Imaging Findings in Transgender Patients after Gender-affirming Surgery

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Gender-affirming surgeries expand the options for physical transition among transgender patients, those whose gender identity is incongruent with the sex assigned to them at birth. Growing medical insight, increasing public acceptance, and expanding insurance coverage have improved the access to and increased the demand for gender-affirming surgeries in the United States. Procedures for transgender women, those patients with feminine gender identity, include breast augmentation using implants and genital reconstruction with vaginoplasty. Some transgender women receive medically unapproved silicone injections for breast augmentation or other soft-tissue contouring procedures that can lead to disfigurement, silicone pulmonary embolism, systemic reactions, and even death. MRI is preferred over CT for postvaginoplasty evaluation given its superior tissue contrast resolution. Procedures for transgender men, patients with a masculine gender identity, include chest masculinization (mastectomy) and genital reconstruction (phalloplasty or metoidioplasty, scrotoplasty, and erectile device implantation). Urethrography is the standard imaging modality performed to evaluate neourethral patency and other complications, such as leaks and fistulas. Despite a sizeable growth in the surgical literature about gender-affirming surgeries and their outcomes, detailed descriptions of the imaging features following these surgeries remain sparse. Radiologists must be aware of the wide variety of anatomic and pathologic changes unique to patients who undergo gender-affirming surgeries to ensure accurate imaging interpretation.

Online supplemental material is available for this article.

Abbreviations: ALT = anterolateral thigh flap, DVT = deep venous thrombosis, PIV = penoscrotal inversion, RFFF = radial forearm free flap

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SA-CME LEARNING OBJECTIVES

After completing this journal-based SA-CME activity, participants will be able to:

- Discuss the current terminology, epidemiology, and care standards related to transgender patients.
- Recognize the neoanatomic features depicted after gender-affirming surgeries across various imaging modalities.
- Explain the use of imaging in diagnosis and management of gender-affirming surgical complications.

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Introduction

The term *transgender* describes a person whose gender identity is incongruent with their sex assigned at birth (Table 1) (1). There are an estimated 25 million transgender persons worldwide, 1.4 million of whom live in the United States (one in 189 adults) (2). Transgender patients who elect to undergo medical or surgical procedures to affirm their gender identity may receive a wide range of care, including mental health counseling, hormonal therapy, and various gender-affirming surgeries (Table 2) (3). The transgender community may colloquially refer to breast and genital procedures as *top* and *bottom* surgeries, respectively. Significant advances in gender-affirming surgical techniques have allowed transgender patients to alter their phenotype to match their inner self-identity, which can contribute to improved quality of life (4–6).

Not every person with gender incongruence will seek gender-affirming surgery. In the 2015 U.S. Transgender Survey (7), only 25% of more than 27 000 respondents had undergone some form of gender-affirming surgery. The low rate of surgery at that time may have resulted from a lack of insurance coverage, other financial con-

TEACHING POINTS

- The term *transgender* describes a person whose gender identity is incongruent with their sex assigned at birth. There are an estimated 25 million transgender persons worldwide, 1.4 million of whom live in the United States (one in 189 adults). Transgender patients who elect to undergo medical or surgical procedures to affirm their gender identity may receive a wide range of care, including mental health counseling, hormonal therapy, and various gender-affirming surgeries. The transgender community may colloquially refer to breast and genital procedures as *top* and *bottom* surgeries, respectively. Significant advances in gender-affirming surgical techniques have allowed transgender patients to alter their phenotype to match their inner self-identity, which can contribute to improved quality of life.
- Silicone injections can lead to local disfigurement, infection, necrosis, and skin ulceration. Systemic sequelae can include hypercalcemia, autoimmune reactions, silicone migration, pulmonary embolism, and even death.
- Radiologic neoanthropometric parameters to be assessed at imaging include neovaginal depth, length of the inferior pelvic aperture and pelvic inlet, angle of the neovaginal axis, and thickness of the rectovaginal septum. A correlation was found between adequate neovaginal dimensions and the patient's overall happiness with the aesthetic results, sexual function, and improved quality of life after gender-affirming surgery. Radiologists should report these measurements for imaging performed after vaginoplasty.
- Phalloplasty is the most complex gender-affirming surgery and requires a multidisciplinary team that may include a gynecologist, urologist, vascular surgeon, and plastic surgeon. The two main options for neophallus creation include phalloplasty and metoidioplasty. The goal is creation of an aesthetically acceptable and functional neophallus. The patient's goals might include the ability to urinate while standing, maintain tactile and erogenous sensation, and participate in penetrative sexual intercourse.
- Metoidioplasty represents a viable technique for the creation of a neophallus for patients in which the RFFF technique is not feasible or when excessive scarring of the flap donor site is unacceptable. The neophallus length achievable with this technique is less than that of flap-based procedures, which may prevent the ability to engage in sexual intercourse. However, most patients can satisfactorily micturate while standing, can achieve an erection, and report high overall satisfaction with their neophallus.

straints, or a paucity of access to surgeons who perform gender-affirming surgery (7,8). These rates are now increasing as many third-party payers expand coverage for gender-affirming surgery. The Centers for Medicare and Medicaid Services (CMS) in the United States now covers gender-affirming surgical procedures deemed reasonable and necessary by qualified health professionals (9). In fact, patients insured by CMS were more likely to have undergone gender-affirming surgeries than patients with other insurance plans (7). In addition, growing public and medical insight into the health needs of transgender patients has created an increased demand for gender-affirming surgeries in the United States (10).

The standards of care guidelines established by the World Professional Association for Transgender Health (3) state that gender-affirming surgery should be performed only in the context of a multidisciplinary team of experienced surgeons (urologists, gynecologists, plastic surgeons, etc) and other experienced health care providers. By extension, radiologists must be aware of the wide variety of anatomic and pathologic changes unique to patients who have undergone gender-affirming surgery to ensure accurate imaging interpretation. Until recently, systematic documentation of gender identity was not a standard practice across the health care system. However, electronic medical record vendors have begun to adapt technology to allow for the collection and display of information such as gender identity, sex assigned at birth, chosen name, and legal gender, which may alert the radiologist to important information about the patient, especially potential history of hormonal therapy and gender-affirming surgery (11–13).

Radiologists should use caution when evaluating pelvic neoanatomy, or a patient's new anatomy following gender-affirming surgery, to avoid misgendering or providing inaccurate descriptions, especially if the patient's affirmed legal gender is reflected in the medical record (eg, reporting "normal prostate and seminal vesicles" in a patient who has undergone hysterectomy). Unfortunately, detailed descriptions of imaging features remain sparse. In this article, we review the various surgical techniques used in gender-affirming surgeries, the expected imaging appearance of the neoanatomy, and associated perioperative and long-term complications. (The original slide presentation for this article from the RSNA Annual Meeting is available online.)

Terminology

Gender identity refers to one's personal sense of masculinity or femininity as it falls on a spectrum, which includes masculine, feminine, or other genders (Table 1) (1). Gender identity may be incongruent with one's sex assigned at birth (also referred to as *sex* and *phenotypic* or *genotypic sex*), which is determined by external genitalia or other phenotypic features. When one's gender identity and sex assigned at birth are aligned, the individual is referred to as *cisgender*. Persons who experience incongruence of their assigned sex and gender identity may be referred to as transgender. Persons who were assigned male sex at birth who have feminine gender identities are referred to as *transgender women* (also as *trans women*, *transfeminine*, or *male-to-female*). Conversely, persons who were assigned female sex at birth who have masculine gender identities are referred to as *transgender*

Table 1: Accepted Terminology Used in Reference to Transgender Populations

Term	Meaning
Cisgender	Person whose gender identity aligns with one's assigned sex at birth (eg, a person born with XY chromosomes, penis, and testes who identifies as male)
Gender-affirming hormone therapy	Hormonal regimens designed to induce phenotypic characteristics of the affirmed gender and suppress those of the birth-assigned sex
Gender-affirming surgery	Surgeries performed to align one's anatomy with one's gender identity; the terms *gender reassignment* and *sex change* are considered offensive and are no longer used
Gender-diverse (also referred to as *gender nonconforming*, *nonbinary*, *gender queer*, or *gender fluid*)	Person whose gender identity differs from their sex assigned at birth but whose gender identity may not be confined to a binary male-female understanding of gender; may use pronouns such as *they*, *them*, or others
Gender dysphoria	Distress caused by the incongruence of a person's gender identity and sex assigned at birth
Gender identity	An individual's inner sense of masculinity or femininity
Sex	Identification as a man, a woman, or intersex at birth on the basis of phenotype and/or genetics
Sexual orientation	An individual's emotional and sexual attraction to others
Transgender	Person whose gender identity differs from the sex assigned at birth
Transgender man	Person with masculine gender identity who was assigned a female sex at birth
Transgender woman	Person with feminine gender identity who was assigned a male sex at birth
Transmasculine, transfeminine	Terms to describe the directionality of gender identity or the expression on the spectrum of gender-diverse persons

Source.—Reference 1.

men (also as *trans men*, *transmasculine*, or *female-to-male*). Other persons may have gender identities that lie outside of the societal binary construct and may identify as *gender nonbinary* or *nonconforming* (also referred to as *gender diverse*, *gender expansive*, or *gender queer*). However, some prefer to avoid these terms as they imply exclusion from a "normal" construct. Others may identify as both male and female (bigender), having no gender (agender), or dynamic and may identify as one or more genders at different times (gender fluid).

Persons who experience significant distress and impairment in social, occupational, or other important functional domains related to gender incongruence may be diagnosed with gender dysphoria, a condition recently adopted into the Diagnostic and Statistical Manual of Mental Disorders (14) to replace the former term *gender identity disorder*.

While a full discussion of terminology is beyond the scope of this article, it should be noted that certain terms are considered outdated and should be avoided. For example, the surgical procedures performed to align one's body with their gender identity are gender-affirming surgeries, and the terms *gender-confirming surgery*, *sex reassignment surgery*, and *sex change surgery* are no longer used, as they can be perceived as offensive. The adjective "transgendered" is also considered inappropriate, as it implies that something happened to the person to cause gender incongruence. Other terms such as *transgenders* and *tranny* and phrases such as "a transgender" are also considered offensive.

Gender identity should be distinguished from a person's sexual orientation (gay, lesbian, bisexual, asexual, etc). These represent separate constructs, as sexual orientation reflects one's emotional or physical attraction to another. That is, transgender and gender-diverse populations may have any sexual orientation, just as is observed among cisgender persons.

Table 2: Summary of Procedures Performed for Gender Affirmation

Feminizing
Breast augmentation
Orchiectomy, vaginoplasty
Facial feminization
Thyroid chondroplasty (ie, tracheal shave)
Voice surgery (glottoplasty, cricothyroid approximation)
Masculinizing
Chest masculinization (subcutaneous mastectomy)
Hysterectomy, oophorectomy
Phalloplasty or metoidioplasty, scrotoplasty
Implantable testicular prostheses or erectile devices
Thyroplasty

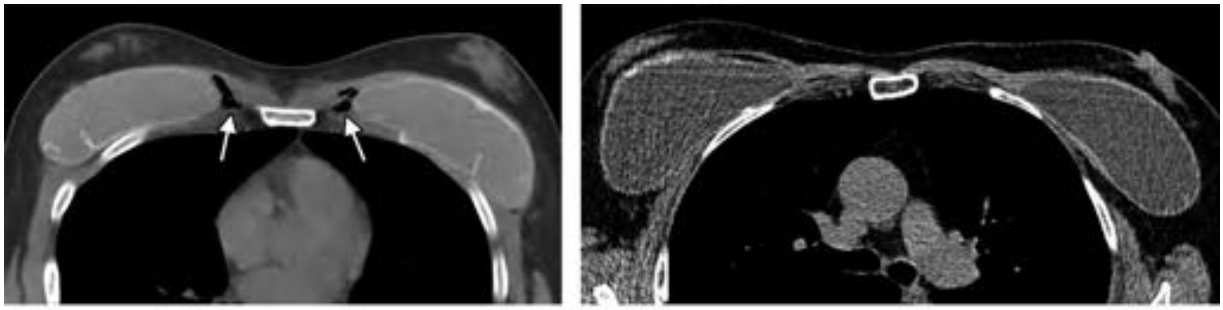

Figure 1. Breast implants at CT in two patients. **(a)** Axial image shows the expected 5-day postoperative appearance of subglandular silicone implants in a transgender woman, with subcutaneous air and stranding (arrows). **(b)** Axial image shows normal subpectoral saline implants in a 63-year-old transgender woman who had inadequate breast development after undergoing hormone therapy. Complications incidentally detected at CT should be further evaluated at physical examination for saline implants and with either MRI or US for silicone implants.

Feminizing Surgeries

Breast Augmentation

Feminizing hormones (estrogen, progesterone, and antiandrogens) induce the development of breast tissue, which is histologically identical to that of cisgender females (15). Maximal breast development typically occurs within 1–2 years of continuous hormone therapy and orchiectomy, but Tanner stage V breast maturation is seldom achieved (16). Consequently, 60%–70% of transgender women surveyed either have undergone or desire to undergo breast augmentation (7). Surgical breast augmentation with saline, silicone, or dual-lumen implants may be elected by transgender women in whom hormone therapy fails to induce adequate breast development (Fig 1).

