

Female Urethral Reconstruction

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Purpose: Female urethral reconstruction can be used successfully to treat a heterogeneous group of urethral disorders through an expanding number of unique approaches. Understanding the diverse etiologies of female urethral stricture and loss is essential in evaluating and diagnosing patients. Although there is an appreciable body of literature addressing female urethral reconstruction individually, there is a paucity of resources that approach this issue holistically. We discuss the relevant female urethral anatomy, pathophysiology, diagnosis and evaluation of female urethral disorders, and current reconstructive techniques, as well as published outcomes data and potential future directions for female urethral reconstruction.

Materials and Methods: We reviewed articles published in English and indexed in the PubMed®, Embase® and Google Scholar™ databases, and consulted textbooks. Key search terms used were female, urethra, urethral reconstruction, urethroplasty, pathology, stricture, vaginal flap, bladder flap, graft, dilation, pubovaginal sling, catheterization, imaging, tissue engineering and bioscaffold. We created a synopsis of relevant articles, including original research studies and reviews.

Results: Urethral tissue loss and strictures are caused by traumatic injuries, iatrogenic injuries and, rarely, infections and malignancies. A comprehensive patient history and physical examination are critical for diagnosis. Flexible cystoscopy, voiding cystourethrography and endovaginal magnetic resonance imaging can help to determine the surgical method of repair. Minimally invasive approaches to female urethral reconstruction are associated with poor outcomes. Definitive treatment options for repair of female urethral stricture include vaginal flap/wall urethroplasty, graft urethroplasty and distal urethrectomy with advancement meatoplasty. Repair techniques for urethral loss include primary closure, vaginal flap/wall urethroplasty and bladder flap urethroplasty. Vaginal flap approaches with well vascularized grafts and buccal mucosal grafts have high success rates. Tissue engineered grafts are being investigated as a novel treatment modality.

Conclusions: Female urethral reconstruction is complex, and one must carefully evaluate patients afflicted with urethral disorders. Urethral stricture and urethral loss have different etiologies. Variations of a standard approach might best address the condition of an individual patient. Long-term outcomes data are not available for contemporary techniques of female urethral reconstruction. The highest success rates have been reported with vaginal flap and buccal mucosal graft urethroplasty. Further studies focusing on newer reconstruction techniques and long-term outcomes are warranted.

Key Words: suburethral slings, tissue transplantation, urethra, urethral stricture, urologic surgical procedures

Abbreviations and Acronyms

BMG = buccal mucosal graft
 FUR = female urethral reconstruction
 FUS = female urethral stricture
 PVS = pubovaginal sling
 VFU = vaginal flap urethroplasty

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FEMALE urethral stricture is an often overlooked and under diagnosed condition that manifests in about 3% to 8% of all women.¹ In women with bladder outlet obstruction the incidence of urethral stricture disease varies from 4% to 13%.² Taken together, urethral stricture disease has an incidence of 0.1% to 1.0% in women with voiding complaints. Women with urethral stricture are sometimes treated with urethral dilation and internal urethrotomy, and are more definitively treated with reconstructive surgery. Indications for urethral reconstruction include urethral stricture and anatomical loss. Female urethral reconstruction is technically challenging and relies on familiarity with the relevant urethral anatomy, physiology, etiology and pathology. The ultimate goal of female urethral reconstruction is to repair the urethra to allow voluntary, unobstructed and painless voiding. We present an overview of the anatomy of the female urethra, the etiology and pathophysiology of selected female urethral disorders, and the surgical techniques for female urethral reconstruction.

MATERIALS AND METHODS

We performed a nonsystematic review of articles and textbooks published in English that are indexed in the PubMed, Google Scholar and Embase databases. We did not define a restricted range for publication date. We collected articles for inclusion during the period of June 1, 2014 to March 1, 2015. Key terms used were female,

urethra, urethral reconstruction, urethroplasty, pathology, stricture, vaginal flap, bladder flap, graft, dilation, pubovaginal sling, catheterization, imaging, tissue engineering and bioscaffold. We excluded all studies not indexed in either PubMed, Google Scholar or Embase and all studies not published in English. All 3 authors used the same search methodology and came to a consensus regarding which articles were most relevant to the review. A synopsis of relevant articles, including original research studies and reviews, and textbook excerpts was created. Figure 1 contains a graphic outline of our findings.

ANATOMY OF FEMALE URETHRA

The female urethra is a thin fibromuscular tube, about 4 cm long, which extends from the bladder neck to the vaginal vestibule. Its walls contain inner circular and outer longitudinal muscular layers, which become less prominent distally, terminating in a minimally compliant, thick collagenous ring. The urothelial lining changes gradually from transitional cells proximally to nonkeratinized stratified squamous cells with more glands distally. Underlying the urethral epithelium and glands is a thick and richly vascular submucosa (fig. 2).³

Just posterior to the pubic symphysis the urethra travels through the pelvic diaphragm and perineal membrane. Near the vaginal vestibule the urethrovaginal sphincter contracts with the bulbospongiosus muscle to tighten the urogenital hiatus. The pubourethral and urethropelvic ligaments

Etiologies		Preoperative patient evaluation	
<u>Traumatic injury:</u> Obstetrical trauma ⁴ Pelvic fracture ⁶ Iatrogenic injury ⁹	<u>Iatrogenic injury:</u> Anterior vaginal surgery ⁸ Urethral surgery ⁸ Urethral catheterization ¹³ Radiation treatment ¹⁴ Urethral sling placement ¹¹	<u>Diagnosis:</u> Patient history and physical examination Cystoscopy, voiding cystourethrography, endovaginal MRI ¹⁷	<u>Indications for surgery:</u> Urethral loss Urethral stricture
<u>Rare causes:</u> Infection and cancer ¹⁵		<u>Timing of surgery:</u> Vagina is free of infection, inflammation, and has pliability ¹⁴	
Surgical approaches and outcomes			
Urethral stricture		Urethral loss	
<u>Minimally invasive approaches:</u> Urethral dilation: High rates of recurrence ²⁴ Overall success in 47% (n=107) ²⁵		<u>Primary closure:</u> Well-suited for small defects ³⁹	
Optical urethrotomy: Case reports of success ^{26,27}		<u>Urethral sling erosion repair:</u> Well-suited approach to remove erosive sling and repair urethra ²⁶	
<u>Buccal mucosal graft urethroplasty:</u> Overall success in 94% (n=32) ²⁵		<u>Bladder flap urethroplasty:</u> Success rate of 67% (n=6) ⁴¹ Case reports, incontinence noted ²⁷	
<u>Distal urethrectomy and advancement meatoplasty:</u> Well-suited for distal urethral strictures ²⁶			
Open urethroplasty for urethral stricture or urethral loss			
<u>Vaginal flap urethroplasty:</u> Overall success in 91% (n=57) ²⁵		<u>Vaginal wall urethroplasty:</u> Success rate of 73% (n=11) ³⁴	

Figure 1. Overview of female urethral reconstruction. *MRI*, magnetic resonance imaging.

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