Female neo-urethral reconstruction with a modified neurovascular pudendal thigh flap (Singapore flap): initial experience

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Purpose: *Complete urethral reconstruction in women is an extreme challenge for urologists. We report a new approach to this challenging procedure, using a modified neurovascular pudendal thigh flap (Singapore flap) for neo-urethral reconstruction in two patients at our institution.*

Materials and methods: *A Singapore flap was raised and transposed to the vagina in two patients with destroyed urethras following several previous uro-gynecologic procedures. In one case, the flap was tubularized distally and anastomosed proximally to the bladder neck. In the second case, the flap served to cover a urethroplasty inlay.*

Results: *We are presently reporting mainly on the surgical technique. At 24 and 27 months respectively, the two flaps are viable and appear to fulfill their designated roles. The first case developed bladder neck stricture 2 months after surgery, and urethral dilation was performed successfully. Urinary incontinence still remains an issue in one of these two patients, and further continence procedures have been used.*

Conclusions: *It has been found that the neurovascular pudendal thigh flap, initially described for vaginal reconstruction, is an attractive technique to aid in complete female neo-urethral reconstruction. Further follow-up of patients is necessary to address the issue of continence.*

Key Words: Singapore flap, pudendal flap, female urethra, reconstruction

Introduction

The sensate, pudendal fasciocutaneous thigh flap is based on the terminal branches of the superficial perineal artery, which is a continuation of the internal pudendal artery.[1] The flap was initially designed in 1989 by Wee and Joseph from Singapore to reconstruct the vagina. Several authors have reported using this axial-patterned flap in a bilateral fashion to reconstruct the vagina.[2,3] Others have demonstrated its versatility in a unilateral fashion for the repair of rectovaginal fistulas.[1,4] Here, we report on the modified, unilateral deployment of the Singapore flap for neo-urethral reconstruction in two female patients.

Complete urethral reconstruction in women is an extreme challenge for urologists. The principles of reconstruction involve the introduction of vascularized bladder flaps,[5] free mucosal grafts from the bladder,[5,6] and full-thickness free skin grafts for long urethral defects.[7] Vaginal flaps, which are the simplest and most accessible, can be also be used in patients with extensive tissue loss. Innovative techniques with a free vascularized appendix[8] and radial artery forearm free flaps[9] have been described in the literature. To date, there has not been any reported use of the Singapore flap for reconstruction of the female urethra.

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Materials and methods

The first patient was a 48-year-old woman who presented with total urinary incontinence. She was treated at another institution for urethral diverticulum, which was complicated by several abscesses. Multiple revisions were attempted with a Martius flap and gracilis interposition, eventually leading to an obliterated urethra. The second patient, a 37-year-old woman, also presented with total urinary incontinence. She previously underwent a hysterectomy for endometriosis. However, her surgery was complicated by a wound infection which ultimately developed into a large urethrovaginal fistula. Both patients came to us with a bladder neck widely opened into the vagina and no urethral remnants. An entire finger could be introduced into the bladder during vaginal examination.

Surgical technique

The patients were anesthetized and placed in the lithotomy position. After standard broad-spectrum antibiotics were given intravenously (1 g Ampicillin and 80 mg Gentamicin), the skin was prepared with standard sterilizing solution and draped. A weighted speculum was inserted into the vagina, followed by cystoscopic evaluation of the bladder. A Foley catheter was inserted, and the balloon inflated at the bladder neck for the measurement of urethral length. A unilateral right pudendal thigh flap was raised and transposed to the vagina in both patients.