Perioperative complications such as hematoma, seroma, and abscess can be diagnosed at US and may be managed by percutaneous drainage (Table 3). Implant integrity in transgender women can be evaluated at mammography, US, and MRI, with identical imaging features to those depicted in cisgender women with breast implants (16–18,30). Implant-displaced views should be obtained in transgender women as would be obtained in cisgender women (19) (Fig 2). Saline implants are best evaluated clinically (20), while silicone or dual-lumen implants are best evaluated at MRI or US. Most implant ruptures are intracapsular (contained within the substance of the fibrous tissue capsule), while 10%–20% are extracapsular (implant contents extend into surrounding tissues) (17). Rarely, implant-associated malignancy (eg, lymphoma) may develop (31) (Fig 3).

Silicone Injections.—Some transgender women may undergo silicone injections for breast augmentation or other soft-tissue contouring procedures (32–34). These procedures are illegal in the United States and are often performed in unsupervised settings. Of the 9238 transgender women respondents in the 2015 U.S. Transgender Survey (7), 3% had undergone silicone injections and 10% desired to undergo the procedure.

Mammographic and CT features of silicone injections include soft-tissue granulomas, which manifest as dense soft-tissue masses, architectural distortion, and skin and trabecular thickening (Fig 4a, 4b). On US images, silicone deposits manifest the pathognomonic "snowstorm" artifact of echogenic and indistinct tissues, which limits evaluation of deep parenchyma (Fig 4c). On MR images, silicone appears as a mass with intermediate signal intensity on T1-weighted images and high signal intensity on T2-weighted images (Fig 4d–4f). Silicone-suppression sequences show loss of signal intensity in the tissue deposits. Dynamic subtracted T1-weighted sequences performed after administration of gadolinium-based contrast material are necessary to detect pathologic enhancement. The sensitivity of mammography and US for breast cancer screening is severely limited in transgender women who have had prior silicone injections, and contrast-enhanced MRI with silicone suppression should be employed as the first-line imaging modality for breast cancer screening in this population (35).

Silicone injections can lead to local disfigurement, infection, necrosis, and skin ulceration. Systemic sequelae can include hypercalcemia, autoimmune reactions, silicone migration, pulmonary embolism, and even death (32–34,36-41) (Fig 5).

Vaginoplasty

The primary goal of feminizing genital surgery is to create a functional and cosmetically acceptable neovagina. The number of transgender women who undergo vaginoplasty is increasing. Fifty-eight percent of transgender women surveyed in the

Table 3: Suggested Imaging Protocols for Evaluation after Gender-affirming Surgery*

Procedure	Indication	Protocol Selection
Breast augmentation	Suspected peri-implant hematoma, seroma, abscess	Color Doppler US with possible image-guided aspiration or drain placement (17–20)
	Suspected implant rupture	Saline implants: clinical breast examination Silicone implant: breast US (17,19,20) Breast MRI with or without silicone suppression, according to implant type (17,19,20)
Masculinizing chest surgery	Suspected postoperative hematoma, seroma, abscess	Color Doppler US, with possible image-guided aspiration or drain placement (17)
Vaginoplasty	Suspected postoperative hematoma or abscess; rectal, bladder, or ureteral injury	Contrast material–enhanced CT; delayed imaging for evaluation of the ureter and bladder Consider CT cystography for suspected bladder injury
	Evaluate neoanatomy, neoclitoral and neovaginal perfusion, and rectovaginal septum; suspected stenosis, fistula, residual erectile tissue	Pelvic MRI: shallow free breathing, phased array, parallel imaging, 1.5 T or higher; at least 3-mm sections, axial and sagittal non–fat-suppressed T1- and T2-weighted FSE; T1-weighted fat-suppressed FSE sequence before and after gadolinium-based contrast material administration with subtraction (21–25) Consider using a neovaginal dilator instrument (metal parts removed) to improve neoanatomic assessment Consider using neovaginal or rectal water-based gel (for MRI) or diluted iodinated contrast material (for CT) to evaluate for fistulas and neoanatomic relationships, 60–120 mL introduced with a 60-mL syringe
	Suspected neovaginal or rectal prolapse	Consider using neovaginal or rectal water-based gel (for MRI) or diluted iodinated contrast material (for CT), 60–120 mL introduced with a 60-mL syringe (24,25) Pelvic MRI with dynamic maneuvers (rest, Kegel, Valsalva, rectal evacuation), midsagittal plane; real-time balanced steady-state gradient sequence,† continuous 60-sec acquisition (24,25) Recommended to perform dynamic maneuvers before the administration of intracavitary contrast material during static pelvic MRI protocol to avoid loss of contrast material
Phalloplasty	Preoperative mapping of native vasculature for pedicle creation	Color Doppler US (26)
	Suspected postoperative vascular compromise	Pelvic and thigh CT angiography (27): supine position, remove underwear, use breath hold, z-axis coverage from knee to umbilicus 100 mL iodinated contrast material, 4.5-mL/sec injection followed with a 45-mL saline solution flush 120 kVp, 200 mAs, 0.5-sec gantry rotation, 0.6-mm table feed 3D and MIP reconstructions Report Cartesian coordinates Report perforator size and distance from the anterior superior iliac spine and lateral patella, presence of arteries and veins, branching pattern Pedicle length, continuity, and anatomic variation Thickness of subcutaneous tissue
	Suspected neourethral stricture, leak, or fistula	Retrograde urethrogram (28); antegrade urethrography could be considered if patient has suprapubic catheter
	Evaluation of erectile or scrotal implants	Contrast-enhanced pelvic CT, extend z-axis coverage from iliac crests to lower thigh (29) Pelvic MRI (dorsal positioning of the neophallus): shallow free breathing, phased array, parallel imaging, 1.5 T or higher; at least 3-mm sections; perform axial, sagittal, coronal T2-weighted FSE in deflation and inflation, axial T1- and T2-weighted FSE; axial T2-weighted fat-suppressed FSE, and T1-weighted fat-suppressed sequences before and after administering gadolinium-based contrast material with subtraction (25)

Note.—Numbers in parentheses indicate reference numbers. FSE = fast spin-echo, MIP = maximum intensity projection, 3D = three-dimensional.

*Appropriate preparation for imaging procedures will ensure an affirming patient encounter. For all protocols, introduce oneself and explain the procedure, using the patient's identified pronouns and referencing anatomic parts with sensitivity. When appropriate, invite patient participation and assistance with positioning of relevant anatomy and introduction of contrast material or dilatation devices. At all times, protect patient privacy and comfort with adequate draping.

†Sequence labels may vary by manufacturer.

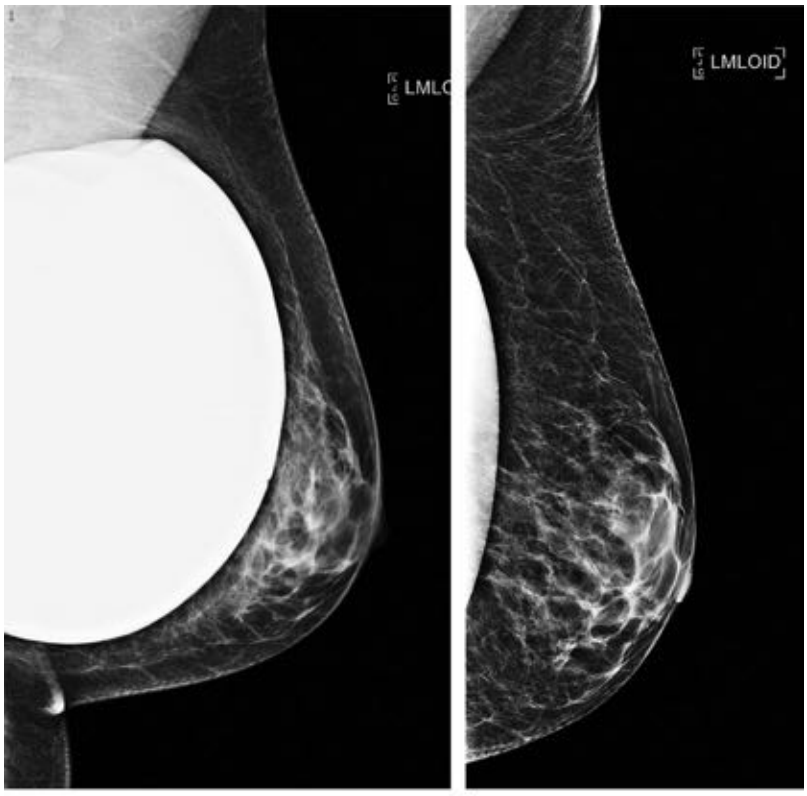

Figure 2. Breast implants at mammography in a 54-year-old transgender woman who underwent feminizing hormone therapy for 14 years and subsequent subglandular breast implant placement. Left mediolateral oblique mammograms show heterogeneously dense breast tissue, which can be better evaluated on the implant-displaced view **(b)**.

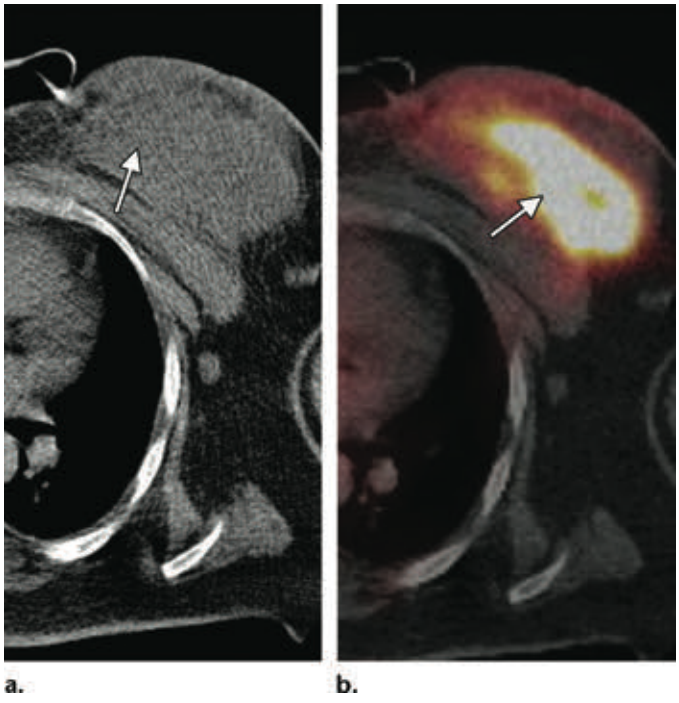

Figure 3. Plasmablastic lymphoma in a 43-year-old transgender woman who presented with left breast erythema 7 years after subglandular saline implant placement. **(a)** Axial CT image of the chest shows stranding (arrow) in the left breast. **(b)** Axial fused fluorodeoxyglucose (FDG) PET/CT image shows masslike FDG avidity (arrow) about the left implant. Suspected infection led to implant removal, and lymphoma was confirmed at surgical pathology.

United States either had undergone or desired to undergo orchiectomy, 12% had undergone vaginoplasty, while an additional 54% desired to undergo the procedure (7). Vaginoplasty is performed using one of four techniques: penoscrotal inversion (PIV), intestinal interposition, peritoneal vaginoplasty, or the use of skin grafts (42) (Fig 6).

