) [25]. Urethral complications are widespread in GAS, even in a similar cohort of patients with prior vaginectomy. Multiple studies have shown the prevalence of urethral complications after both phalloplasty and metoidioplasty creating a strong argument for patient centered outcome reporting.

Both feminizing and masculinizing chest surgeries are generally considered to be safe procedures with minimal complications. A single institution conducted a retrospective chart review covering their surgeons' subfascial approach to mammaplasty augmentation. They found low complication rates including hematoma (4.29%), infection (2.86%), wound dehiscence (2.86%), hypertrophic scar (2.14%), and seroma (1.42%) [26]. These complication rates are congruent with the rates found in comparable studies [27]. Feminizing chest reconstruction is a sought-after form of GAS. While complications are observed, the rates are lower than other types of GAS. An institutional retrospective review of subcutaneous mastectomy reported a major complication rate of 2.7%. The major complication rate category encompassed surgical site infection and hematoma requiring evacuation [28]. Feminizing and masculinizing chest reconstruction are different operations; however, they document similar types and frequencies of complications.

Anatomic Factors

Variations in pelvic anatomy and architecture exist not only between males and females, but also among individuals of the same gender. While these anatomical differences are well-established in broader surgical literature, their direct implications in GAS remain underreported. A 2023 systematic review and meta-analysis found that the most common origin of the obturator artery was the internal iliac artery, with the second most common origin being the external iliac artery. In rare cases, double and triple obturator arteries were found [29]. Unrecognized vascular variants increase the risk of inadvertent vessel injury, particularly in GAS, where extensive dissection in the pelvis and groin is routine. If surgeons are unaware of differences in vascular patterns, they can cause inadvertent vascular injury. There is a high possibility of this in GAS where extensive procedures are performed in the pelvis and groin. Similar anatomical variability has been reported in the pudendal nerve, with a cadaveric study by Maldonado et al. highlighting significant variation in its branching patterns [30]. As with the obturator artery, there is risk for iatrogenic injury of the pudendal nerve during the extensive dissection required in GAS. A study by Hudson and Langdon examined skeletal remains and observed that despite ancestral differences and variations in body size, female pelvic girdles are consistently wider than male pelvic girdles [31]. Pelvic bone structure cannot be changed due to genetic disparities; therefore, it may influence the ability to construct anatomically and aesthetically accurate genitalia in GAS. Anatomic variations in the groin and pelvis can lead to insufficient genital skin for vaginoplasty, thereby impacting surgical outcomes [32]. Skin deficiency is another form of anatomic discrepancy which limits the outcomes of GAS for transgender individuals.

Cisgender females and cisgender males present with differences in breast tissue and chest anatomy, which must be considered when performing gender affirming surgery. A retrospective chart review from Mehra et al. describes that when transgender females present for breast augmentation during male-to-female transition, they have less glandular tissue and larger pectoralis muscles [33]. When breast augmentation is used for GAS in contrast to a cosmetic procedure, preoperative hormones may be required and different surgical techniques are used to obtain the desired outcome. A pinch test, where the tissue above the nipple-areolar complex is pinched and measured, can be used to assess the tissue and decide which surgical technique should be utilized. Jagasia et al. found that surgeons at their institution used a hybrid procedure combined with fat grafting for GAS when pinch tests were below 2 cm [26]. Pinch tests vary for cis-gender people and individuals undergoing gender affirming mammoplasty. Flexibility in surgical technique allows transgender patients to receive more natural appearing mammoplasties. Cisgender males have a shorter distance from the nipples to the inframammary folds than cisgender females, which can be corrected by making an inframammary incision under the original inframammary fold. Bekeny et al. reported that the average inframammary fold distance should be lowered by 3 cm to achieve more feminizing chest proportions [34]. It is important to continue to explore how to adjust GAS based on anatomical factors, as has been done with breast augmentation, in order to achieve appropriate results.