Our technique of flap elevation was virtually identical to that described by Wee and Joseph.[3] A skin flap measuring 15 cm x 6 cm was designed with a marking pen lateral to the hair-bearing area of the labia majora and centered on the crease of the groin. The template design for the flap respected the fundamental reconstructive limitation of a 4 to 1 length to width flap ratio. Plastic surgery principles were strictly respected with the use of optical loops and fine surgical materials. The incision, beginning at the tip of the flap, was deepened through the skin and subcutaneous tissue down to the deep fascia on the two sides, except for the proximal margin of the flap. The deep fascia at the distal aspect of the flap was sutured to the skin anteriorly with 4-0 Vicryl, and the flap was elevated with the deep fascia and the epimysium over the proximal part of the adductor muscles. Such a maneuver raised the deep fascia with the superficial vascular supply, the posterior labial artery, Figure 1. The proximal flap skin

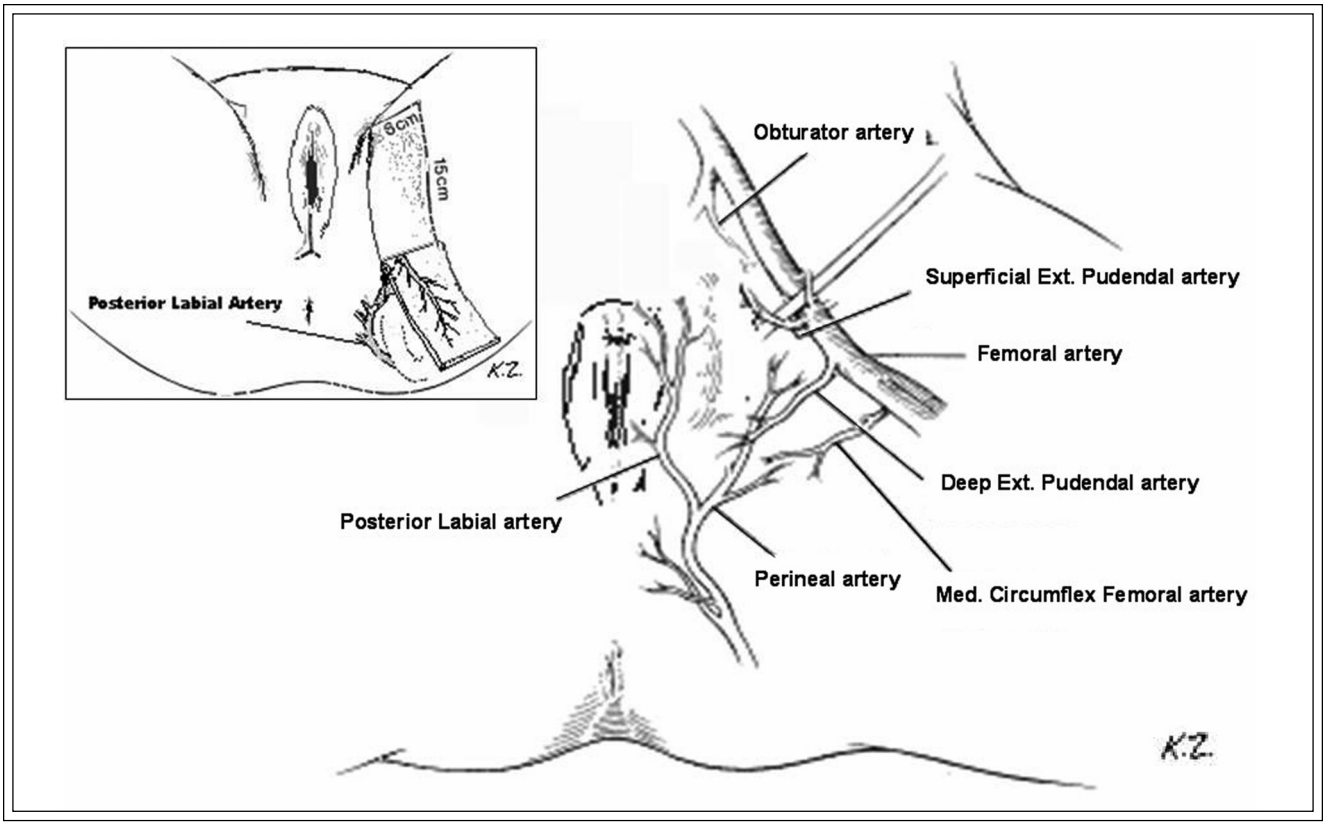

Figure 1. Design of the pudendal thigh flap based on the posterior labial artery and its associated vascular supply.