Penoscrotal Inversion.—PIV is the most widely used and studied surgical technique for vaginoplasty. Orchiectomy, penile disassembly, shortening of the urethra, and repositioning are performed simultaneously (Fig 7b). The remaining penile, perineal, and scrotal skin is inverted and folded back to line a neovaginal tunnel created by blunt

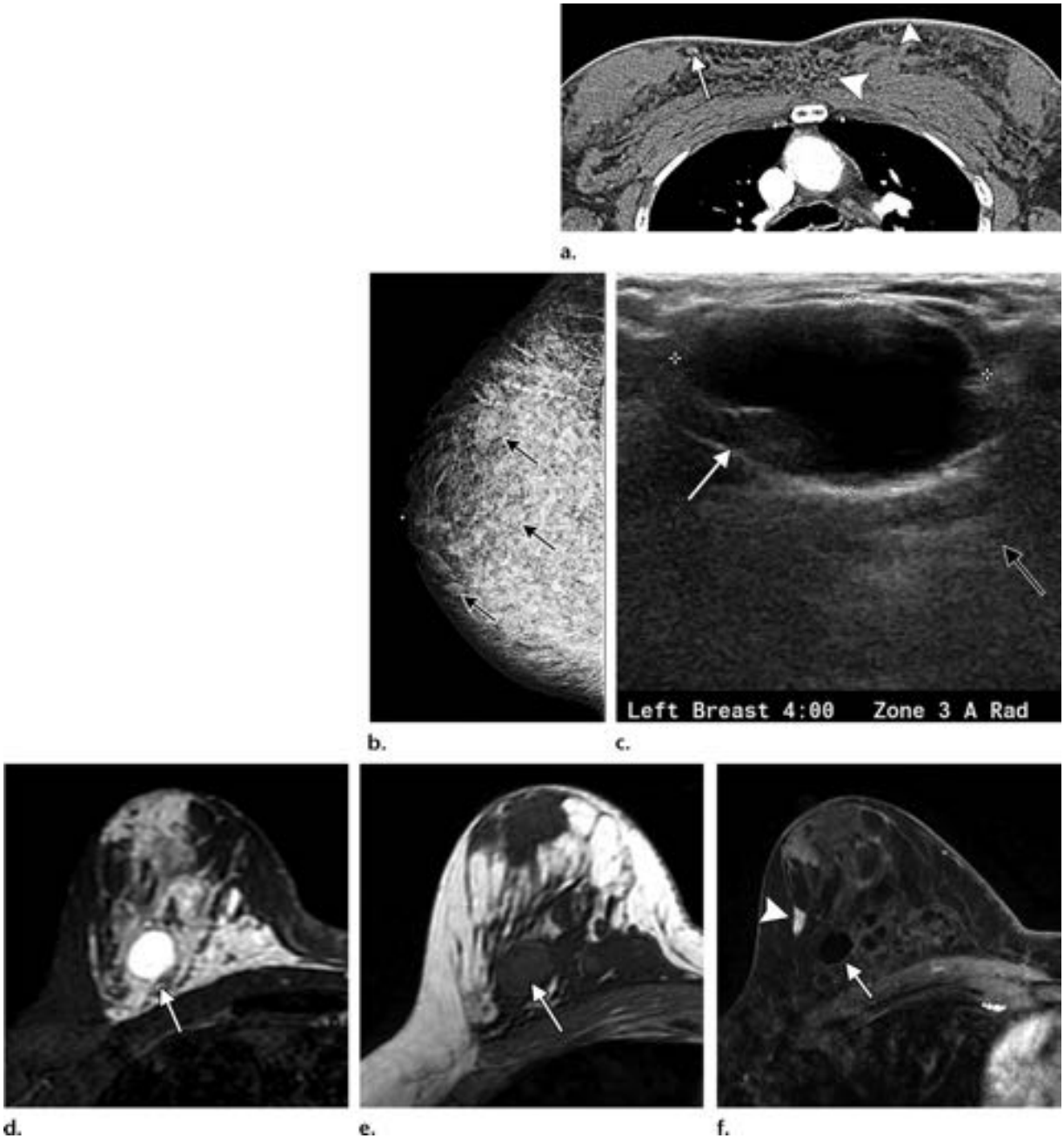

Figure 4. Silicone injections in three patients. **(a)** Axial contrast-enhanced chest CT image shows expected sequelae of bilateral breast augmentation with free silicone injections, including masses (arrow), skin and trabecular thickening (arrowheads), and architectural distortion. **(b)** Right craniocaudal mammogram in a 42-year-old transgender woman with free silicone injections shows architectural distortion, trabecular thickening, and dense masses (arrows). **(c)** US image of the left breast in the same patient as in **b** shows a complicated cyst with debris (white arrow). Adjacent tissues (black arrow) are echogenic and indistinct, with the "snowstorm" appearance associated with free-tissue silicone, which limits the evaluation of deep tissue. **(d)** Axial short τ inversion-recovery MR image shows parenchymal edema and a T2-hyperintense circumscribed silicone deposit (arrow) in a 48-year-old transgender woman with silicone injections. **(e, f)** Axial T1-weighted MR images in the same patient as in **d** without (**e**) and with (**f**) fat suppression and silicone suppression show loss of signal intensity within the silicone deposits (arrow). Gadolinium-based contrast material administration is necessary to detect enhancing lesions (arrowhead in **f**). The results of a biopsy confirmed active granuloma.

dissection of the perineum and retroprostatic space (42–47) (Figs 6a, 7b). The neovaginal flap may be sutured to the sacrospinous ligaments to prevent prolapse and improve neovaginal depth (48). A sensate neoclitoris is formed from a portion of the glans penis and preserved native dorsal penile neurovascular structures (Fig 7b, 7c). The labia majora are created from the remaining perineal and scrotal skin at the time of vaginoplasty or later after tissue healing has occurred (46). Considered the surgical standard, PIV has the lowest complication rate among vaginoplasty techniques and reliably achieves satisfactory technical, aesthetic, and functional outcomes (43,49).

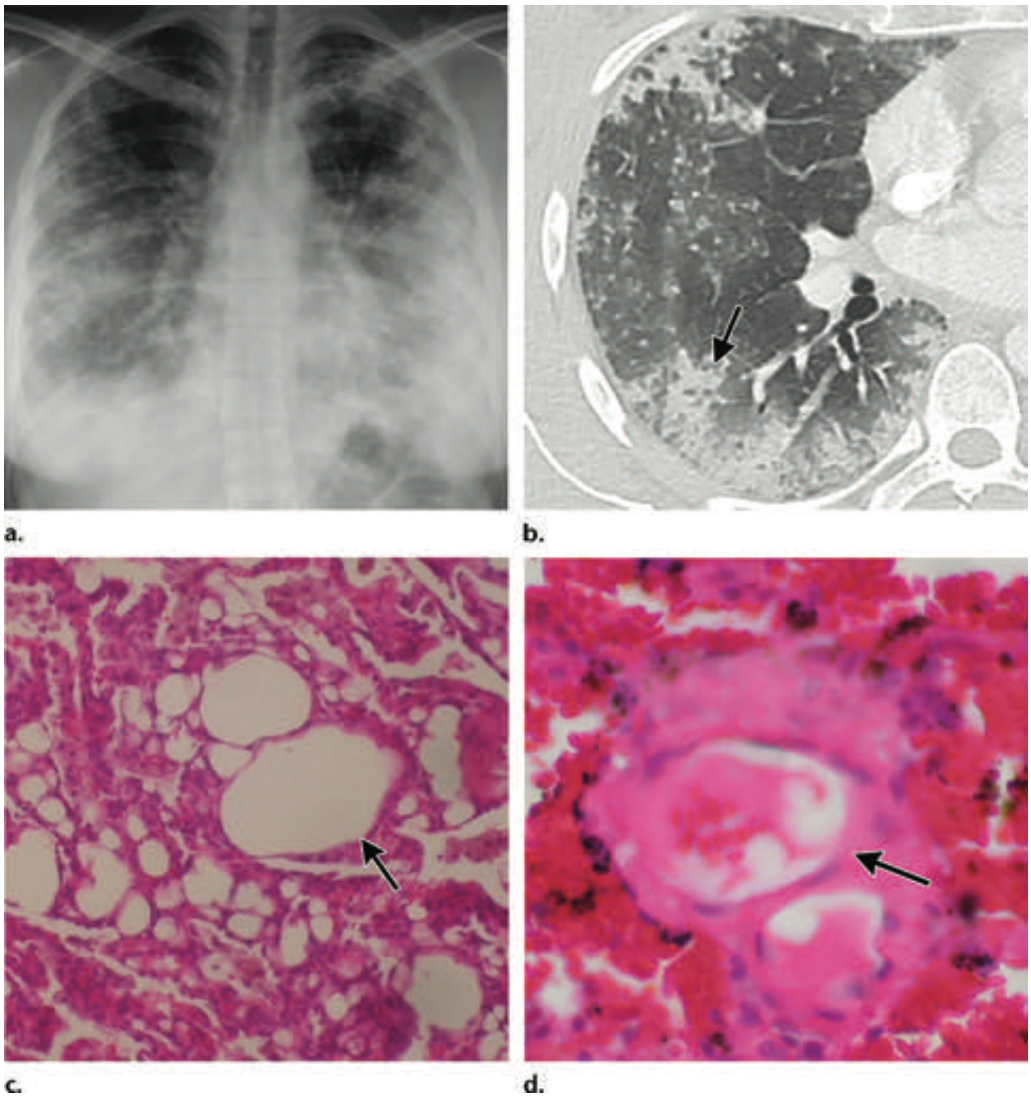

Figure 5. Silicone pulmonary emboli in a 24-year-old transgender woman after gluteal augmentation with free silicone injections. **(a)** Frontal chest radiograph shows extensive bilateral peripheral consolidations and interstitial markings. **(b)** Axial chest CT image (lung window) shows corresponding peripherally distributed ground-glass opacities and consolidations (arrow). **(c, d)** Postmortem photomicrographs show globular silicone deposits within pulmonary capillaries (arrow), surrounding pulmonary hemorrhage, and perialveolar inflammatory infiltrate. (Hematoxylin-eosin stains, original magnification ×40 and ×100, respectively.) (Case courtesy of Carlos S. Restrepo, MD, Department of Radiology, University of Texas Health Science Center, San Antonio, Tex.)

Intestinal Interposition.—In certain circumstances, a pedicled segment of rectosigmoid colon can be used to create a neovagina by coloperineal anastomosis (Fig 6b). Although intestinal interposition is both safe and efficacious, it is generally reserved as a second-line option to PIV or for revision vaginoplasty (50–52). Pedicled ileal segments also have been used, although less frequently than those of the sigmoid colon (42). Transgender women who underwent puberty-suppressing hormone therapy as children or adolescents may have underdeveloped genitalia and less penile and scrotal tissue available for grafting and may benefit from alternate techniques such as intestinal interposition or peritoneal vaginoplasty (43,50–53).

Skin Grafts.—Other vaginoplasty techniques such as the use of split- or full-thickness skin grafts and pudendal-thigh fasciocutaneous flaps have been described but are seldom performed today (43,45,47).

Imaging Features following Vaginoplasty

Imaging features of neovaginal anatomy are presented in Figure 8. In the immediate postoperative period, stranding may be depicted in the pelvic subcutaneous and deep fat. Packing material in the neovaginal cavity may appear as mottled soft-tissue attenuation with gas bubbles, mimicking an abscess (Fig 8a). In most settings, the neovagina is collapsed and difficult to fully evaluate at routine CT

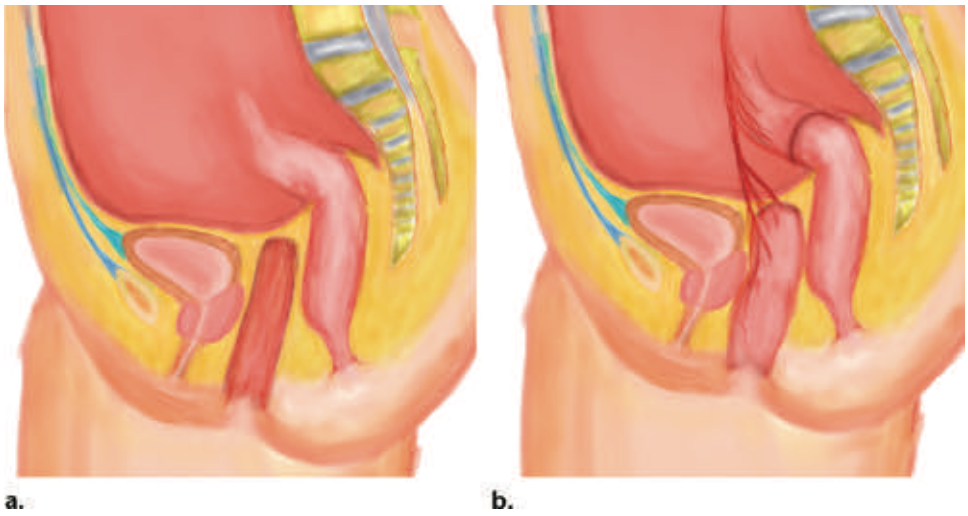

Figure 6. Vaginoplasty techniques. Illustrations show the sagittal view of PIV **(a)** and intestinal interposition **(b)** vaginoplasty techniques.

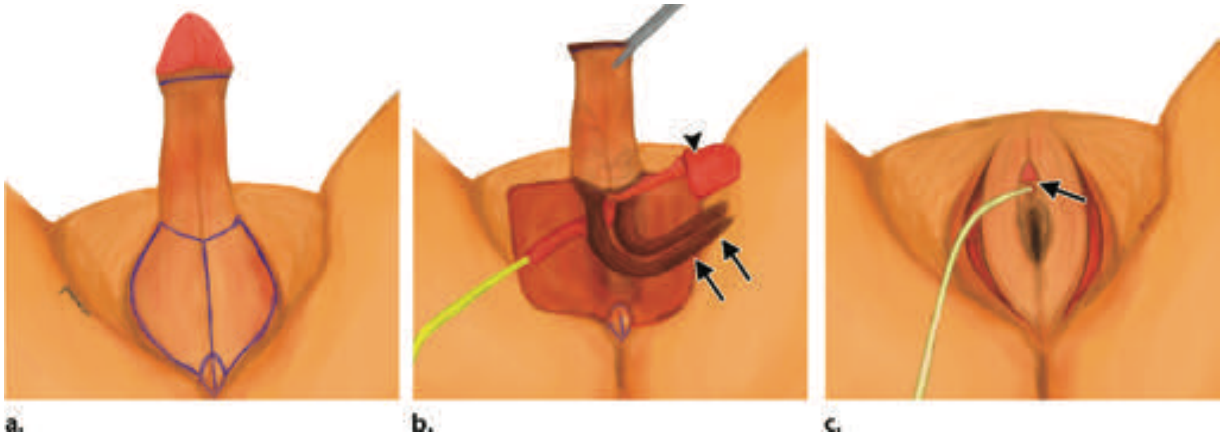

Figure 7. PIV vaginoplasty procedure. **(a)** Illustration shows the penis and scrotum, which are first marked at the planned incision sites (blue lines). **(b)** Illustration shows penile disassembly, which includes removal of the erectile tissues (corpora cavernosa recti and spongiosum) (arrows). The glans (arrowhead) is reduced in size while preserving the dorsal neurovascular bundle to create a sensate neoclitoris. **(c)** Illustration shows the urethra, which is shortened and positioned posterior to the neoclitoris (arrow). Skin from the penile shaft and scrotum, which remains after penile disassembly and orchiectomy, is inverted and folded back to line the neovaginal tunnel created by blunt dissection of the perineum and retroprostatic space.