Prior surgical interventions have the capacity to affect anatomy and impact the outcomes of gender-affirming surgery. Huang et al. explains how many individuals undergoing vaginoplasty have had a past bilateral orchiectomy which causes scrotal atrophy and scarring. Therefore, they recommend concurrent bilateral orchiectomy and vaginoplasty because more skin grafting may be required if done separately [32]. Transgender patients should be made aware of the risks involved if opting to have orchiectomy prior to vaginoplasty, and surgeons should possess a strong understanding of these risks and counsel their patients appropriately. Huang et al. further emphasizes that prior circumcision can result in insufficient penile skin for vaginoplasty, presenting an additional surgical challenge [32]. As circumcision is typically done shortly after birth, surgeons would not be able to counsel transgender patients to wait to receive them as with orchiectomy. Surgeons must complete a thorough history and physical exam to be prepared for the quality and availability of gential skin of each patient. Bekeny et al. reports that many patients use illicit silicone injections to self-treat prior to seeking GAS. They analyzed their transgender patients who received breast augmentation, and despite high rates of illicit silicone injections, they found low complication rates [34]. This further emphasizes the need for a comprehensive history and physical exam prior to GAS. GAS will only be successful if all outcomes are explored and surgeons are aware of prior procedures that could cause complications.

Hormonal Factors

Estrogen plays an important role in tissue structure and architecture, directly influencing outcomes in transfeminine surgeries. Its main functions include thickening the epidermis while also increasing dermal collagen and hydration. This results in more elastic and resilient skin that responds better to incisions and grafting procedures [35]. These properties are particularly beneficial in procedures requiring incisions, grafts, or flaps, such as vaginoplasty and breast augmentation [36]. By improving skin pliability and stabilizing wound margins, estrogen exposure helps reduce the risk of postoperative complications such as wound dehiscence and graft failure—two outcomes that significantly influence the success of both vaginoplasty and feminizing mammoplasty. These effects are primarily mediated through estrogen receptor β (ER-β), which activates dermal fibroblasts and promotes angiogenesis and extracellular matrix remodeling. More recent studies suggest that implantable or topical biomaterials, which are newer substances designed to deliver estrogen directly to tissue, can accelerate wound closure and also improve skin tensile strength [37]. These benefits appear to be time-dependent, with maximal skin remodeling and vascular changes typically occurring after 6 to 12 months of continuous estrogen therapy. These findings continue to highlight estrogen's critical role in promoting tissue healing and minimizing flap-related complications in transfeminine surgery.

Estrogen also affects fat distribution, redistributing adipose tissue toward the hips, thighs, and breast region. These changes contribute to more aesthetic soft-tissue contours. Estrogen also increases areolar diameter and pigmentation, which supports improved postoperative chest aesthetics [38]. Based on these effects, current guidelines recommend at least 12 months of

feminizing hormone therapy prior to surgery to allow sufficient time for these physiologic changes. Although estrogen is often paused before surgery to minimize thrombotic risk, short-term cessation does not appear to reverse its benefits to skin quality [39]. Recent imaging studies have confirmed that within one year of estrogen therapy, transfeminine patients show a significant increase in subcutaneous fat in the gluteal and femoral regions, enhancing lower-body contours and aligning more closely with cisfemale fat distribution [40]. These cumulative effects of enhanced fat deposition, softer skin, and areolar remodeling, provide both a visual and surgical advantage in procedures like breast augmentation, allowing for more natural implant positioning and better skin pliability. In addition to its effects on fat distribution and skin pliability, estrogen enhances vascularization and dermal regeneration, which are critical for postoperative healing. A recent preclinical study demonstrated that estrogen-treated skin flaps had significantly increased capillary density, reduced tissue hypoxia, and improved epithelial organization compared to controls, indicating a more robust and predictable wound-healing environment [41]. These findings provide an insight into why prolonged estrogen exposure may benefit outcomes in gender-affirming procedures such as breast augmentation and vaginoplasty, where tissue viability is extremely important to outcome. These changes not only help patients align more closely with their gender identity but also enhance flap viability and surgical predictability, supporting more consistent aesthetic and functional outcomes.

