Pressure ulcers occur frequently in patients who are paraplegic or quadriplegic after spinal cord injuries. An estimated 1.3 to 3 million individuals developed some form of pressure ulcer in 2004.¹ New pressure ulcers are associated with significantly longer hospitalizations and cost and have been categorized as “never events” by the Center for Medicare and Medicaid Services (CMS), and hospitals are penalized by decreased reimbursement. Accordingly, the treatment of pressure ulcers represents a clinically and financially important issue. Pressure ulcers progress through a continuum ranging from blanching erythema to exposure of bone, which may develop osteomyelitis. Patients who are either insensate or unable to move carry a significant risk of both primary and recurrent pressure ulcers. Some spinal cord injury patients over time develop recurrent and large pressure sores for which there are few reconstructive options. There remains a finite quantity of local tissue for conventional fasciocutaneous and myocutaneous flaps, and when all options have been exhausted, there remain a large surface area and volume of cavitation that will require reconstruction; ulcers at this stage are in essence end-stage pressure ulcers.

Background: The purpose of this article is to describe the indications, operative technique, outcomes, and systematic review of the literature on the reconstruction of patients with end-stage pressure ulcers using a fillet flap technique. In this technique, the femur, tibia, and fibula are removed from the thigh and leg, and the soft tissue is used as a pedicled, or free, myocutaneous flap for reconstruction. Long-term outcomes, salient surgical technique of flap elevation, and design are detailed for patients who had a fillet of leg flap for reconstruction of extensive pressure ulcers.

Methods: The indications, surgical technique, and postoperative outcomes of 5 patients who had pedicled fillet flaps are reviewed including patient age, sex, underlying comorbidities, duration of paraplegia, operative technique, and complications. A systematic review of the literature was performed searching PubMed, Cochrane Database, and Medline with the following MeSH terms: pressure ulcer, pressure sore, decubitus ulcer, fillet flap, and fillet flap. Inclusion criteria were use of a fillet technique, article data on the number of reconstructions before fillet flap, complications, and English language.

Results: Most of our patients were male 75% (n = 3) with an average age of 47.5 years, had been paralyzed for an average of 16 years, and had few medical comorbidities. Two patients (3 flaps) required hip disarticulation, 1 patient had a bilateral fillet flaps, and 3 patients had resection of tibia/fibula. After following patients for an average of 1.4 years (4 mo to 2 yr), complications were limited to 1 patient who had partial-thickness flap loss at the distal skin flap that healed by secondary intention and 1 patient who had ulcer recurrence because of noncompliance. Four articles met inclusion criteria for systematic review and 3 were excluded.

Conclusions: The fillet of leg flap remains a useful and reliable method of reconstructing end-stage pressure ulcers. (Plast Reconstr Surg Glob Open 2016;4:e1001; doi: 10.1097/GOX.0000000000001001; Published online 12 August 2016.)

Disclosure: The authors have no financial interest to declare in relation to the content of this article. The Article Processing Charge was paid for by the authors.
There is little written about the reconstruction of end-stage pressure ulcers, specifically with respect to the long-term outcomes. There are 7 articles detailing the operative technique and postoperative outcomes of using a fillet technique for pressure ulcer reconstruction, with 1 article describing free tissue transfer of the filleted tissue. Excision of the femur and lower extremity bones with preservation of the soft tissue (ie, a fillet) for pressure ulcer reconstruction was initially described in 1956 by Georgiade et al for treatment of a sacral pressure ulcer and reported an overall good outcome in 1 patient, followed by an article 13 years later by the same group detailing their experience in 28 patients. Menzoian et al in 1972 published a case report on the use of a fillet technique in combination with bilateral hip disarticulation in 1 patient without complication. Chen et al performed a free tissue transfer of a fillet segment for a large sacral ulcer reconstruction in 1986. Berger et al subsequently described the division of a thigh flap into 2 segments, thereby creating independent flaps based off the profunda femoris and superficial femoral artery. In 2009, Jandali and Low published a case report entailing 4 patients who underwent an anteriorly based flap; unique to this article was use of the entire-leg soft-tissue envelope to the ankle. Most recently in 2014, Verveld et al published their experience with reconstructing 5 patients using a fillet technique; an interesting variation in their technique is starting the operation in the supine procedure, basing the flap on the posterior thigh soft tissue and tunneling the flap from anterior to posterior through a gluteal defect.

Our plastic surgery division has provided comprehensive multidisciplinary care to patients with pressure ulcers and complex wounds for over 30 years. Perhaps unsurprisingly, we intermittently encounter recalcitrant end-stage pressure ulcers in whom the total surface area of the wound far exceeds all other local options (which have previously been utilized). In the past 2 years, we have performed 5 fillets of leg flaps for such ulcers. We sought to perform a systematic review of this technique to offer surgeons caring for similar populations insight into the outcomes, complications, and surgical approaches to the fillet flap for the purpose of pressure ulcer reconstruction.

METHODS

A database review was performed of patients who underwent reconstruction of pressure ulcers requiring removal of the femur, tibia, fibula, or foot (fillet technique). Patient demographics included (1) age, (2) etiology of immobilization and level of spinal cord injury, (3) duration of immobilization, (4) number of prior operations for ulcer reconstruction, and (5) complications. Complications were defined as major if they resulted in flap necrosis or needed reoperation. Minor complications were defined as superficial sheer, dehiscence not requiring reoperation, or superficial infection.

A systematic analysis of PubMed, Cochrane Database, and Medline was done for the following MeSH terms: pressure ulcer, pressure sore, decubitus ulcer, fillet flap, and fillet flap. Inclusion criteria were use of a fillet technique for pressure ulcer reconstruction, patient age, number of reconstructions before fillet flap, complications, and English language.

