The rectus abdominis myoperitoneal flap for vaginal reconstruction

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ABSTRACT

To review the indications, technique and results of the rectus abdominis myoperitoneal (RAMP) flap for vaginal reconstruction from literature and at a single institution. A literature search was conducted of vaginal reconstruction to identify published cases using RAMP flaps. All cases of vaginal reconstruction at Sunnybrook Health Sciences Center (SHSC) from 2007 to 2019 were reviewed. Twenty-one published cases of vaginal reconstruction with RAMP flaps were identified. Eleven had partial longitudinal vaginal defects, 5 had circumferential defects and 5 had unspecified defects. Eight patients with circumferential defects developed vaginal stenosis. None of the 11 patients with partial longitudinal defects developed vaginal stenosis and 8 resumed sexual activity. There were 2 cases of donor site hernia and 4 donor site infections, but no flap loss. At SHSC, 5 cases of RAMP flap vaginal reconstruction were identified. Cases 1–3 and 5 had circumferential vaginal defects and Case 4 had a partial longitudinal defect. There were no cases of flap necrosis or donor site hernia. Case 1 died 18 days after pelvic exenteration from bowel ischemia. Case 2 developed a rectovaginal fistula after an anastomotic leak from a low anterior resection. Case 3 had a wound infection and vaginal shortening to 3–4 cm. Cases 4 and 5 had no complications and the vagina appeared normal on exam post-operatively. The literature and our experience support the use of RAMP flaps for reconstruction of partial longitudinal vaginal defects but not circumferential defects where the risk of vaginal stenosis and shortening is high.

1. Introduction

Pelvic exenteration (PE) has impact on quality of life, body image and sexual functioning (Roos et al., 2004). In two studies of quality of life after PE, approximately 30% of patients who retained vaginal function resumed sexual activity post-operatively (Roos et al., 2004; Dessole et al., 2016). Roos et al. (2004) found women who underwent vaginal reconstruction had improved self-confidence. Anatomically, vaginal reconstruction assists in wound closure, fills large pelvic defects and can improve blood supply from the vascular flap (Rietjens et al., 2002). For many patients, vaginal reconstruction is an important addition to PE (Roos et al., 2004; Dessole et al., 2016).

Vaginal defects were classified by Pusic and Mehrara (2006) as type 1 for partial longitudinal defects resulting from anterior or posterior exenteration, and type 2 for circumferential defects resulting from total PE. Multiple types of neovagina have been described including bowel segment flaps, myofascial flaps, myocutaneous flaps, and myoperitoneal flaps (Rietjens et al., 2002; Georgas et al., 2000; Cortinois et al., 2018). The ideal neovagina should have adequate dimensions, normal appearance and function with minimal donor defect (Wu and Song, 2005). Techniques used for vaginal reconstruction include the rectus abdominis myocutaneous (RAM) flap and the gracilis myocutaneous flap. Myocutaneous grafts can be problematic due to hair, bulk in obese patients, donor site defects, and not generating mucosa (Niazi et al., 2001; Scott et al., 2010), whereas RAMP flaps spare the abdominal skin and anterior rectus sheath, do not require additional incisions, have less bulk in obese patients than myocutaneous grafts, and do not generate mucosa (Hockel, 1996). Hockel (1996) originally described the transversus and rectus abdominis muscularoperitoneal (TRAMP) composite flap which includes the rectus abdominis muscle in continuity with the epigastric part of the transversus abdominis muscle, posterior rectus and transversalis fascia and parietal peritoneum. RAMP flaps have subsequently been described that include only the rectus abdominis muscle, the posterior rectus sheath and the peritoneum (Wu and Song, 2005).

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Despite the benefits of RAMP flaps, there is limited literature about this technique. The aim of this study is to describe the indications, technique, and results of vaginal reconstruction using RAMP flaps from the literature and experiences at Sunnybrook Health Sciences Center.

2. Methods

A literature review identified published cases of RAMP flaps for vaginal reconstruction and a manual review of the cases’ references identified additional articles. The literature search was conducted in Ovid MEDLINE 1946 to November week 2 2018. The search strategy was designed with our academic hospital library information specialist. Search terms combined “vagin*.mp,kw” OR “neovagin*.mp,kw” with “Reconstructive Surgical Procedures OR Surgical Flaps OR Rectus Abdominis/surgery” OR Myocutaneous OR Surgical Flaps OR Rectus Abdominis/surgery OR Myocutaneous flap OR (rectus abdomin*$ adj3 flap?$).mp,kw OR (rectus muscle? adj3 flap?$).mp,kw OR (myoperiton* adj3 flap?$).mp,kw OR (musculoperiton* adj3 flap?$).mp,kw OR musculo-periton* adj3 flap?$).mp,kw OR RAMP.mp,kw. We excluded animal studies. The resulting titles and abstracts were reviewed by two of the study authors to identify studies for inclusion. All cases of vaginal reconstruction using a RAMP flap were included from 2007 to 2019 at Sunnybrook Health Sciences Center were reviewed. Research Ethics Board approval was obtained. Cases were identified using ICD codes for vaginal reconstruction. The identified charts were reviewed to find cases where RAMP flaps were used. Collected data included patient age, BMI, comorbidities, diagnosis, indication for vaginal reconstruction, concurrent surgical procedures, intraoperative and post-operative complications, presence of post-operative vaginal shortening, stenosis, fistula, donor site complications and oncologic outcome where applicable.