Testosterone changes tissue in a way that supports masculinization but introduces specific challenges for surgery. It increases muscle mass and thickens the dermis through greater collagen deposition and sebaceous activity, which can enhance chest wall definition but reduce skin pliability [42]. These pathophysiologic changes underscore the importance of tailoring closure techniques and scar mitigation strategies in patients with long-term androgen exposure. Testosterone also elevates red blood cell production by stimulating erythropoiesis. While this may benefit oxygen delivery in general health, there is a heightened thrombotic risk in microvascular surgeries, such as phalloplasty using radial forearm or anterolateral thigh flaps [43]. Many surgical teams pause testosterone prior to surgery to reduce this risk with preoperative hematologic screening and perioperative testosterone cessation as common practices to mitigate this risk, particularly when hematocrit exceeds 54% [39]. In addition to hematologic concerns, animal studies have shown that testosterone prolongs wound inflammation and delays re-epithelialization. Murine models have shown that testosterone delays epithelial closure by prolonging the inflammatory phase of wound healing and proinflammatory cytokine expression while reducing fibroblast migration [44]. These findings may have implications for transmasculine postoperative healing, though there is limited human data. This is particularly relevant in staged procedures or urethral reconstructions, where impaired healing may lead to higher rates of fistulas, strictures, or graft failures. Prospective human studies are needed to determine whether temporary hormonal modulation could improve these outcomes.

Hormone exposure plays a significant role in the quality and quantity of donor tissue available for genital and chest reconstruction. In transfeminine vaginoplasty, prolonged estrogen therapy can reduce penile and scrotal tissue volume, which may limit inversion depth options [11]. In transmasculine patients, testosterone-induced clitoral hypertrophy is essential for metoidioplasty. Hormone therapy is usually maintained for one to two years before surgery to ensure adequate growth. Some patients use additional techniques like topical DHT or vacuum therapy to enhance length [45]. Testosterone also affects donor site tissues used in phalloplasty. Vaginal mucosa becomes thinner and less vascular, which can affect its suitability for urethral reconstruction [46]. Forearm or thigh donor sites also develop thicker dermis and denser hair growth, which increases the importance of preoperative defatting and permanent hair removal. Laser hair removal has been shown to be an effective method for preparing these sites [47]. When not adequately addressed, these changes may lead to misaligned or poorly vascularized urethral segments, compromised flap adherence, or difficulty achieving a tension-free closure. These all can result in graft failure or fistula formation, underscoring the importance of early endocrine-surgical coordination in phalloplasty planning. Moreover, androgen exposure may impair urethral wound healing during later phases, increasing the likelihood of stricture or fistula formation, which is a complication particularly relevant to phalloplasty outcomes [48]. Hormone-related modifications should be proactively managed in the surgical planning phase in order to optimize the integration of grafts and reduce the likelihood of a revision procedure.

Timing of hormone therapy around surgery is critical. Testosterone is often paused before flap-based reconstructions, and estrogen may be held prior to vaginoplasty depending on thrombosis risk. These adjustments are made to balance surgical safety with the benefits hormones provide for tissue quality and function [39]. Rather than applying a one-size-fits-all protocol, endocrine-surgical coordination should be based on the specific reconstructive technique, graft type, and comorbid risk. This kind of integrated hormone-surgical planning is increasingly viewed not just as optional optimization, but as standard of care in gender-affirming surgery. Recent data suggest that continuing hormone therapy during the perioperative period does not significantly increase complication rates, which challenges older assumptions about mandatory hormone cessation [49]. For example, a cohort study found no increase in thromboembolic events among transfeminine patients who remained on estrogen during gender-affirming surgery, supporting individualized management strategies [50]. Collectively, these findings support a shift toward more personalized, risk-stratified hormone protocols rather than routine interruption.