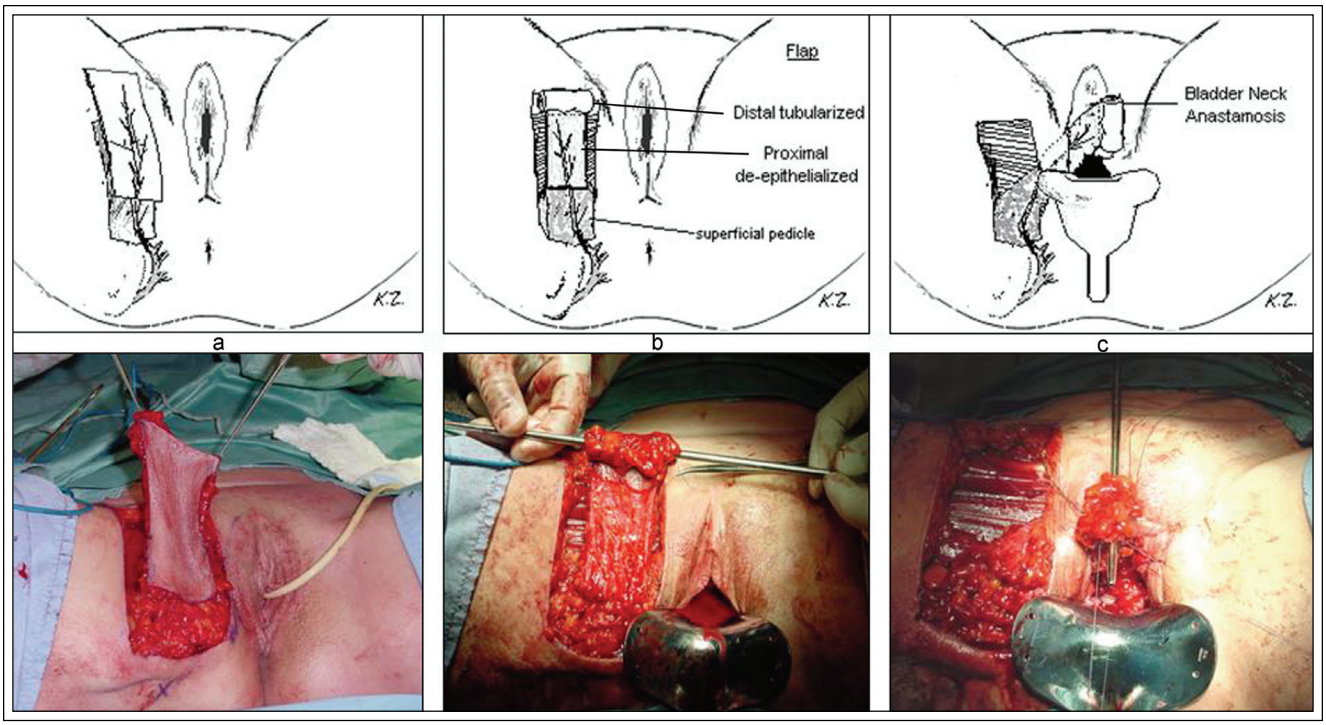

Figure 2. Raising of the Singapore flap (a), with tubularization of the distal flap (b) and medial transposition of the flap beneath the labia for bladder anastomosis (c).

and subcutaneous tissue were incised superficially into the connective tissue and then meticulously undermined in a plane parallel to the skin. This allowed the flap, based on a subcutaneous pedicle by the posterior labial arteries, to be tunneled medially under the labial folds.

