Vulvovaginal Reconstruction Following Radical Resections

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The aim of the gynecologic oncologist is to cure the cancer patient without sacrificing normal function. Although excellent progress has been made in tumor eradication, the restoration of preexisting function frequently remains elusive. Too often, treatment for gynecologic cancer can leave patients with the crippling defects of irradiation ulcers, fistulas, and inadequate vaginas (Fig. 1). During the past decade, however, the use of musculocutaneous flaps has proved advantageous in preventing and correcting pelvic defects resulting from cancer therapy and tumor recurrence.

The first person to recognize the usefulness of musculocutaneous flaps taken from the leg for pelvic reconstruction was Dr. John McCraw, who, while a plastic surgeon at Wilford Hall USAF Medical Center, developed the surgical techniques by animal experimentation, cadaver dissection, and, later, patient application. Previously, the concept of skin–muscle unit integrity had not been applied to the female patient with a pelvic malignancy. Owens, and later Bakamjian, designed the first compound skin–muscle flaps using the sternomastoid muscle.1,2 Orceochea used a gracilis musculocutaneous cross–leg flap to cover an ankle defect3 and also devised an ingenious method for total penile reconstruction using a gracilis musculocutaneous flap;4 however, it remained for Dr. McCraw to apply the extremely useful technique of the musculocutaneous flap to pelvic reconstruction. In the 10 years since his original article was published,5 the principle of using the skin–muscle unit to transfer viable tissue into a damaged or resected area of the pelvis has resulted in the development of many useful flaps. The biceps femoris, gracilis, tensor fascia lata, gluteus maximus, quadriceps, rectus femoris, rectus abdominis, sartorius, and bulbocavernosus muscles all have been used for flap construction. In addition, rapid

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Clinical Application

After Dr. McCraw's experimental groundwork in 1975, exciting clinical applications became apparent. The first patient, after radical vulvectomy and postoperative radiotherapy, had a painful perineal irradiation ulcer that resisted all forms of local therapy. After excision of the damaged tissue, a unilateral biceps femoris flap was used to cover the defect. The area promptly healed, and the patient had no pain. This procedure demonstrated the usefulness of the musculocutaneous flap as a new source of blood supply, effective even in irradiated fields. The patient also regained sensation in her perineal area, awakening her long-dormant libido. A neovagina was constructed with a second flap, and she was again sexually functional, even orgasmic, after many years of frustration.

This initial success led to the construction of a neovagina in several patients who previously had total pelvic exenteration but did not have construction of a neovagina at the time of the extirpative surgery. It was learned that the procedure is difficult when the perineum is closed because a large cavity is required for insertion of the bulky flaps. It was sensed that this disadvantage would be an advantage if the procedure were done at the time of exenteration. Subsequently, bilateral gracilis musculocutaneous flaps for neovaginal reconstruction were used at the time of pelvic exenteration. The gracilis muscle was chosen, rather than the biceps femoris, because of a more constant vascular pedicle, allowing for greater flexibility of rotation.

At first there was concern that the addition of vaginal reconstruction to the exenterative procedure would produce unacceptable morbidity. Fortunately, this was not the case. In fact, the morbidity was lessened because the large pelvic cavity was filled. Neovaginal reconstruction, along with the use of the omental sling for pelvic

Definition

An island musculocutaneous flap is an integral skin–muscle unit supplied by a muscle vascular pedicle. The blood supply of the skin is derived primarily from perforating muscular vessels, rather than from named, longitudinal axial cutaneous vessels. While cutaneous axial flap principles are well established, only a few axial flaps have been described outside the head and neck areas. The reason for this paucity of recognized independent cutaneous vascular territories is the scarcity of longitudinal cutaneous vessels, which are not perforating muscular vessels. That is, most skin flaps are random flaps because flap elevation interrupts their normal blood supply, i.e., perforating muscular vessels. It follows that skin viability depends on the integrity of the skin–muscle unit. This important concept led to the development of musculocutaneous flaps for pelvic reconstruction.6

development of flaps in many other body areas also has taken place. However, the gracilis musculocutaneous flap remains the most versatile and widely used for pelvic reconstruction.
VULVOVAGINAL RECONSTRUCTION

coverage, was found to significantly decrease the fluid loss and made early postoperative care easier.