Surgical Factors

Gender-affirming surgeries involving the creation of neourethras and neo-genital structures pose a set of challenges when considering complications of surgery. According to Hage and De Graf, the ideal phalloplasty should be one stage surgery that creates a neo-urethra capable of standing micturition, retaining tactile and erogenous sensation, and maintaining an erection. Other ideals include being accepted by the patient aesthetically, as well as minimal scarring and no functional loss [51]. However, the reality of current surgical techniques falls short of these ideals, with significant complication rates that highlight the biochemical and immunologic challenges of donor site characteristics and local wound environments. The creation of functional neourethras represents one of the most challenging aspects of gender-affirming surgery, with complication rates that remain persistently high across different surgical approaches. The choice of donor tissue for urethral reconstruction significantly impacts surgical outcomes. Traditional approaches using vaginal flaps for the "bulbar urethra" construction have shown particularly high complication rates, with 69% of patients experiencing fistulas and/or strictures [52]. In contrast, the use of buccal mucosa, vaginal mucosa, and other specialized graft materials has shown promise in reducing complications.

Graft failure in radial artery forearm free flap phalloplasty remains the main donor site complication [53]. To address challenges such as this, researchers have explored various modifications to surgical techniques. Recent innovations in graft techniques, including the use of vaginal mucosal graft for prelamination urethra (VMGPU) combined with modified urethral anastomosis, have demonstrated improved outcomes in retrospective studies [54]. These findings suggest a potential for enhanced urethral construction and reduced postoperative complications. However, attempts to improve donor site morbidity through additional dermal matrix applications have shown no significant difference in donor site appearance or functionality [55]. As a result, future advancements should also focus on alternative reconstructive methods rather than simple changes in graft materials, indicating that donor site management remains a key area for further research.

The process of epithelialization, which serves to restore a surface layer that acts as a protective barrier, in neo-genital structures presents unique challenges that differ significantly from conventional wound healing. In vaginoplasty procedures, complete epithelialization of the neovagina typically requires 1-4 months, depending on the surgical technique and individual healing characteristics [56]. The large surface area and depth of the artificial neovagina create conditions that can impede normal epithelialization processes. Recent research has explored novel approaches to enhance epithelialization, including the use of growth factors and stem cell-derived therapies. Fibroblast growth factor (FGF) has shown promise in promoting epithelialization of neovaginal tissue, with studies demonstrating morphologically similar epithelium to normal vaginal tissue [57]. Additionally, emerging research on small extracellular vesicles (sEVs) derived from stem cells suggests potential for accelerating wound epithelialization through sustained release mechanisms [58]. These promising results indicate that epithelization can be actively guided in the future rather than passively awaited, which would dramatically improve the aesthetic outcomes and recovery for vaginoplasty procedures. The long-term structural integrity of neo-genital constructions remains a critical concern that directly impacts patient satisfaction and functional outcomes. Progressive obstructive voiding disorders due to meatal stenosis and urethral stricture represent ongoing complications that may develop months or years after initial surgery [59]. These complications often require multiple revision procedures, with high reoperation rates reflecting the ongoing technical and physiologic constraints of current surgical approaches. The durability of neo-genital structures is influenced by multiple factors, including the mechanical properties of graft materials, local wound environment, and the patient's individual healing response. Scar tissue formation can significantly impact long-term function, particularly in urethral reconstructions where stricture formation may progressively impair urination [60]. These long-term challenges emphasize the need for a more integrated approach that places importance on both surgical precision and sustained management strategies. As techniques for GAS advance, long-term viability should remain a central marker for procedural success in order to create a future with lasting outcomes for patients.

Systemic Factors

Despite the increasing demand for gender-affirming care, current education in surgical training lacks uniformity across specialties and institutions. Ha et al. recently reported that of 130 plastic surgery residency programs, 58% offered clinical training in GAS and only 38% incorporated didactic instruction; strikingly, 42% provided no formal training and no elective pathway to acquire it [61]. This limited and uneven training structure hinders the development of technical proficiency, especially for high-risk, multistage operations that require mastery in microsurgery and individualized tissue planning. Moreover, McLaughlin et al. found that even at the sub-internship level, access to GAS experiences is stratified by geography and program size. Applicants rotating in the Midwest and West, or at medium-sized programs, had significantly more exposure to facial and clinical aspects of GAS compared to those in the South or at smaller institutions [62]. These discrepancies suggest that early surgical engagement with GAS is not only unpredictable but also shaped by broader structural and sociopolitical factors, which may perpetuate inequities in surgical readiness and patient outcomes. Compounding this issue, Kelly-Schuette et al. found that only 37.9% of residents and 46.2% of attending physicians felt confident providing care for transgender patients, and less than one-third of surgical respondents reported sufficient knowledge to describe gender-affirming procedures [63]. In the context of GAS, where success hinges on an intricate understanding of hormonal physiology, anatomical nuance, and reconstructive technique, these educational gaps are clinically consequential. Addressing these gaps through standardized, competency-based training is imperative to ensure that all surgeons are equipped to provide safe and technically sound care.