(Fig 8b). If the clinical scenario dictates specific neovaginal evaluation, a commercially available silicone dilator instrument with a hollow bore can be used to distend the cavity and improve visualization (Figs 8c, 9c). Radiologic neoanthropometric parameters to be assessed at imaging include neovaginal depth, length of the inferior pelvic aperture and pelvic inlet, angle of the neovaginal axis, and thickness of the rectovaginal septum (21–24, 44,54) (Fig 9). A correlation was found between adequate neovaginal dimensions and the patient's overall happiness with the aesthetic results, sexual function, and improved quality of life after gender-affirming surgery (5,54). Radiologists should report these measurements for imaging performed after vaginoplasty.

Vaginal Depth

Obtaining adequate neovaginal depth is important for those patients who wish to have penetrative intercourse. Neovaginal depth of at least 7.9 cm is consistent with the average vaginal depth in patients assigned female sex at birth and is achievable if not exceeded in most patients using PIV (21–24,44,54). The amount of penile skin determines the ability of PIV to achieve adequate neovaginal depth. As such, patients with smaller penile lengths may undergo PIV with supplemental skin grafts (52).

Angle of Inclination

The angle of inclination affects neovaginal functionality and is determined by drawing intersecting reference lines on midsagittal images from the inferior aspect of the pubic symphysis to the tip of the coccyx and parallel to the neovaginal long axis (23) (Fig 9c). The vagina of patients assigned female sex at birth is obliquely inclined from anterior to posterior and inferior to superior, at angles of approximately 40° (range, 34°–44°) (23). A normal angle of inclination has been

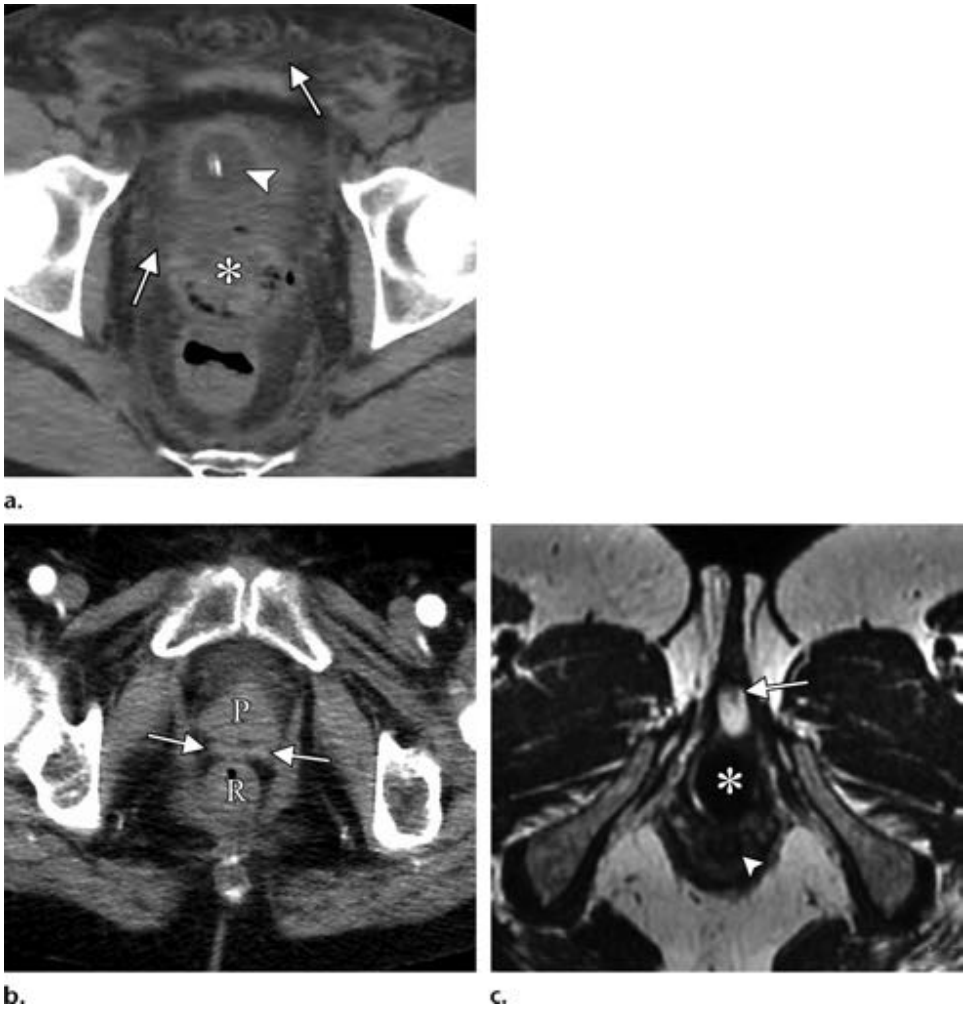

Figure 8. Normal imaging appearance of neovaginal anatomy following PIV in three patients. **(a)** Axial CT image in a febrile 42-year-old transgender woman 5 days after PIV shows expected early postoperative features of pelvic soft tissue and fat stranding (arrows). A catheter (arrowhead) is in the bladder. Mottled soft-tissue attenuation and air in the retrovesicle space represent packing material in the neovagina (*), not to be confused with abscess. **(b)** Axial CT image in a 66-year-old transgender woman shows the normal neoanatomic orientation of the prostate *(P)*, rectum *(R)*, and decompressed neovagina (arrows). **(c)** Axial T2-weighted MR image in a 40-year-old transgender woman shows the neovagina containing a dilator instrument (*), positioned between the urethra (arrow) and anus (arrowhead). Note the T2-hyperintense remnants of the corpora spongiosum about the urethra.

defined as 54° (range, 30°–70°), slightly greater than that of cisgender women (23).

Thickness of the Rectovaginal Septum

Neovaginal depth and width result from wide blunt dissection of the retroprostatic and anterior rectal space (22). Overzealous dissection of this space may lead to violation of the anterior rectal wall, while inadequate dissection may result in suboptimal neovaginal inclination (22,23,45,54,55). Rectovaginal septal thickness should be at least 3–4 mm, readily measured on midsagittal MR images (23) (Fig 9d).

Complications of Vaginoplasty

Vaginoplasty complications may be immediate or may manifest within the early (days to weeks) or late (months to years) postoperative period (Table 4) (42,46,52). These may be divided into wound-related, genitourinary, and gastrointestinal events. While many complications are recognized at physical examination, imaging may be used to further delineate their extent.

Common wound-related complications include postoperative bleeding, hematoma, and infection, all of which may be characterized at imaging or treated with imaging-guided procedures. The most common source of bleeding is residual periurethral erectile tissue (42,46), while wound infections are more common in patients with diabetes (46). US is typically the first-line imaging modality used in the evaluation of postoperative hematomas, seromas, or abscesses and may facilitate imaging-guided drainage (Fig 10d). Contrast-enhanced CT

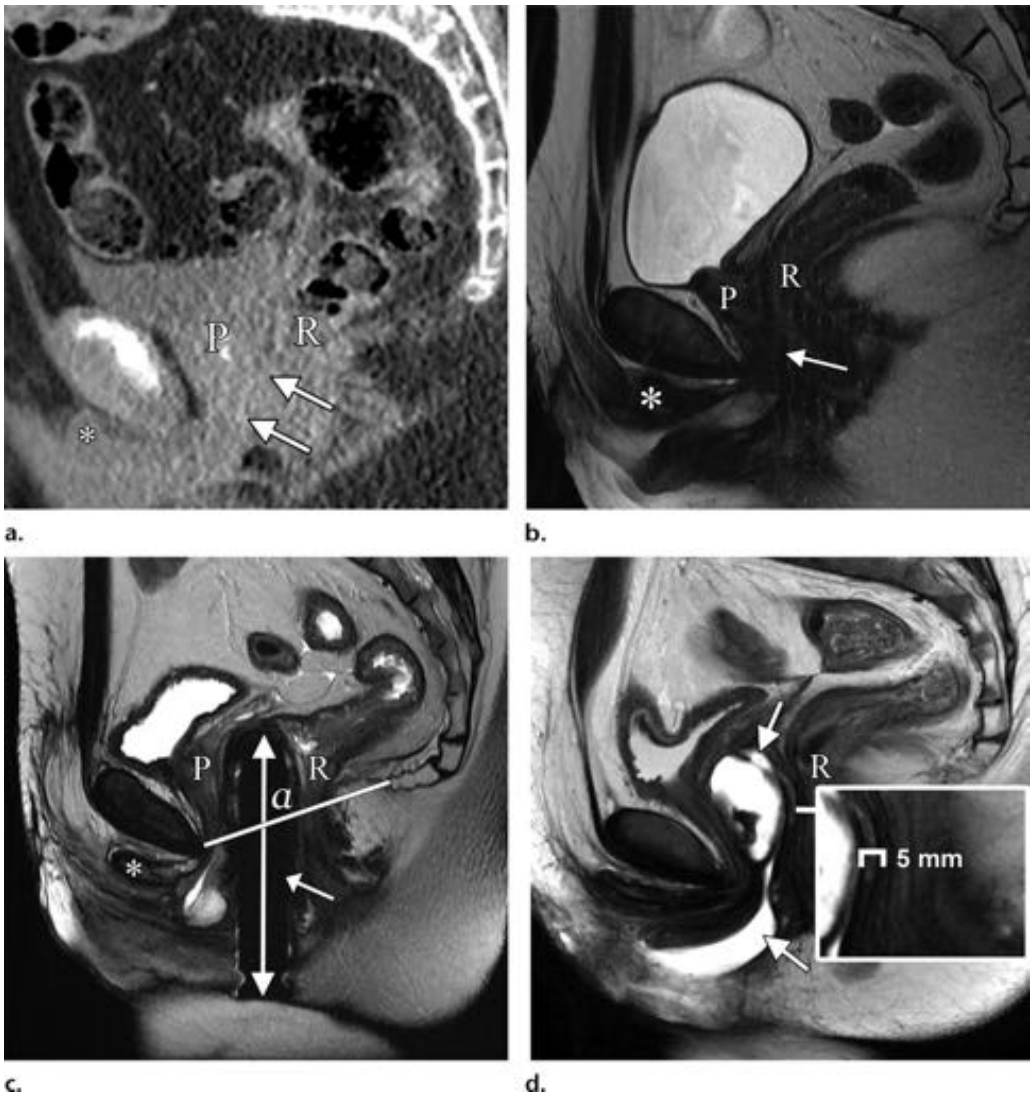

Figure 9. Imaging evaluation after PIV. *R* = rectum. **(a)** Sagittal CT image shows a poorly characterized decompressed neovagina (arrows). In **a–c**, *P* = prostate, ∗ = neoclitoris and dorsal penile neurovascular bundle. **(b, c)** Sagittal T2-weighted MR images in a 43-year-old transgender woman **(b)** and a 40-year-old transgender woman **(c)** show the superior tissue contrast resolution of MRI over CT, which improves evaluation of the neovagina (arrow in **b**) and surrounding anatomy. A neovaginal tutor (arrow in **c**) distends the cavity for better characterization, and normal neovaginal anthropomorphic measurements are depicted, including length (double-headed arrow in **c**) and angle of inclination (*a;* straight line in **c**) (range, 30°–70°). **(d)** Sagittal MR image shows water-soluble gel (arrows), which may be used to distend the neovagina, particularly when evaluating for fistulas. Note the thickness of the rectovaginal septum (bracket in inset). Neovaginal anthropomorphic measurements have implications for surgical outcomes and patient satisfaction.

and MRI may also characterize these fluid collections, with the added ability to evaluate potential involvement of deeper pelvic spaces.

Urethral stenosis and urinary retention are common short-term complications of vaginoplasty (56). Most cases are self-limited and improve as local tissue swelling decreases. However, some patients may require intermittent dilatation or urethral meatotomy (44). Complete resection of the corpora cavernosa recti during penile disassembly will prevent physiologic engorgement of these tissues during sexual arousal, which can lead to neourethral narrowing and acute urinary retention (22,23,46,51,57, 58).

When residual erectile tissue is found, patients may require re-excision. Residual erectile tissue manifests as enhancing tissue around the urethra on contrast-enhanced CT images and hyperintense tissue on T2-weighted MR images (42–45) (Fig 11). Radiologists should report the presence or absence of residual erectile tissue, as this may indicate the need for reoperation in the correct clinical setting.