As experience was gained and fewer pictures were taken, vaginal reconstruction could be completed before the conduit and colostomy were finished. Thus, no additional operative time was required, and the 200–300-ml blood loss was not a significant added risk. Furthermore, because vaginal reconstruction at the time of exenteration gave the patient an anatomic vagina, she could begin the psychologic recovery phase of her surgery much earlier than had been previously possible. An added advantage was the provision of a portal of entry for examination. Moreover, due to the pad of adipose tissue inherent in each flap, the neovagina was found to be aesthetically pleasing to the patient and her husband.

The gracilis musculocutaneous flap has been found to be useful in the following clinical circumstances:

1. Vaginal reconstruction with an exenteration
2. Vaginal reconstruction with an abdominal perineal resection
3. Perineal reconstruction after extensive tissue resection with radical vulvectomy
4. Groin reconstruction postradiation necrosis
5. Perineal reconstruction postradiation necrosis
6. Closure of a vesicocutaneous fistula after radiotherapy

The procedure has not been satisfactory for vaginal reconstruction secondarily because adequate cavity creation is difficult. Also, it is not the procedure of choice for vaginal agenesis, since the McIndoe Procedure is easier and can be used with a smaller cavity.

Surgical Procedure

The patient is placed in obstetric stirrups in the ski position with the hips abducted 45 degrees and flexed 15 degrees (Fig. 2). After iodine preparation, the flap is outlined with the use of a sterile marking pen. In obese patients, the gracilis muscle may be difficult to palpate. If the procedure is being done at the time of exenteration, the subcutaneous tunnel between the perineal defect and the leg can be made at this time, so that the gracilus muscle can be located just posterior to the abductor longus (Fig. 3). The anterior border of the flap lies along a line drawn between the proximal adductor longus tendon in the groin and the distal semitendinosus tendon at the popliteal fossa. The flap may be 6–8 cm

FIG. 2. The patient is placed in the ski position and the flaps are outlined. Careful placement over the gracilis muscle is important.
wide and 20–25 cm long, depending upon the size of the patient.

Flap elevation is begun at its anterior margin, just beneath the adductor longus muscle. The vascular pedicle is seen beneath the fascial layer separating the adductor longus and brevis muscles, about 7 cm distal to the pubic tubercle (Figs. 4 and 5). After the anterior incision is complete, the posterior incision (Fig. 6) can be made rapidly because the vascular pedicle, which eventually will be the rotation point for the flap, will be in full view.

The gracilis muscle is transected distally along with the fat and skin, so as to allow for rotation of the flap, but the muscle proximally is left intact (Fig. 7). The fascia deep to the gracilis muscle is elevated with the flap. The muscle is sutured distally to the skin of the flap so that the muscle is not

FIG. 3. The incision has been made anteriorly, exposing the adductor longus muscle. The gracilus muscle and the partially dissected flap are seen below the adductor longus.

FIG. 4. The hemostat is touching the adductor longus muscle at about the point where the vascular pedicle to the gracilis will be found.
FIG. 5. The vascular pedicles to the gracilis are seen coursing from behind the adductor longus. This is why the first step in flap construction is to find the adductor longus.

separated from the remainder of the flap during later manipulation. If separation occurs, the skin will lose its blood supply and become necrotic.

Before rotation careful dissection adjacent to the vascular pedicle may be necessary to obtain the necessary mobility. A large subcutaneous tunnel is made beneath the skin, bridging the leg incision and the pelvic cavity. This bridge should not be cut and the flap placed across, because the result is an unpleasant perineal bulge that some patients liken to a scrotum. Instead, rotating the now mobile flap posteriorly under the skin bridge will prevent such a bulge (Fig. 8).

After it has been determined that adequate mobility has been achieved, the flap is placed back in its original position and held in place by wrapping it with a moist

FIG. 6. After the vascular pedicles are located, the distal and inferior margins of the flap are dissected free from the leg.
FIG. 7. The skin, fat, and muscle are transected at the distal end. Proximally the skin and fat are incised but the gracilis muscle is left intact. Note the intact vascular pedicle and remaining adductor muscles.