In the first case, the flap was tubularized distally and anastomosed at its proximal end to the bladder neck, Figure 2. A 9-cm segment of the proximal flap was de-epithelialized with a 20-blade knife to provide a hairless and less bulky pedicle for the distal flap. The remaining distal tissue was allowed to roll perpendicularly to its axis. The 4-0 Vicryl interrupted sutures fixed the tissue in a circular conformation. An incision at the base of the right labia majora was carried down to the ischiopubic ramus. The tubularized flap was passed through the defect directly into the vagina and rotated in a 90-degree counterclockwise direction. No vascular compromise was noted on the basis of temperature, tissue color and bleeding. The most superior aspect of the tubularized flap was spatulated and anastomosed to the bladder neck with 6 interrupted 5-0 Vicryl sutures. The distal neo-urethral flap was anastomosed with 5-0 Vicryl, taking full thickness skin around the urethral meatus. The perineal defect created in the groin was easily closed with skin hooks. Traction at the superior-lateral and infero-medial aspects of the graft created a linear or lazy-Z patterned defect, Figure 3. The 3-0 Vicryl sutures were placed in the subdermis tissue in an interrupted fashion to align the wound. Subcutaneous running 4-0 Monocril or skin staples were used to close the skin. The vaginal defect through which the vascularized pedicle of the Singapore flap passes was closed with interrupted

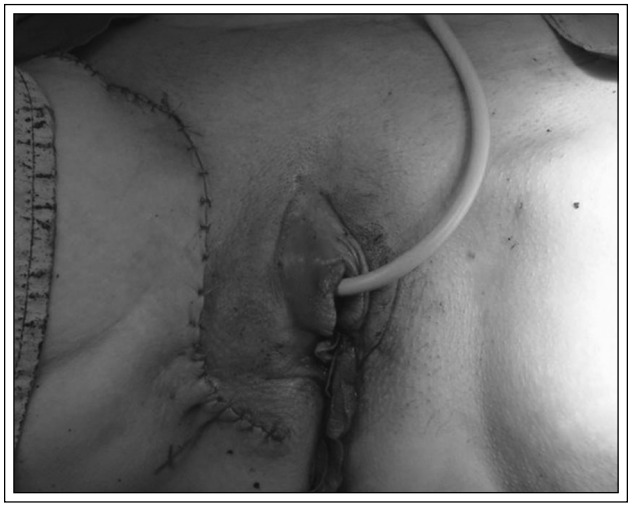

Figure 3. Final donor-site closure of the Singapore flap. Note the lazy-Z pattern of the closure which lies in the natural skin crease of the groin.