2.1. Surgical technique

The donor site for the RAMP flap was chosen based on existing scars and stoma sites. The flap was harvested by dissecting the rectus abdominus muscle from the anterior rectus sheath. The peritoneum underlying the rectus muscle was sutured to the muscle to prevent shearing. The muscle was transected at the level of the umbilicus and mobilized medially and posteriorly (Fig. 1A). The inferior epigastric vessels were preserved (Fig. 1B). The muscle with its peritoneum was rotated inwards to create an augmentation of the vagina, with the peritoneum sutured to the vaginal mucosa in a configuration dependent on the type of vaginal defect (Fig. 1C). An in-house custom-made mould was placed vaginally and sutured to the vulva. The mould was created using Kee-tron PEEK Classix Life Sciences Grade material and machined manually at the Odette Cancer Centre at SHSC on a lathe and milling machine (see Supplemental Content 1). The vaginal mould was removed on post-operative day 5. The patients were given vaginal dilators to use with lubricant 3 times daily upon discharge until the onset of sexual activity. Fig. 2 depicts the vagina at 4-weeks post-operative.

3. Results

Our search generated 1724 publications and we identified 21 cases of RAMP flap vaginal reconstruction from 5 publications (Rietjens et al., 2002; Wu and Song, 2005; Niazi et al., 2001; Hockel, 1996; Soper et al., 2005). Most of the studies used TRAMP flaps. There was a single series of 5 patients that used RAMP flaps alone (Table 1). The identified studies did not specify the patient’s BMI or abdominal wall thickness and most did not describe the reason for choosing RAMP flap over a myocutaneous flap. Of the 21 cases identified, 11 had partial longitudinal (type 1) vaginal defects, 5 had circumferential (type 2) defects and 5 had unspecified defects. Eight patients with circumferential (N = 3) or unspecified (N = 5) defects developed vaginal stenosis. None of the patients with type 1 defects developed vaginal stenosis. The studies by Rietjens et al. (2002) and Soper et al. (2005) compared myoperitoneal flaps to corresponding myocutaneous flaps (Wu and Song, 2005; Niazi et al., 2001). Both studies found that myoperitoneal flaps had higher rates of vaginal stenosis than myocutaneous flaps. Rietjens et al. (2002) compared 5 TRAMP flaps to 5 transverse rectus abdominis myocutaneous (TRAM) flaps. They found TRAMP flaps had complete or partial vaginal stenosis whereas TRAM flaps maintained at least 6 cm vaginal length by 6 months after surgery, but the type of vaginal defects were not specified (Rietjens et al., 2002). Soper et al. (2005) compared 32 vertical rectus abdominis myocutaneous (VRAM) and TRAM flaps to 7 TRAMP flaps. The vaginal defect was type 1 in 25% of RAM flaps and 57% of RAMP flaps. They noted flap loss in 6%
vs 0%, stricture or stenosis in 13% vs 43%, rectovaginal RV, rectovaginal; TPC total proctocolectomy; SW, super Kustner-Hauster; NACT, neoadjuvant chemotherapy; Endo, endometrial; BSO, bilateral salpingo-oophorectomy; APR, abdominoperineal resection; post, posterior; Cx, cervical; CA, cancer; TRAMP, transversus and rectus abdominis musculoperitoneal; Vag, vaginal; RT, radiation therapy; Hyst, hysterectomy; RKH, Rokitansky-Kuster-Hauster; NACT, neoadjuvant chemotherapy; Endo, endometrial; BSO, bilateral salpingo-oophorectomy; APR, abdominoperineal resection; post, posterior; RV, rectovaginal; TPC total proctocolectomy; SW, superficial wound; RAMP, rectus abdominis myoperitoneal.