FIG. 8. The distal end of the flap is rotated posteriorly and then brought through the skin bridge separating the leg and perineal incisions.

FIG. 9. Preserving the vascular pedicle is the key to flap viability.
towel. This decreases the stress on the vascular pedicle while the second flap is being raised (Fig. 9).

Both flaps then are rotated posteriorly and the distal ends pulled beneath the skin bridge so that they are located just outside the perineal defect (Fig. 10). The flaps may be trimmed as desired, especially at the distal ends, so that the neovagina will not be conical in shape (Fig. 11). The flaps are made into a tube by approximating the distal and lateral margins of the flaps using absorbable suture material (Fig. 12). Interrupted sutures are more time consuming but seem to allow less suture line separation postoperatively.

The neovagina then is rotated into the pelvic cavity and sutured to the presacral fascia or levator muscles (Figs. 13 and 14). The omentum is brought down into the pelvis from above and is used to cover the raw surfaces and the neovagina. A soft, suction-type drain is placed beneath the omentum and is brought out a lateral abdominal stab wound. Initially drains were brought out adjacent to the flaps, but they caused granulation tissue and dyspareunia, so they are no longer used.

The skin of the neovagina is sutured to the perineal skin. Lateral skin darts should be made to prevent contraction at the introitus. The leg incisions are closed without drains or bolsters (Fig. 15). The patient may walk immediately.

Complications

Pulmonary Embolus

It was originally thought that the patient should be kept in bed for a few days. How-
ever, pulmonary embolus developed in two patients. Since that time, having the patient walk early and administering low-dose heparin have greatly decreased the incidence of embolus. We have had no postoperative deaths.

**Flap Necrosis**

Careful planning and preservation of the vascular pedicles prevent flap necrosis. In more than 100 flap constructions, only one flap has been completely lost. This resulted from the muscle being stripped from the subcutaneous tissue and skin as it was pulled through the tunnel. The muscle should always be sutured to the skin as the flap is being raised to prevent this problem.

**Flap Skin Necrosis**

Varying degrees of superficial skin necrosis may occur, especially in obese patients in whom the skin of the leg may sag, making flap planning difficult. Palpation of the gracilis muscle through the skin bridge before flap construction may be helpful. Even if some skin necrosis does occur, the

**FIG. 12. Flap construction is near completion. Note the bulk of the neovagina, which is a valuable asset in filling the large pelvic defect.**

**FIG. 13. The neovagina is now complete and the distal end will be rotated into the pelvic defect.**
FIG. 14. The distal end of the flap is sutured to the sacrum or levator muscles. The subcutaneous tissue seen at the perineum may be trimmed before suturing the flap to the perineal skin.

FIG. 15. The reconstruction is complete in the patient who had a posterior exenteration. Drains or bolsters for the leg incisions were found to be unnecessary.

FIG. 16. A patient who had a total pelvic exenteration after healing was complete. Note how normal the perineum appears.
FIG. 17. Not only is the neovagina important for sexual function, but it may be used for examination to detect an early recurrence of cancer.

FIG. 18. The flaps have been rotated anteriorly. This is not a step in vaginal construction, but it demonstrates how they may be used for repair of defects in the groin and lower abdomen.

FIG. 19. A gracilis flap is used here in the closure of a vesicocutaneous fistula in the lower abdomen that resulted from radiotherapy.
result will still be good, as long as the muscle is viable.

**Inadequate Vagina**

Inadequate vagina has occurred in only two situations: first, when vaginal reconstruction was done after the perineum was completely closed and an inadequate cavity was created, and, second, when a pelvic abscess developed behind the neovagina, resulting in dense fibrosis and a narrow vault.

**Leg Hypersensitivity**

Occasionally pressure on the neovagina causes an uncomfortable sensation in the legs. Usually this diminishes with time, so that it is not a significant problem.

**Conclusion**

For the past decade, many surgeons have demonstrated the versatility and applicability of musculocutaneous flaps in pelvic reconstruction and in many clinical circumstances that previously had remained unsolved problems (Figs. 16–19). In the future, additional improvements can be made for the benefit of all our patients for whom such surgery is indicated.

**References**