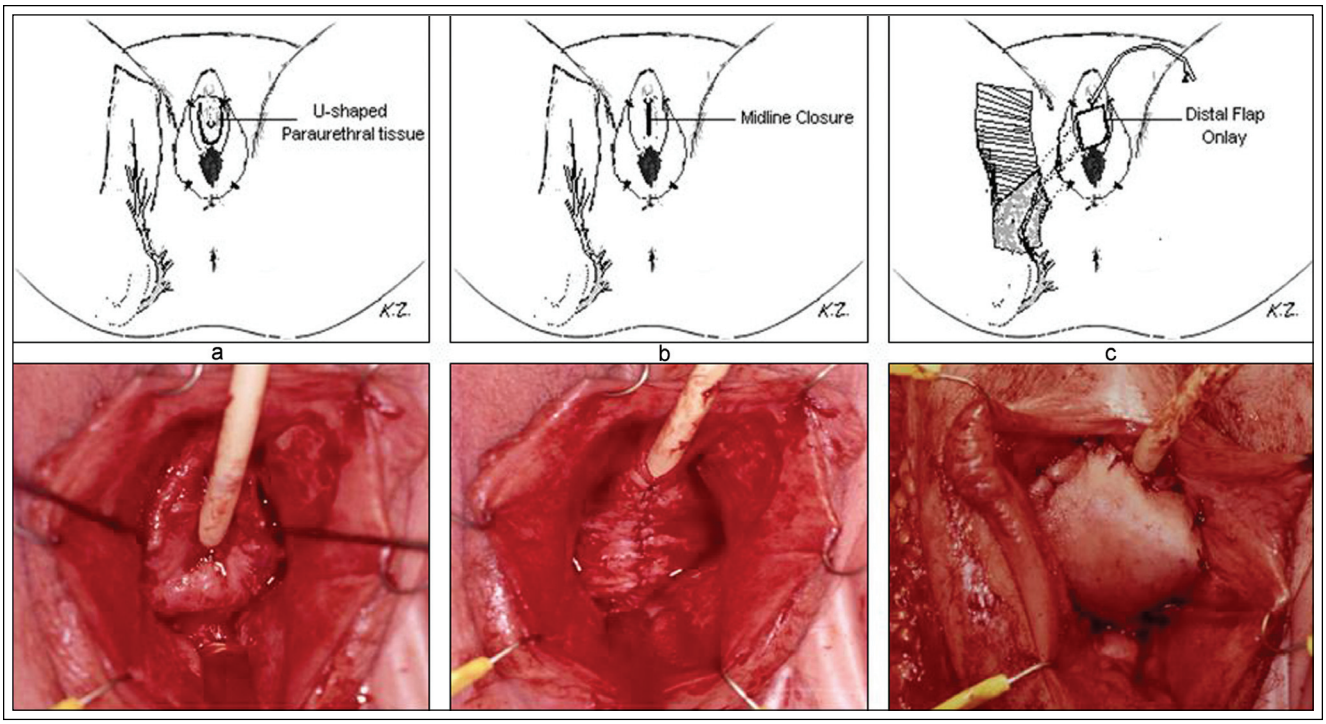

Figure 4. Peri-urethral U-shaped incision (a), midline closure of peri-urethral tissue for urethral lengthening (b), and transposition of the Singapore flap for vascularized closure (c).

4-0 Chromic sutures. Broad-spectrum antibiotics were given during foley catheter drainage for 2 weeks.

The Singapore flap in the second case was used to cover a Duplay-type urethroplasty inlay, Figure 4. The urethra was reconstructed with the lateral para-urethral vaginal epithelium. The role of the Singapore flap was to provide healthy vascular coverage onto which the urethroplasty would take. With the same standard preparation as in the previous surgery, a U-shaped incision into para-urethral tissues was made with a 20-blade knife. After enough dissection of these flaps to allow for tension-free neo-urethral reconstruction, the urethra was created by their closure over a 16F silastic catheter. Closure of these flaps along the midline ensured urethral lengthening. At this point, the Singapore flap was designed, raised and transposed in the same manner as described earlier to provide locally-available vascularized tissue. In this case, however, the flap was not tubularized. Post-operative management was identical to the first case. Both patients were discharged on post-operative day 4 with the catheter left in place for 2 weeks.

Results

At 2-month follow-up of the first case, the patient complained of dribbling and difficulty emptying. A catheterization trial was unsuccessful, and the post-void residual was over 200 ml.

Cystoscopy under anesthesia revealed tight bladder neck anastomosis. After difficult catheterization of the bladder neck under cystoscopic guidance, the urethra was expanded with dilators to a 20 French-size, and a catheter was left in place for 3 weeks. Unfortunately, her symptoms of obstruction recurred almost immediately after removal of the catheter, and a new catheter had to be installed. A month later (4 months after the initial surgery), the patient underwent urethroplasty with a buccal mucosal graft. Eight months thereafter, she had a patent urethra and presented with stress urinary incontinence in the standing position only. We performed a fascial sling with the hope of controlling this residual incontinence. After only a few weeks of continence, the patient started to leak again. Two injections of collagen (Contigen™, CR Bard Inc., Covington, GA, USA) improved her continence enough to make it socially acceptable. Twenty-four months after the initial procedure, the patient is wearing only two to three panty liners/day for mild stress incontinence and considers herself "cured".

The second patient had an uneventful post-operative course. At removal of her catheter, she was completely continent with a maximum flow rate of 9.3 ml/sec and no residual volume. At 2 years, she is

still continent with no lower urinary tract symptoms. She resumed vaginal sexual intercourse 3 months after her surgery and considers it satisfactory.

Discussion

The neurovascular pudendal thigh flap first described by Wee and Joseph has proved to be a valuable tool in perineal reconstruction over the last 10 years. Based on the posterior labial vascular bundle, it is innervated by the posterior labial branch of the pudendal nerve. The tissue provides large amounts of vascularization that is thin, pliable, and can be easily inserted in the perineal area to reconstruct the female urethra.