Preoperative counseling plays a pivotal role in shaping both the psychosocial and physical outcomes of gender-affirming surgery, yet its implementation remains inconsistent and often insufficient. Brody-Camp et al. emphasized that effective counseling must begin with affirming communication where staff should consistently use correct names and pronouns, and surgeons should take time to explore each patient's specific aesthetic goals and social context before discussing procedural options [64]. This individualized approach not only establishes trust but also reduces dissatisfaction that may arise when patients hold unrealistic expectations regarding the outcomes of facial feminization or other gender-affirming procedures. However, beyond interpersonal rapport, structured educational interventions can substantially improve patient preparedness. Poceta et al. evaluated a four-hour multidisciplinary surgery readiness class and found that over 95% of transgender and non-binary participants reported feeling more informed about surgical options, postoperative care, and possible complications, underscoring the value of formalized counseling in reducing perioperative uncertainty and bolstering consent quality [65]. This suggests that patient education is not merely a courtesy but a critical determinant of surgical literacy and psychological readiness, particularly as many patients arrive with fragmented or inaccurate information sourced from online forums or social media. Tollinche et al. emphasized the need for culturally humble, person-centered counseling, stating that many transgender patients enter surgical consultations having faced prior medical discrimination, which potentially further marginalizes this population [66]. This suggests both emotional safety and an informed discussion of hormone use, airway management, and potential risks related to comorbid conditions is necessary. Taken together, comprehensive preoperative counseling must go above the technical aspects of consent to encompass gender-sensitive language, visual aids, discussion of postoperative timelines, and collaborative decision-making frameworks. Without such efforts, the gap between surgical outcomes and patient satisfaction may persist, particularly in procedures with long recovery periods or those affecting self-perception and social identity.

Limited access to multidisciplinary care plays a major role in shaping the disparities seen in complication rates and surgical outcomes for patients undergoing gender-affirming surgery. Johnstone et al. found that many patients are forced to travel an average of 191 miles, with over a third crossing state lines to reach a provider [67]. Long travel such as this can interfere with timely follow-up visits and make it harder for patients to receive consistent care, increasing the likelihood of complications. Bocchino et al. highlighted the importance of well-coordinated care teams—consisting of mental health providers, endocrinologists, surgeons, anesthesiologists, and nursing staff—in helping prevent complications and tailoring care to each patient's needs [68]. When these teams are missing or poorly integrated, care becomes disjointed, which can compromise outcomes and contribute to patient dissatisfaction. Shin et al. added that patients who received care through an interdisciplinary perioperative model reported fewer concerns after surgery, largely due to better communication, clear discharge planning, and smoother transitions between stages of care [69]. Together, these findings point to the need for more accessible and better integrated multidisciplinary programs. This will not only improve the patient experience, but also work to close the outcome gap faced by many transgender individuals undergoing GAS.

Gaps in insurance coverage continue to shape the success and accessibility of gender-affirming surgery, making it harder for many transgender patients to receive the care they need. Kim et al. found that individuals from lower socioeconomic backgrounds are more likely to rely on public insurance, which often offers limited coverage for both surgical procedures and essential postoperative support [70]. As a result, patients in the lowest income quartile were more frequently discharged to home healthcare or nursing facilities. These outcomes reflect not just clinical needs, but the broader structural inequities that influence recovery. Adding to this picture, Bakko and Kattari reported that insurance denials for necessary care like

hormone therapy and surgery were more common among those with Medicaid or military-based plans compared to people with private insurance [71]. These denials delay or fragment patient care, making it more difficult for patients to heal both physically and emotionally after surgery. LaGuardia et al. further highlighted how inconsistent Medicaid policies across states often exclude or fail to clearly define coverage for gender-affirming procedures [72]. For patients, this translates into unpredictable costs and fewer options for care, which adds stress during an already vulnerable time.