### Table 1

Literature review cases of RAMP flap vaginal reconstruction.

| Author          | Year | Diagnosis              | Primary procedure | Flap type | # of cases | Vaginal defect type | Donor site complications | Flap complications | Sexually active |
|-----------------|------|------------------------|-------------------|-----------|------------|---------------------|------------------------|-------------------|-----------------|
| Hockel          | 1996 | Recurrent Cx CA Anal cancer | Anterior exenteration Posterior exenteration | TRAMP     | 2          | Type 1 (2)          | None                  | None              | 2/2             |
| Niazi et al.    | 2001 | Vag stenosis after RT for Cx CA RKH syndrome | Hyst, upper vaginectomy | TRAMP     | 2          | Type 2 (2)          | None                  | None              | 1/2             |
| Rietjens       | 2002 | Advanced Cx CA after NACT Recurrent vulvar CA | Anterior exenteration | Hyst-BSO-perineal resection | TRAMP     | 5          | ND                  | None              | Stenosis (5) | 0/5             |
| Soper et al.    | 2005 | Cervical CA (2) | Total exenteration (1) | TRAMP     | 7          | Type 1 (4)          | Hernia (2)            | Stenosis (3)     | ND             |
| Wu et al.       | 2005 | Rectal cancer | APR, post vaginectomy | RAMP     | 5          | Type 1 (5)          | SW infection (1)      | None              | 4/5             |

By 4 months postoperative, the vagina was normal in length and re-epithelialized with vaginal mucosa.

### 4. Discussion

PE has the potential to cure patients with central pelvic disease, but is associated with high perioperative morbidity and poor global health and body image scores (Dessole et al., 2016). Vaginal reconstruction helps fill the pelvic dead space, improves local blood supply and can restore sexual function (Carlson et al., 1996; Goldberg et al., 2006). For reconstruction of circumferential vaginal defects, the RAM flaps are most popular due to their robust blood supply from the inferior epigastric vessels, large arc of rotation, low rate of necrosis, and high patency rates without using vaginal dilators (Ferron et al., 2015). However, RAM flaps use hair-bearing skin that does not undergo metaplasia to vaginal mucosa, and requires a moderate to large amount of abdominal wall skin and anterior rectus sheath. Obesity is a relative contraindication to a RAM flap as it will be too bulky to fit in the pelvic space which could compromise the flap’s blood supply (Scott et al., 2010). In contrast, the RAMP flap spares the abdominal skin, fat, and anterior rectus sheath, has less bulk in obese patients and the peritoneum undergoes metaplasia to vaginal mucosa (Hockel, 1996).

In three out of our five cases, a RAMP was used for a circumferential vaginal defect due to patient obesity. One patient died of complications from her exenteration procedure, one developed a rectovaginal fistula due to a leak from her LAR and the third had vaginal shortening by three months after surgery. The fourth circumferential vaginal defect...
| Case 1 | Case 2 | Case 3 | Case 4 | Case 5 |
|--------|--------|--------|--------|--------|
| Age | 71 | 46 | 50 | 53 | 41 |
| Diagnosis | Recurrent vaginal CA, SCC | Recurrent cervical CA, SCC | Vaginal melanoma | Recurrent (2nd) cervical adenocarcinoma | Total exenteration, peri-aortic lymphadenectomy, ileal conduit, FS adenopathy and peri-ureteric tissue negative |
| Primary Surgery | Anterior exenter, ileal conduit, FS | TAH-BSO, Radical ant. vaginalctomy, Microsurgical partial bladder reconstruction | TAHS-BSO-vaginectomy | Total exenter, LAR, ileal conduit, FS adenopathy negative | 2 years (EPR and VB) and 4 months (IB) prior to 2nd recurrence |
| Radiation | 14 years prior to recurrence | 6 months prior to recurrence | 15 months prior to vaginal stenting | No | None |
| Complications | Superficial wound infection | None | None | Normal length, re-epithelialized | None |
| Follow Up Time | 18 days | 13 months | 3 months | 20 months | 4 months |
| Flap complications | None | None | 3-4 cm | None | None |
| Type 1 flap complications | 3 months | 12 months | 3-4 cm | 3-4 cm | None |
| Complications from 1° surgery | None | None | 3-4 cm | None | None |
| Donor site complications | ND | ND | ND | ND | ND |
| Donor site complications | ND | ND | ND | ND | ND |
| Flap complications | None | None | None | None | None |

CA, cancer; SCC, squamous cell carcinoma; RT, radiation therapy; exent, exenteration; FS, frozen section; LAR, low-anterior resection; TAH, total abdominal hysterectomy; BSO, bilateral salpingo-oophorectomy; ant, anterior; EPR, external perineal radiation; VB, vault brachytherapy; IB, intestinal brachytherapy; 1, primary; SMA, superior mesenteric artery; POD, post-operative day; SBD, small bowel obstruction; ND, not documented.

5. Conclusion

In summary, the RAMP flap may be useful for the reconstruction of partial longitudinal vaginal defects, particularly in obese patients. RAMP flap loss and major donor site complications are low, and the use of post-operative vaginal stents and dilators are important to maintain vaginal patency. For circumferential vaginal defects, the RAMP flap has a high rate of vaginal stenosis and shortening, and other options such as RAM flaps should be considered.

Author contribution

All authors have provided substantial contribution to the final manuscript.

Declaration of Competing Interest

The authors declared that there is no conflict of interest.

Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.gore.2020.100567.

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