The cuticular vascular territory of the Singapore flap is precisely identified; the medial border of the skin island is in the groin crease lateral to the labia edge, and extends to a point of the mid-perineum 3 cm lateral to the anal verge.[10] As defined by Wee and Joseph, maximal safe dimensions of the flap identify a skin island < 6 cm wide and < 15 cm long.[3]

Classically, the pudendal thigh flap has been used in a bilateral fashion, mainly in patients with congenital vaginal atresia. We agree on the distinct advantages of this flap, which include the following: 1) it is a simple technique that can be completed in 2 hours with little blood loss; 2) the flaps are very robust and have a reliable blood supply; 3) no stents or dilators are required; 4) the donor site can be closed primarily; and 5) the sensate flap does not contract. There have been no previous reports of flap necrosis.

Other options for urethral reconstruction, such as local vaginal flaps is techniquely more preferable. However, when such tissues are not available or have poor vascularity, the Singapore flap may be the next step on the reconstructive armamentarium. In our second patient, due to a paucity of blood supply of the Martius flap, additional vascular supply was required for successful reconstruction.

Kahveci et al[11] noted that urethroplasties with tube-shaped skin grafts or flaps are not always successful because of post-operative complications, such as infection, hair growth, fistulas, stone formation, diverticula and strictures. Fistulas are a major problem for all tube-shaped flaps or grafts. In our experience, a bladder neck anastamotic stricture occurred in the first patient where the Singapore flap was tabularized. As such, we do not advocate the tabularized grafts. Despite dilation, urethroplasty was required. Buccal mucosa grafts were successfully placed on the Singapore flap owing to the robust blood supply of this tissue (para-urethral tissue of the first Singapore flap based on the posterior labial artery).

Jordan recently reviewed the use of the perineal artery flap for penile circular fasciocutaneous reconstruction in complex anterior urethral strictures.[10] In most cases, the skin island could be configured as an on-lay patch or placed into a perineal urethroplasty to be incorporated later in urethral continuity by means of staged delay techniques.[10] Although the skin islands could be tubularized, tubing in his experience should be avoided whenever possible.[10]

As mentioned previously, Singapore flaps have been used for vaginal reconstruction. Casey et al compared the outcome of Singapore flap, vertical rectus abdominis musculocutaneous flap (VRAM) and gracilis musculocutaneous flap vaginal reconstruction in their retrospective review of 99 patients with complete vaginal defects.[12] A total of 45 modified Singapore flaps were performed. The overall complication rate was lower following VRAM then either gracilis or Singapore flap reconstruction (31.7% versus 61.5% and 46.7%, respectively). One of the possible complications of the Singapore flap was linked with the tendency for retraction. Vaginal dilation was required to maintain patency for sexual activity. The authors conclude that the VRAM has become the vaginal reconstructive flap of choice at the Mayo Clinic.

Tosun et al also evaluated the use of various flap tissues for vaginoplasties in 27 patients with vaginal agenesis.[13] It was found that adequate blood supply was difficult to achieve with the gracilis flaps. The Singapore flap achieved perfect innervation and good contour, however tended to be hairy.

This study has several limitations that warrant discussion. The retrospective nature of the study with a limited sample size, based on data from a single institution must be pointed out. Similarly, our study describes different uses of the Singapore flap for female urethral reconstruction- as a tabularized flap and as an on-lay flap to provide vascular support. Comparison therefore is difficult. In our first case, the initial results of the tabularized flap were poor with urinary continence and a concomitant stricture. As such, we do not believe that the use of the Singapore tabularized flap should be recommended for female urethral replacement. A multi-institutional, prospective, study, with larger patient numbers and longer follow-up time may better evaluate functional outcomes and complication rates perhaps related to hair production and flap contracture.

In this initial experience, the issue of incontinence still remains after the use of the Singapore flap for obliterated urethral reconstruction. Sling techniques could be considered for the restoration of continence in these patients.

Conclusion

It has been found that the neurovascular pudendal thigh flap is a feasible procedure that can be undertaken by urologists to aid in the reconstruction of the female urethra in acquired conditions where local tissues are lacking. Because of its robust vascularity, the Singapore flap appears to be ideally suited for complex, high-risk patients with ischemic strictures. However, it is not recommended as a base for tubularized stricture replacement. Further follow-up of our patients will be necessary to address the issue of incontinence. □

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