Neovaginal and introital stenosis are the most common late complications of vaginoplasty, although they are usually diagnosed clinically (Fig 12a, 12b) (Table 4). Rectal injury was reported in up to 4.5% of patients following PIV (42). Most

Table 4: Relative Frequency of Vaginoplasty Complications by Technique

Time of Occurence	Type of Complication	Technique (%)		
		Penoscrotal Inversion	Intestinal Vaginoplasty	Nongenital Skin Grafts
Intraoperative	Rectal injury	1.1–4.5	…	…
	Urethral or bladder injury	4	0	…
Short-term postoperative (days to weeks following procedure)	Hematoma or bleeding	1.7–10.1	1–33	0–36
	Wound infection and/or abscess	4.8–16.8	0–9	0–9
	Flap dehiscence and/or necrosis	6.7–33	0	0–45
	Urethral stenosis and/or urinary retention	1.1–40	1	0–6
Long-term postoperative (months to years following procedure)	Neovaginal shrinkage and/or stenosis	1.2–22	3–18	0–100*
	Introital stenosis	2.5–41	1.2–75	…
	Rectoneovaginal fistula	0.8–17	3–8	0–18
	Urethroneovaginal fistula	0.8–3.9	…	0–18
	Neoclitoral or urethral necrosis	1.3–10	…	…
	Neovaginal prolapse	0.3–6.0	0–8	0–18
	Residual corpora tissue	8–15	…	…

Sources.—References 42–46,49–52,55–57.
Note.—Rare complications include deep venous thrombosis (DVT), pulmonary emboli, stroke, rectocele, compartment syndrome, and peroneal nerve paralysis. Cosmetic problems that require reoperation include excessive labial skin and neoclitoral oversize.
*Occurred in three of three patients who underwent split-thickness skin grafts alone.

instances of rectal injury were recognized intraoperatively and treated with primary closure, but they can predispose the patient to rectoneovaginal fistulas (42,46). Fistulas after primary vaginoplasty are uncommon, but the risk increases in patients who require revision (59). Most patients with rectoneovaginal fistulas present with symptoms of neovaginal flatus or fecal discharge. While some rectoneovaginal fistulas may be treated conservatively (45,60), others may require treatment with fistulectomy or diversion colostomy (42,45,46).

Historically, fistulas have been diagnosed at fluoroscopy. However, this technique alone fails to delineate the surrounding anatomy and secondary findings such as abscesses, and it may be considered invasive and unacceptable by the patient (59). CT and MRI fistulography with intracavitary contrast material offer more diagnostic information in the workup of neovaginal fistulas and facilitate surgical planning before reoperation (24,59–61) (Fig 12c). With its superior contrast resolution, avoidance of ionizing radiation, and clear depiction of fistulas and abscesses, MRI may become the first-line imaging modality for evaluation of pelvic complications following vaginoplasty.

Neovaginal prolapse can be generally diagnosed at clinical examination. Surgical fixation of the neovaginal tube to the sacrospinous ligaments or fascial planes anterior and posterior to the neovaginal cavity may prevent this complication (48,62,63). Rarely, damage to the urethra during vaginoplasty may lead to urethroneovaginal fistulas, which may be diagnosed with fluoroscopic or CT cystourethrography and MRI (24,42,46,59).

Protocol for Imaging Complications

Cross-sectional imaging is the preferred imaging modality for evaluation after vaginoplasty, with MRI providing superior soft-tissue contrast resolution for detailed assessment of pelvic neoanatomy (Table 3) (21–24). Imaging protocols should include the use of a dilator instrument to distend the neovagina. The use of intracavitary water-soluble iodinated contrast material at CT or water-based gel at MRI may assist in the distention of the neovagina and evaluation of fistulas (21,23). Sagittal dynamic pelvic MRI using pelvic squeeze and Valsalva maneuvers may be considered for evaluation of prolapse (24,25).

Perioperative Thrombosis

Thrombogenic events such as deep venous thrombosis (DVT) and pulmonary embolism reported in transgender patients undergoing

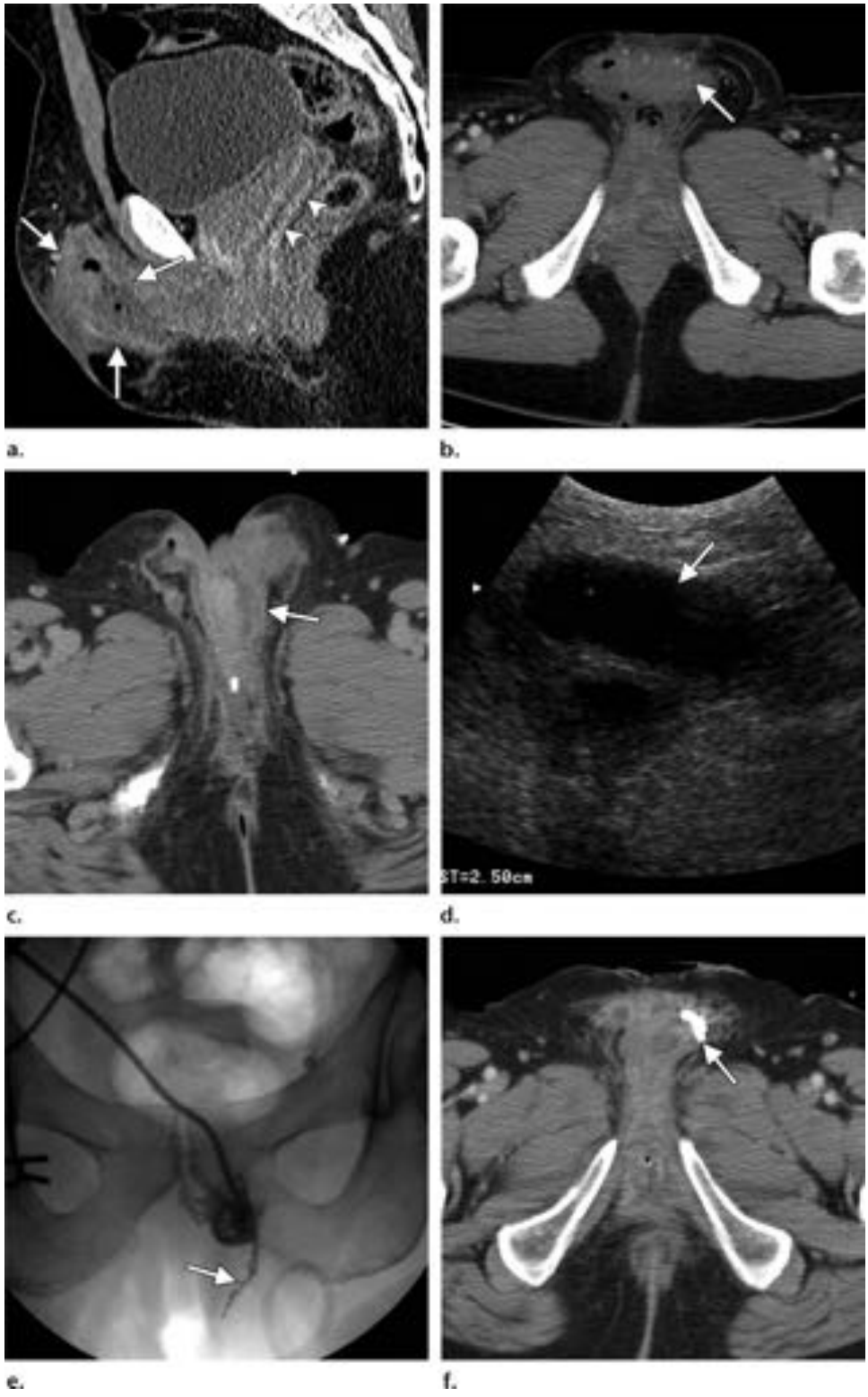

Figure 10. Postoperative abscess in two patients. **(a, b)** Sagittal **(a)** and axial **(b)** contrast-enhanced CT images in a 39-year-old transgender woman, who presented with fever and pain 3 weeks after PIV performed at an outside institution, show a rim-enhancing fluid and air collection (arrows) in the mons veneris, which extends to the neovaginal cavity. Note the normal enhancement of the collapsed neovagina (arrowheads in **a**). **(c)** Axial contrast-enhanced CT image shows a neolabial sinus tract (arrow) in a 63-year-old transgender woman who presented with purulent neovaginal discharge and perineal pain 3 weeks after PIV. **(d)** US image in the same patient as in **c** shows a mildly complicated fluid collection (arrow) surrounded by echogenic inflamed tissue. **(e)** Abscessogram in the same patient, performed to better delineate the suspected neolabial sinus tract (arrow), demonstrates this finding. **(f)** Axial contrast-enhanced CT image shows that a drain (arrow) was left in place.

a.

b.

c.

Figure 11. Residual erectile tissue. **(a)** Coronal contrast-enhanced CT image in a 63-year-old transgender woman shows enhancement of residual corpora cavernosa recti (arrow). **(b)** Coronal T2-weighted MR image in a 32-year-old transgender woman, who presented with symptoms of urinary retention 2 months after vaginoplasty, shows an area of hyperintense signal about the urethra, a finding compatible with residual corpora cavernosa recti and spongiosa tissue (arrows), which may have contributed to her symptoms. **(c)** Sagittal T2-weighted MR image in a 40-year-old transgender woman shows residual erectile tissue (arrow) depicted as an area of high signal intensity near the urethra. When engorged, residual erectile tissue may cause unpleasant symptoms or urethral stenosis or serve as a source of bleeding.

gender-affirming hormone therapy have called into question the risks of continuing hormone therapy during surgery (46). Most reports have been associated with oral estrogen use in doses and formulations not currently standard for gender affirmation, and current evidence suggests that routine discontinuation of gender-affirming hormone therapy before surgery is unnecessary (64). In fact, the risks of discontinuing hormone therapy for many transgender patients (emotional lability, depression, perimenopausal symptoms) may outweigh the low likelihood of developing thrombogenesis. Nonetheless, suspected DVT and pulmonary embolism can be diagnosed at duplex color Doppler venous US and CT pulmonary angiography or ventilation-perfusion scintigraphy, respectively.

Masculinizing Chest Surgery

Masculinizing chest surgery is often the first and only gender-affirming surgery sought by transgender men, and 97% of this population surveyed either have undergone or desire to undergo the procedure (7). Unlike the standards of care guidelines for genital surgery, transgender men are not required to undergo hormone therapy or a year of living in one's gender role that is consistent with one's gender identity before undergoing chest masculinization surgery (3). The goal is to achieve a male chest appearance by removing breast tissue, excess skin, and the inframammary fold and create properly sized and positioned nipples (7,65) (Fig 13).

Surgical techniques for chest masculinization include variations on subcutaneous or skin-sparing mastectomy, and choosing which to perform is determined on the basis of the qualities of the native breast tissue and nipple-areola complex (NAC) (66). Complications are comparable to those found in cisgender women who undergo mastectomy and include hematoma, seroma, abscess, and nipple necrosis (66). Hematoma evacuation is required in 6% of cases, while secondary surgeries to revise scars, contours, or the NAC are required in 27% of cases (67). Imaging modalities such as US are useful for detecting these complications and directing image-guided interventions (17) (Fig 14).

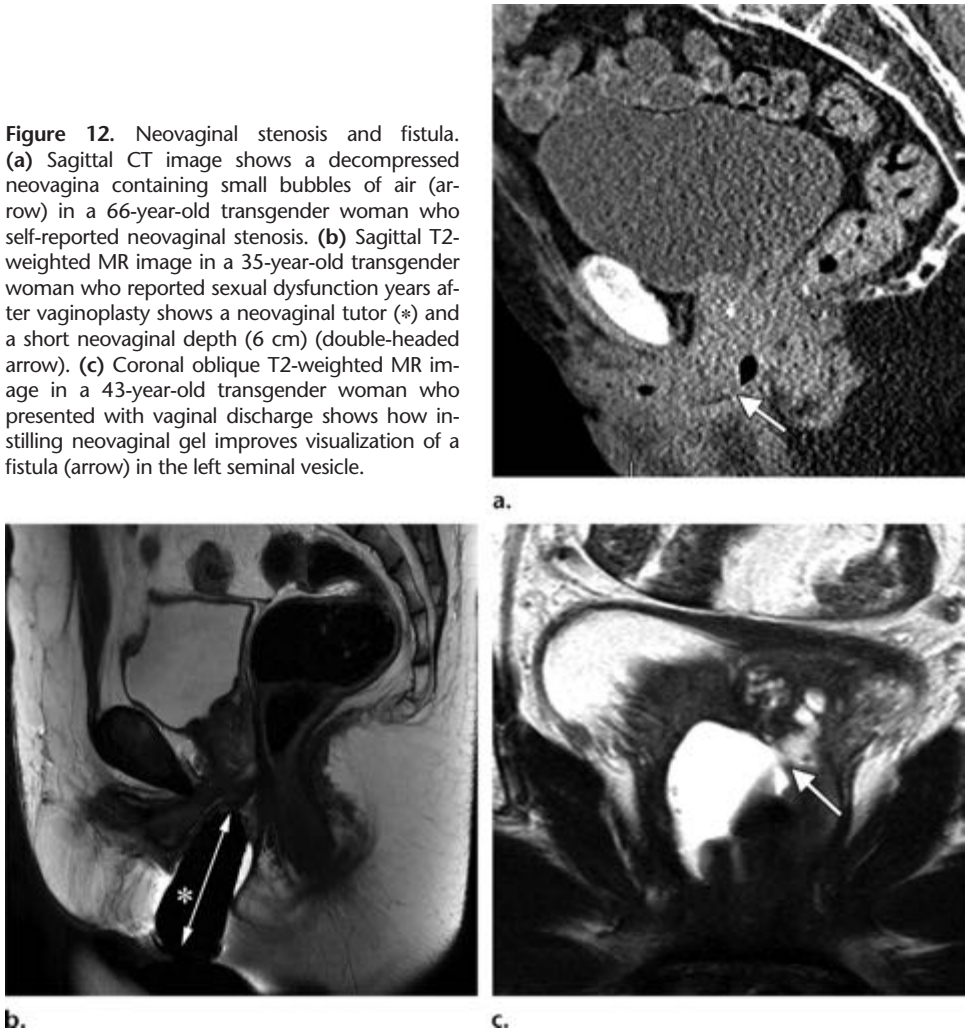

Figure 12. Neovaginal stenosis and fistula. **(a)** Sagittal CT image shows a decompressed neovagina containing small bubbles of air (arrow) in a 66-year-old transgender woman who self-reported neovaginal stenosis. **(b)** Sagittal T2-weighted MR image in a 35-year-old transgender woman who reported sexual dysfunction years after vaginoplasty shows a neovaginal tutor (*) and a short neovaginal depth (6 cm) (double-headed arrow). **(c)** Coronal oblique T2-weighted MR image in a 43-year-old transgender woman who presented with vaginal discharge shows how instilling neovaginal gel improves visualization of a fistula (arrow) in the left seminal vesicle.