High revision and reoperation rates after gender-affirming surgery continue to pose serious challenges, particularly in procedures requiring complex reconstruction. Veerman et al. documented that approximately 73% of transgender men undergoing urethral lengthening experienced complications such as strictures and fistulas that necessitated revision surgery [73]. This not only demonstrates the technical difficulty of creating a durable neo-urethra, but also reveals the limitations of current techniques in achieving reliable and functional urinary outcomes. Similarly, Hassan et al. reported a high frequency of unplanned reoperations following phalloplasty, with complications ranging from hematomas to wound dehiscence and vascular thrombosis [74]. These issues suggest that even in well-resourced settings, surgical refinement and improved perioperative protocols remain urgent priorities. Bene et al. further examined outcomes in vaginoplasty, noting that the choice of tissue for neovaginal construction significantly influenced risks for complications like stenosis and insufficient depth, often resulting in additional interventions [75]. This finding points to the importance of tailoring surgical approaches to each patient's unique anatomy while also advancing techniques that maximize long-term structural viability. In addition, Kalmar et al. brought attention to racial and ethnic disparities in postoperative outcomes, identifying higher reoperation rates among Black and Hispanic patients compared to White patients [76]. These disparities likely reflect systemic barriers that extend beyond the operating room. Addressing high revision and reoperation rates will require not only technical improvements, but also broader efforts to reduce these structural inequities in the delivery of medical care.

Future Directions

As gender-affirming surgery becomes increasingly accessible, future directions must prioritize the standardization of outcome reporting to meaningfully reduce complication rates and better account for anatomic variability. Two systematic reviews by Oles et al. draw attention to a persistent lack of methodological consistency across GAS studies, demonstrating that a wide variety of methods and instruments are used to determine the success of transgender surgical outcomes [77,78]. This fragmentation obstructs comparative analysis and weakens our understanding of how surgical technique, anatomical variation, and even hormonal background intersect to influence outcomes. Such gaps are especially consequential in genitoplasty, where the choice of technique must align with individualized anatomical constraints, yet data on long-term functional durability remains heterogenous and often anecdotal. Moreover, as emphasized by Agochukwu-Mmonu et al., the near-total absence of validated patient-reported outcome measures (PROMs) perpetuates a system that favors surgical opinion over patient experience [79]. Incorporating PROMs as well as a unified surgical success outcome tool co-developed with transgender communities could illuminate underappreciated complications, guide future revisions, and redefine success for transgender individuals. Further research into these will not only harmonize surgical protocols, but elevate the standard of care across all settings to achieve safer, more precise, and equitable gender-affirming surgical care.

Conclusion

A vital component of transgender healthcare involves gender-affirming surgery. This review encompasses the importance of highlighting integral components of these procedures, from the complications and outcomes to the standardization of protocols. GAS has radicalized transgender health, allowing patients to match their gender identity with their physical features, leading to significant improvements in the psyche of individuals who take part. However, the procedure has been poorly studied, leading to uncertainties in care. GAS can lead to discrepancies in both outcomes and complications due to anatomical variations, tissue availability, hormonal factors, and other biological components. Alongside this, past surgical history, insufficient surgical training, limited insurance coverage, the role of race, and limited access to multidisciplinary care play a role in the development of poorer outcomes. Unfortunately, there is also a lack of standardization in surgical reporting, leading to inconsistencies that impair the system from improving, contributing to a diminished quality of care. Looking forward, the field must prioritize research to allow for effective and safe care. To achieve this, there needs to be an effort to increase educational awareness, demonstrate clinical innovation, acknowledge systemic barriers, and include the transgender community to voice their concerns and experiences. Affirming patients' experiences, optimizing the standardization of surgical protocols, eradicating systemic barriers, and moving towards a healthcare system that promotes equitable care for all individuals will lead to better care for individuals engaging in GAS.

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