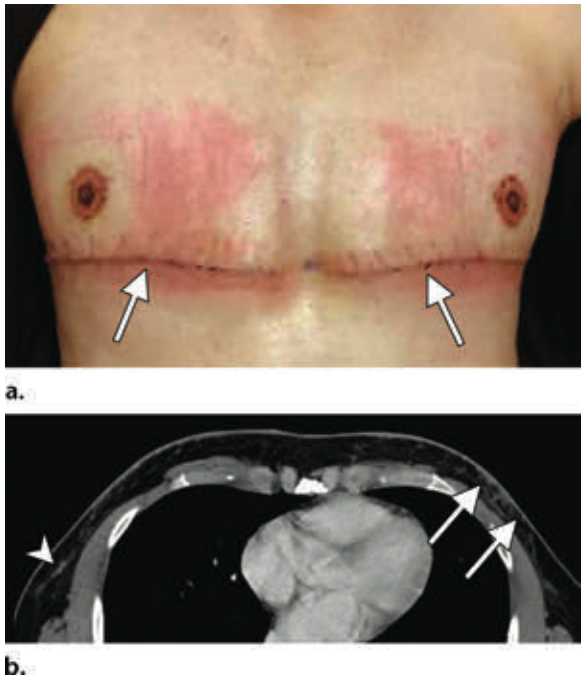

Figure 13. Masculinizing chest surgery with free nipple graft technique. **(a)** Clinical photograph of a 32-year-old transgender man shows the expected appearance of the chest wall 2 weeks after subcutaneous mastectomy with free nipple graft. Transverse scars represent the double incision used to remove the inframammary fold (arrows). **(b)** Axial contrast-enhanced CT image in a 35-year-old transgender man shows a linear scar and distortion (arrows) along the primary incision, which extends to the midaxillary line. Breast tissue (arrowhead) might be spared to allow aesthetic contouring and may remain at risk for neoplasia.

Masculinizing Genital Surgeries

There are a number of genital surgeries that transgender men can undergo, including hysterectomy, oophorectomy, vaginectomy, phalloplasty, metoidioplasty, and scrotoplasty (65) (Table 2). Procedures are generally staged, with hysterectomy (with or without oophorectomy) performed several months before phallic constructive procedures (vaginectomy, phalloplasty, metoidioplasty, and scrotoplasty). Single-stage surgical approaches can place patients at risk for prolonged operative times and increased blood

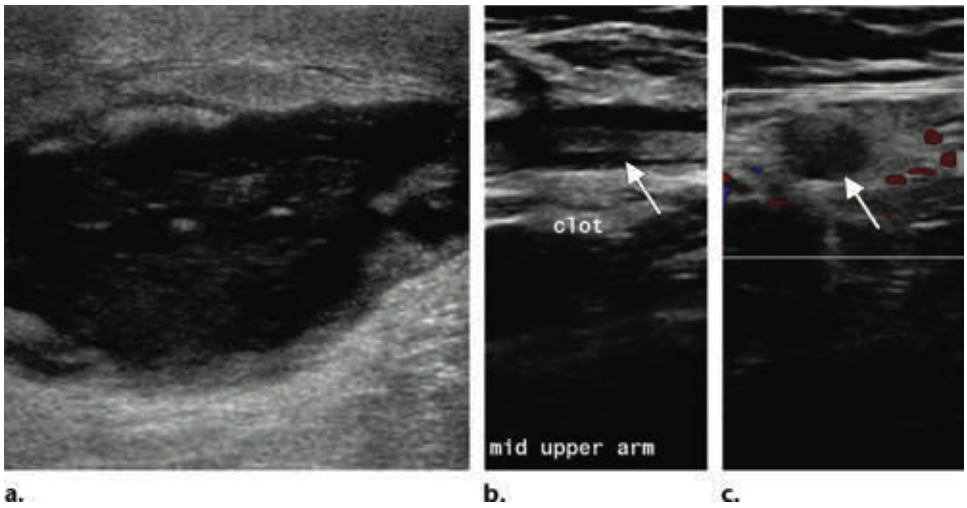

Figure 14. Complications of masculinizing chest surgery. **(a)** US image in a 48-year-old transgender man after subcutaneous mastectomy shows an abscess in residual breast tissue. (Figure 14a reprinted, with permission, from reference 17.) **(b, c)** Gray-scale **(b)** and color Doppler **(c)** US images show no DVT in a 25-year-old transgender man who reported redness and swelling in the chest and left arm during a postoperative follow-up visit for drain removal 6 days following chest masculinization surgery and liposuction. The superficial basilic and cephalic veins (arrow) were thrombosed.

loss (65,66,68). Currently, a low percentage of transgender men undergo these procedures. Of 7950 transgender men surveyed, only 14% had undergone hysterectomy, 3% had undergone phalloplasty, and 2% had undergone metoidioplasty (7). However, a much larger percentage of transgender men desire to undergo surgery, with 57% indicating a desire to undergo hysterectomy, 25% to undergo metoidioplasty, and 19% to undergo phalloplasty (7). Therefore, these procedures will likely become more common as surgical availability, technical expertise, and insurance coverage expand.

Hysterectomy

Hysterectomy is the second most common gender-affirming surgery performed in transgender men after chest masculinization surgery (7). Historically, abdominal or vaginal approaches were used, but new data favor laparoscopic or robot-assisted approaches owing to lower rates of perioperative complications (69–72). Laparoscopic techniques help preserve the inferior epigastric vessels, minimize abdominal scarring, shorten length of stay, and expedite rehabilitation (69). Complications of laparoscopic hysterectomy include bladder perforation, hematoma, infection, and vaginal cuff dehiscence.

Imaging features immediately after laparoscopic hysterectomy include small-volume pneumoperitoneum or soft-tissue air at the site of trocar placement, which should resolve within 7 days (Fig 15a). Contrast-enhanced CT or targeted US may be required to assess for wound-related infection (Fig 15b). If vaginectomy (ie, the removal of the vaginal mucosal lining and canal closure) is not performed, the vaginal cuff may appear as collapsed enhancing soft tissue posterior to the bladder (Fig 15a).

Phalloplasty

Phalloplasty is the most complex gender-affirming surgery and requires a multidisciplinary team that may include a gynecologist, urologist, vascular surgeon, and plastic surgeon. The two main options for neophallus creation include phalloplasty and metoidioplasty (6,47,51,65,66,73–76). The goal is creation of an aesthetically acceptable and functional neophallus. The patient's goals might include the ability to urinate while standing, maintain tactile and erogenous sensation, and participate in penetrative sexual intercourse (6,10,65). Vaginectomy and urethroplasty (ie, the use of vascularized vaginal mucosa to bridge the native and neourethral anastomosis) are typically performed concurrently.

Several local-regional and free-flap techniques have been explored for phalloplasty, including the use of abdominal wall, anterolateral thigh, gracilis muscle, fibular, latissimus dorsi muscle, and groin flaps (6,47,65,76). Most of these techniques have been abandoned owing to poor outcomes (76). However, some may still be performed depending on patient preference and surgeon skill. Despite frequent complications, patients still report high rates of satisfaction with the appearance and function after phalloplasty (6,76).

Radial Forearm Free Flap.—With the use of advanced microsurgical techniques, the use of a

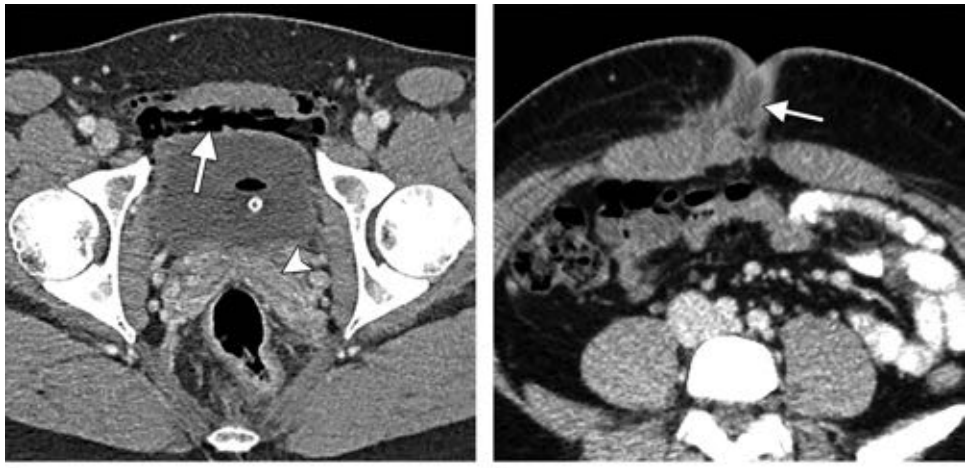

Figure 15. Imaging findings after laparoscopic hysterectomy and oophorectomy. **(a)** Axial contrast-enhanced CT image shows the expected appearance of the pneumoperitoneum (arrow) in a 36-year-old transgender man who reported worsening abdominal pain immediately after laparoscopic oophorectomy. Note the normal enhancement of the remaining collapsed vaginal cuff (arrowhead). **(b)** Axial contrast-enhanced CT image in a 24-year-old transgender man with fever and pain 1 week after laparoscopic hysterectomy shows a periumbilical abscess (arrow) at the site of the port placement.

radial (or ulnar) forearm free flap (RFFF) has emerged as the preferred technique for neophallus creation. The tube-in-tube reconstruction results in the creation of a skin-lined neourethral inner tube and outer neophallus in a single flap (6,65,76) (Fig 16). The medial and lateral antebrachial nerves are coapted to the ilioinguinal, dorsal clitoral, or deep pudendal nerves to achieve both tactile and erogenous sensation. The use of an RFFF fulfills most surgical goals of phalloplasty by producing a competent neophallus, which permits upright micturition and erogenous sensation. The main disadvantage of the RFFF is donor-site morbidity. The use of full- or split-thickness skin grafts is necessary to reconstruct the forearm skin, resulting in unsightly or stigmatizing scarring (77).

Anterolateral Thigh Flap.—Pedicled (or free) ALT flap phalloplasty incorporates tissue from the thigh that is shaped into a tube-in-tube configuration, with the inner tube becoming the neourethral conduit and the outer tissue becoming the neophallus (Fig 16). The lateral or medial femoral cutaneous nerves are coapted to the dorsal clitoral nerve to provide erogenous sensation to the graft (6,65,76). More than half of patients who have undergone ALT flap phalloplasty can micturate in the standing position and engage in penetrative sexual intercourse (65).

CT angiography may be used in the preoperative evaluation of perforating arteries and flap size before surgery (Table 3) (27). A Cartesian coordinate system is created using the anterior superior iliac spine and lateral patella as cranial and caudal reference points. Perforating arteries arising from the femoral vessels pierce the fascia and pass through deep tissues to the skin and subcutaneous tissues. Preference is given to broad perforators with mediolateral and craniocaudal branching patterns (27). Postoperative CT features of ALT flap phalloplasty include surgical clips about the femoral vessels and enhancement of the neophallus vasculature (Fig 17).

Abdominal Flap.—Abdominal flap phalloplasty uses a pedicled section of the lower anterior abdominal wall skin, fat, and vasculature, which is tubularized and positioned over the native clitoris (6,65,76) (Fig 18). The abdominal flap procedure can be combined with urethroplasty. This technique results in less donor-site scarring but also often creates a less aesthetic and less functional neophallus. This technique has been largely abandoned over time owing to high complication rates, the inability to innervate the graft, and overall unsatisfactory achievement of standing urination and penetrative sexual intercourse (6,76). Imaging features include a fat-attenuating neophallus representing the tubularized abdominal subcutaneous fat with arterial supply through inferior epigastric or circumflex iliac arteries (Fig 18c).

Other Techniques.—Latissimus dorsi free flaps comprise a functional musculocutaneous transfer of skeletal muscle and its accompanying thoracodorsal neurovascular bundle, allowing for patient-controlled contraction of the neophallus (6,65,77). This is combined with a staged urethral reconstruction. Most patients are able

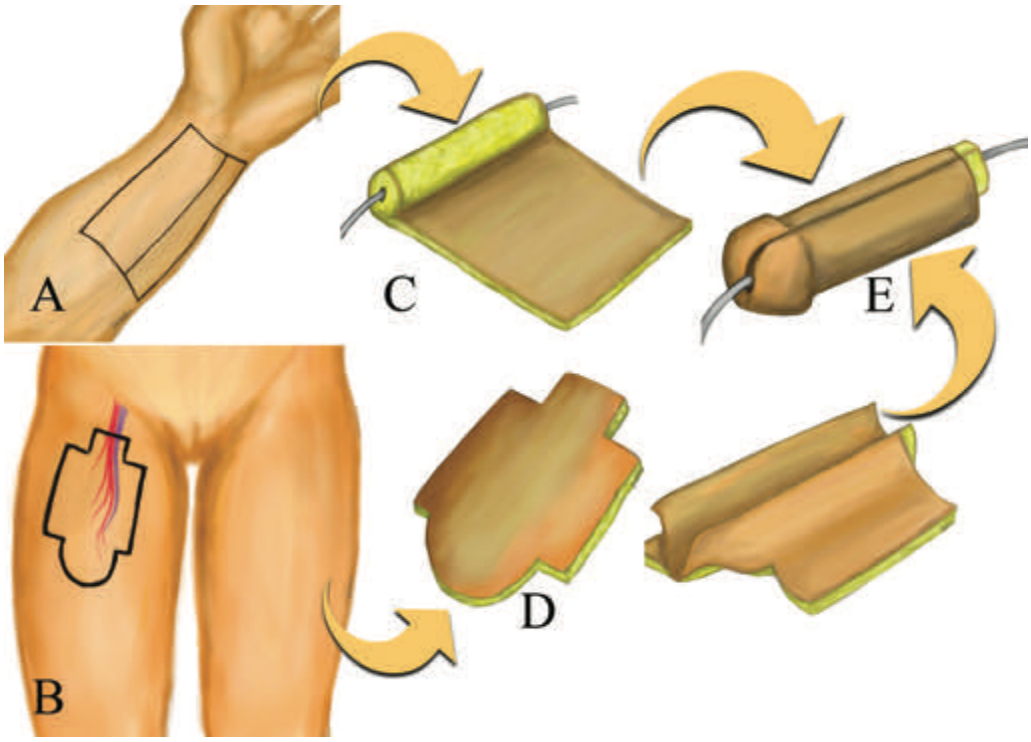

Figure 16. Illustration shows the techniques used for free and pedicled flap phalloplasty. RFFF phalloplasty *(A)* uses ventral forearm skin, radial artery branches, and antebrachial cutaneous nerves to create a flap. Anterolateral thigh (ATL) flap phalloplasty *(B)* uses skin and subcutaneous tissue from the thigh, including the femoral artery branches and femoral cutaneous nerves, to create a flap. The RFFF *(C)* and ATL flap (D) are each rolled around a catheter to create a skin-lined neourethra *(E)* through a tube-in-tube design. Tactile and erogenous sensations are achieved through coaption of the retained donor site nerves to the dorsal clitoral nerve.

Figure 17. Mature ALT phalloplasty. **(a)** Axial CT angiogram obtained in the arterial phase 1 year after ALT phalloplasty shows vascular clips (arrows) along the femoral venous outflow pedicle. **(b)** Axial CT angiogram shows normal arterial enhancement within the neophallus (arrow). Note the neoscrotal skin thickening (arrowhead), which is an expected finding and represents scar. CT angiography and Doppler US are performed preoperatively to delineate the adequacy of the native vasculature for pedicle creation and postoperatively for assessing vascular compromise.

to micturate through the neourethra, but only 15% can perform penetrative sexual intercourse (65). Osteocutaneous free flap techniques using segments of the fibula, radius, and iliac crest have also been explored to give the neophallus rigidity for sexual intercourse without the need for a prosthesis. However, the modern RFFF phalloplasty procedure has abandoned the incorporation of radial bone owing to high rates of fracture and urethral complications (26,76).

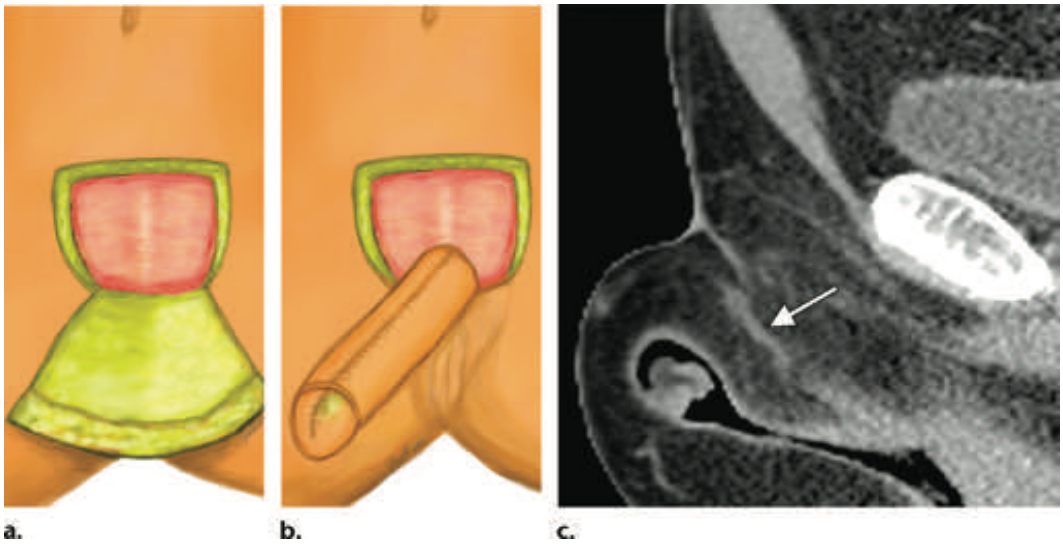

Figure 18. **(a, b)** Illustrations show the abdominal (suprapubic) flap phalloplasty, which uses tubularized abdominal skin and subcutaneous fat tissue (yellow area in **a**) to create the neophallus **(b)**. **(c)** Sagittal pelvic CT image shows the normal CT appearance following an abdominal phalloplasty. Fat tissue within the neophallus has an equivalent attenuation to that of the donor abdominal wall. The flap vascular supply is from the right inferior epigastric artery (arrow).

Phalloplasty Complications

Phalloplasty is a complex procedure with high complication rates, which often requires additional corrective surgery (Table 5). In the early postoperative period, most complications are flap-related. Vascular insufficiency is a feared early complication, requiring frequent monitoring of flap perfusion using commercially available optical oxygenation meters and with color Doppler US, as necessary (26). Hematoma and infection also can be encountered in the first days to weeks after surgery (Fig 19). Long-term complications most commonly affect the neourethra and include strictures, fistulas, or anastomotic dehiscence (28,73). A higher incidence of urethral dehiscence and fistulas occur in those patients who do not undergo simultaneous vaginectomy, as less tissue is available to cover the proximal anastomosis (73).

Retrograde or voiding urethrography are the standard imaging modalities for assessment of the urethra following phalloplasty. The normal appearance of the native, midportion, and phalloplasty or pendulous urethra are depicted in Figure 20. The midportion of the urethra may have an irregular shape and slightly wider caliber than that of a native or pendulous portion of the urethra, as the midportion urethra is formed from mucosal flaps. Strictures are diagnosed at urethrography as focal neourethral narrowing, most often at the pendulous urethra–midportion urethra or midportion urethra–native urethra anastomoses owing to tenuous blood supply in these areas. Fistulas and leaks manifest on urethrograms as extravasated contrast material with connections to the surrounding anatomy or skin (Fig 21). Neourethral strictures may also be assessed at US by using saline solution to distend the urethra (78).

Metoidioplasty

Metoidioplasty is an alternate technique to phalloplasty in which the neophallus is created from a hormonally hypertrophied clitoris (6,47,73,76). The native urethra is lengthened and anastomosed to the clitoris, which serves as the glans. The urethra is lengthened by division of the clitoral suspensory ligaments at the urethral plate and reconstructed with vaginal mucosal and labia minora flaps (73). Additional skin is harvested from the labia minora to construct the shaft of the neophallus. Metoidioplasty represents a viable technique for the creation of a neophallus for patients in which the RFFF technique is not feasible or when excessive scarring of the flap donor site is unacceptable. The neophallus length achievable with this technique is less than that of flap-based procedures, which may prevent the ability to engage in sexual intercourse (65). However, most patients can satisfactorily micturate while standing, can achieve an erection, and report high overall satisfaction with their neophallus (6).

Complications from metoidioplasty are less common and less severe than those of other phalloplasty techniques. The most common complications are urethral stricture and fistulas (6,65,76). Older techniques did not routinely include vaginectomy, leaving the partially closed remnant vaginal cavity to drain through a mucous fistula to the perineal skin. This predisposes the patient to fistula development between the neourethra and native vagina.

Table 5: Relative Frequencies of Phalloplasty Complications by Technique

Category	Complication Type	Free and Pedicled Flaps (%)							Metoidioplasty (%)
		RFFF	Fibula	LD	Abd	ALT	Gracilis	Groin	
Urethral	Fistula	26.6	5.4	13.2	21.8	22.2	9.1	5.5	16.9
	Stricture and/or stenosis	39.06	24.6	…	27.7	6.7	…	1.2	9.1
	Other or wound-related	0.27	…	…	32.7	2.2	…	1.2	…
Flap-related	Hematoma	0.09	…	13.2	2.5	…	…	3.0	1.2
	Necrosis, dehiscence, partial or complete flap loss	7.75	11.8	1.9	17.4	4.4	27.3	21.2	4.5
	Other	9.08	9.8	9.5	1.0	…	…	9.7	…
Donor site-related	Regrafting, infection, swelling, poor scarring, partial graft loss, hematoma, and other	4.98	NR	1.9	0.5	2.2	NR	1.8	NR
General	Hematoma and/or bleeding	0.09	…	NR	…	NR	…	…	0.4–4.5
	Infection and/or abscess	0.98	3.3	NR	11.9	NR	…	4.2	0.4–4.5
	Other and wound-related	9.52	9.8	NR	9.9	NR	9.1	2.4	0.4–4.5

Sources.—References 6 and 76.
Note.—Abd = abdominal flap, LD = latissimus dorsi free flap, NR = not reported.

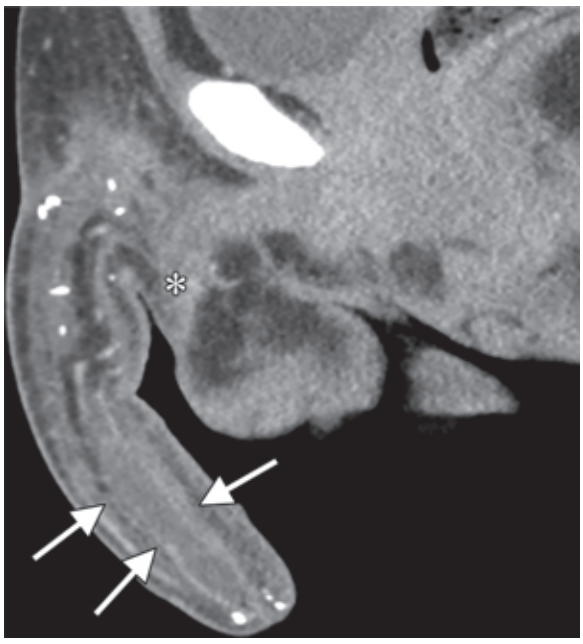

Figure 19. Abscess. Sagittal contrast-enhanced CT image in a 43-year-old transgender man with fever and pain 2 weeks after RFFF phalloplasty shows a rim-enhancing collection (arrows) in the distal neophallus. Note the native urethra (*), positioned between the neophallus base and neoscrotum.

The neourethral segments assessed at imaging include the native, midportion, and pendulous portions, as they are assessed following phalloplasty (Fig 22a). Small postoperative hematomas appear as hyperintense collections in the operative bed on T1- and T2-weighted MR images, or a small area of hyperintense signal on T2-weighted images at the site of vaginectomy (Fig 22).

Implanted Erectile Devices

If a patient intends to engage in penetrative intercourse, grafts of sufficient bulk are necessary to accommodate insertion of a hydraulic penile prosthetic device (79). Two penile prosthesis designs are available: malleable or semirigid and inflatable or hydraulic (29). Malleable prostheses typically consist of a metallic core surrounded by silicone or polytetrafluoroethylene, giving them rigidity. Implanting these devices results in a permanent erection that must be manipulated into position before intercourse and may be difficult to conceal when not engaged in sexual intercourse (29). Inflatable prostheses are available in two-piece or three-piece designs, both of which allow adequate rigidity and flaccidity, depending on when an erection is desired (29).

The three-part system includes two inflatable cylinders positioned superolaterally along

the length of the phalloplasty, a scrotal pump, and a subrectus reservoir, which are connected by silicone tubing (Fig 23). Hydraulic cylinders are anchored posteriorly at the pubic symphysis with standard or metallic sutures. The reservoir is typically placed in a subrectus pocket or in some cases in the extraperitoneal space deep to the rectus abdominus and anterior to the bladder. The scrotal pump is squeezed and draws saline solution from the reservoir into the cylinders, resulting in tumescence.

While radiographs may depict the metallic components of these devices, US, CT, and MRI allow for a more detailed assessment of the individual components. US images may show the prosthesis reservoir as an anechoic collection (approximately 60 mL in volume) under the rectus abdominus muscle or adjacent to the bladder, which may simulate an abnormal fluid collection or bladder diverticulum. However, the check valve of the reservoir results in reverberation artifact within the saline solution, differentiating it from a pathologic fluid collection (29,80). An inflammatory pseudocapsule may develop around the reservoir and should not be mistaken for an abscess. The silicone and metallic device components will have low signal intensity on both T1- and T2-weighted images. The saline solution within the system will appear as a hyperintense signal on T2-weighted images (29).

Higher complication rates may be encountered with erectile device placement in transgender men compared with those of cisgender men with erectile dysfunction (79). Mechanical device failure is more common in this population, as many transgender men have devices implanted at a younger age than that of cisgender men with erectile dysfunction (79). Device malposition or protrusion may occur more frequently in transgender men because corpora cavernosa are unavailable for device insertion and the tissue of the neophallus lacks supportive fascial layers. Prosthetic infection may be more common in transgender men given these differences in tissue quality, especially in the setting of scar tissue from previous stages of phalloplasty (79).

Scrotoplasty and Testicular Prostheses.—Testicular prostheses are generally placed within the neoscrotum about 6 months after phalloplasty (6). Imaging features of testicular prostheses are dependent on their material construction; they are most commonly made of silicone and appear as an area of high attenuation on CT images (Fig 24). If one of the prostheses is substituted for a hydraulic pump apparatus, it will appear as an area of fluid attenuation and will be connected to silicone tubing. Reported complications of testicular prostheses include infection and implant expulsion, erosion, rupture, or dislocation (79).

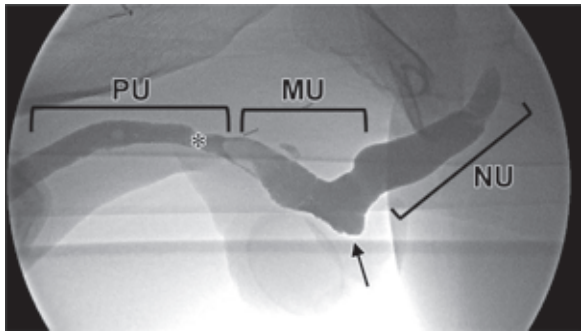

Figure 20. Normal appearance following RFFF phalloplasty in a 33-year-old transgender man with postvoid urine drip. Retrograde urethrogram shows the sections (brackets) of the proximal native urethra *(NU)*, lengthened midportion urethra *(MU)* (constructed from perivaginal flaps), and distal pendulous urethra *(PU)*. Note the mild stricture (*) of the proximal portion of the PU. Moderate outpouching (arrow) of the MU was thought to be pooling urine, so it was surgically tapered. Suprapubic urinary diversion is required for at least 3 weeks after surgery and may facilitate antegrade urethrography.

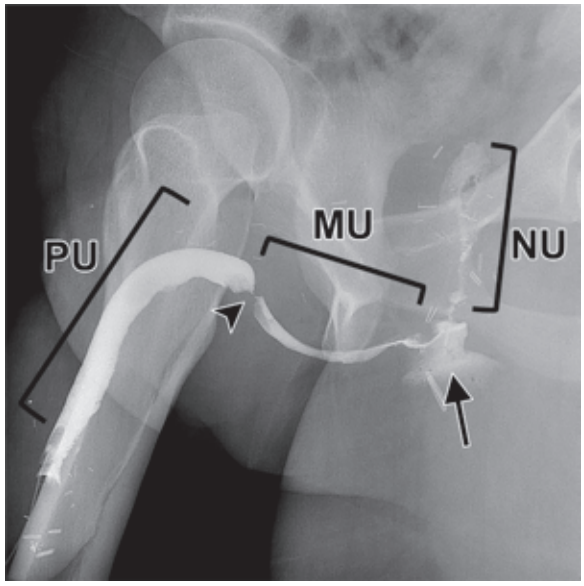

Figure 21. Urethral complications following RFFF phalloplasty in a 24-year-old transgender man. Retrograde urethrogram shows extravasation of contrast material (arrow) at the native urethra *(NU)* and midportion urethra *(MU)* anastomosis, a finding consistent with a fistula to the intact native vagina. Without vaginectomy, there is a higher incidence of fistula development, as less perivaginal tissue covers the proximal anastomosis. Strictures (arrowhead) are most common at the pendulous urethra *(PU)*–MU anastomosis owing to tenuous blood supply at the flap edges. Brackets = NU, MU, and PU sections.

Conclusion

Radiologists can reasonably expect to interpret imaging studies in transgender patients, either for postoperative evaluation or while working up other conditions. As transgender patients continue to seek medical care for their transition and

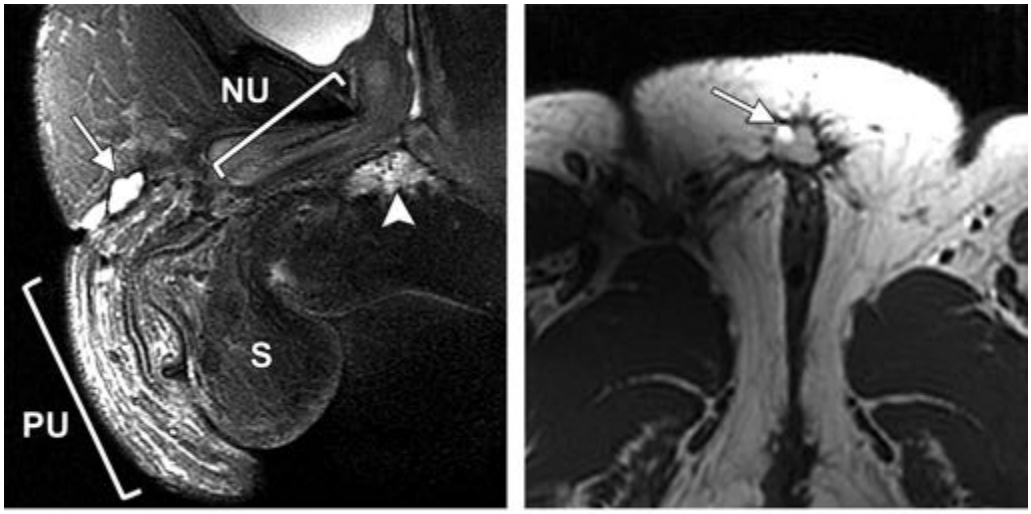

Figure 22. Normal postoperative appearance after metoidioplasty in a transgender man who presented with late dehiscence of the vaginectomy scar 4 months after metoidioplasty. Sagittal fat-suppressed T2-weighted **(a)** and axial T1-weighted spin-echo **(b)** MR images depict an asymptomatic small hematoma above the neophallus (arrow). Hyperintense signal in the vaginectomy bed (arrowhead in **a**) is an expected postoperative finding and likely not related to the superficial wound dehiscence. *NU* = native urethra, *PU* = pendulous urethra, *S* = neoscrotum.

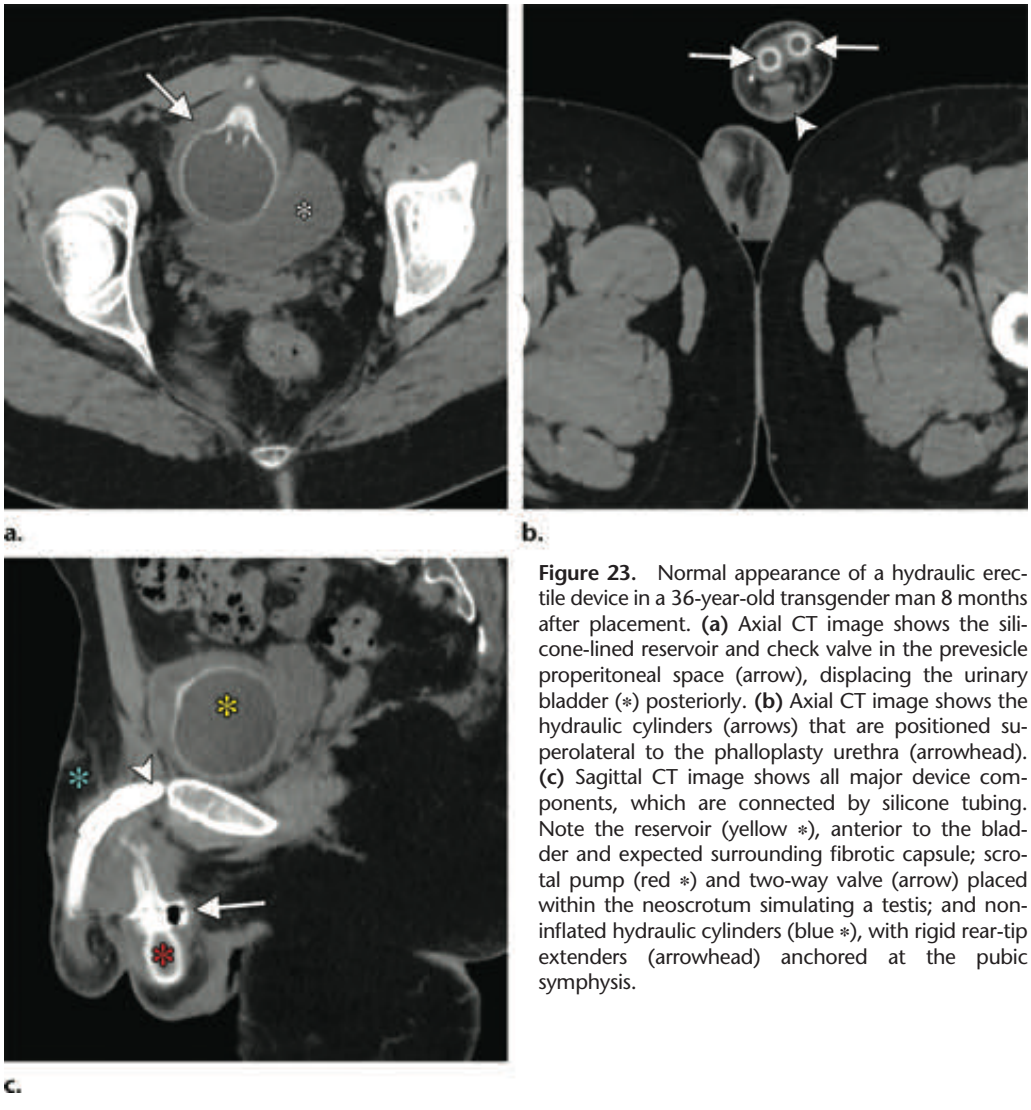

Figure 23. Normal appearance of a hydraulic erectile device in a 36-year-old transgender man 8 months after placement. **(a)** Axial CT image shows the silicone-lined reservoir and check valve in the prevesicle properitoneal space (arrow), displacing the urinary bladder (*) posteriorly. **(b)** Axial CT image shows the hydraulic cylinders (arrows) that are positioned superolateral to the phalloplasty urethra (arrowhead). **(c)** Sagittal CT image shows all major device components, which are connected by silicone tubing. Note the reservoir (yellow *), anterior to the bladder and expected surrounding fibrotic capsule; scrotal pump (red *) and two-way valve (arrow) placed within the neoscrotum simulating a testis; and noninflated hydraulic cylinders (blue *), with rigid rear-tip extenders (arrowhead) anchored at the pubic symphysis.

the number of patients who seek gender-affirming surgeries increases, it will become increasingly necessary for radiologists to recognize the normal and abnormal imaging features associated with these procedures. Knowledge of the surgical techniques and complications will allow the radiologist to assess the expected and unexpected outcomes of surgery. Radiologists and surgeons must work in concert to ensure appropriate use of imaging in pre- and postoperative evaluations, tailoring imaging protocols to ensure patient comfort and maximize clinical utility.

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Figure 24. Testicular implants in a 65-year-old transgender man who underwent abdominal flap phalloplasty 40 years earlier. Contrast-enhanced CT image shows the expected appearance of silicone (arrow) and saline (arrowhead) prostheses. The latter may function as a pump for hydraulic erectile devices.

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