RESULTS

Case Series

Four patients underwent the procedure for the treatment of recalcitrant pressure ulcers, including the one who had bilateral fillet flaps (5 flaps total). Most were men (n = 3) with an average age of 47.5 years (38–59 yr). All patients had spinal cord injuries for an average of 18 years (14–24 yr) and had an average of 3 prior surgical procedures per pressure ulcer. The mean length of follow-up was 1.4 years (4 mo to 2 yr). Complications were limited to 1 patient who had partial-thickness necrosis of the distal skin flap adjacent to the inset and 1 patient who had recurrent stage 4 pressure ulcer because of noncompliance. The former complication healed by secondary intention following debridement, whereas the latter was treated with debridement and negative pressure wound therapy (V.A.C., Acelity, San Antonio, Tex.) as he did not desire to undergo a contralateral fillet flap.

Technique of Flap Elevation

The initial focus of the operation is debridement of the pressure ulcer, which can also be done in a staged manner. Following gross debridement of the pressure ulcer and the sinus tract, the exposed boney pelvis is debrided using a curved osteotome until healthy bleeding and bone turgor are achieved and a deep bone sample is sent for aerobic and anaerobic culture. The design for flap elevation begins with a curvilinear incision beginning at the superolateral aspect of the pressure ulcer, which then extends inferiorly and anteriorly down the lateral aspect of the thigh, approximating the lateral border of the biceps femoris muscle and the vastus lateralis (Fig. 1); this incision can be altered to incorporate existing incisions (eg, posterior thigh flap). The incision is carried caudally to approximately 2 cm above the fibular head at which point the incision is brought anterior toward the anterior border of the peroneus longus muscle to preserve the peroneal artery and common peroneal nerve (Fig. 2). The incision is then continued caudally (to the ankle if necessary) until there is sufficient soft tissue for ulcer coverage at which point a circumferential incision is made; we have found that performing a distal amputation is helpful in covering extensive defects on both sides of the pelvis, whereas a flap with shorter length may not reach across midline.

Following the distal ligation of the posterior tibial, peroneal, anterior tibialis and veins, the distal leg and foot are amputated; the peroneal nerve branches (superficial and deep) and posterior tibial nerves are divided sharply distally and buried in the adjacent musculature to prevent neuroma formation. Removal of the tibia and fibula distal to the knee joint begins with approaching the fibula from the posterior surface. Upon displacing the gastrocnemius and soleus muscles medially, the periosteum of the fibula is readily identified. A Cobb elevator is then used to perform subperiosteal
dissection circumferentially around the proximal third of the fibula to protect the neurovascular bundle; the musculature overlying the remainder of the fibula is dissected using electrocautery. Then, the posterior tibial artery and nerve are bluntly dissected off the posterior tibia, and the Cobb elevator is again used to encompass the tibia and preserve the anterior tibial artery. Upon disarticulation of the tibia and patella, the femur is approached lateral to the bicep femoris muscle from the region of the knee joint to the hip. Perforating branches from the profunda femoris are ligated. A sagittal saw is then used to transect the femur inferior to the greater trochanter. An attempt is made to preserve the femoral head and neck to preserve pelvic stability and balance. However, if the flap is not long enough to be inset after rotating it over the femoral stump, the femur is disarticulated at the hip joint to permit tension-free inset. The flap is then folded upon itself with the hamstring musculature being sutured into the dead space using 0 Vicryl suture (Fig. 3). The muscle segments may be elevated off the skin flap for a short segment (~5 cm) to independently tailor them to the wound topography. The remainder of the flap is then inset into the defect by suturing the deep fascia to the recipient fascial layer after placement of #19 Blake drains. The deep dermal layer and superficial layer are then approximated with 2-0 Vicryl and 2-0 Nylon sutures and staples.

**Systematic Review**

The initial search provided 76 articles of which 4 met inclusion criteria resulting in a total of 11 patients and 11 fillet flaps, all of which were unilateral (Table 1). There was 1 article, which had the largest series (41 flaps in 28 patients); however, it did not meet inclusion criteria because of lack of patient-specific data. Most patients were male (n = 7; 63%) with an average age of 42.3 years, and 36% had 3 or more prior surgeries. Of the 4 articles, 3 used an anteriorly based skin flap that began in the prone position with an incision that approximated the lateral border of the fibula head at which point the incision is brought anterior to the anterior border of the peroneus longus muscle to preserve the peroneal artery and common peroneal nerve.

**DISCUSSION**

Although seemingly radical in its approach, this fillet flap technique offers an overall safe and effective means...
to treat end-stage pressure ulcers in patients who have no local options for reconstruction. It provides obliteration of dead space, restoration of pelvic padding, and durable cutaneous resurfacing. This technique may be associated with a higher complication rate compared with conventional local flaps for pressure ulcer reconstruction, specifically with respect to wound dehiscence. All patients in our series including the patient with bilateral fillet flap reconstruction were able to resume their preoperative activities of daily living and use their wheelchairs. The technique importantly preserves sufficient pelvic stability to resume activities of daily living, because every attempt was made to preserve as much proximal femur as possible.

The indications for this flap include (1) multiple decubitus ulcers or recurrent ulcers, with insufficient adjacent tissue for satisfactory flap coverage, (2) ulcers too large for reconstruction with a rotational flap, (3) multiple ulcers associated with severe contractures of the hip and knee joint, and (4) ulcers with extensive osteomyelitis of the pelvis. We also recommend that patients have an end colostomy before
the fillet flap reconstruction to optimize bowel care and postoperative nursing care. We usually wait about 4 to 6 weeks after the colostomy before doing flap reconstruction. Similar to other operations, a thorough review of the risks, benefits, and patient expectations is of great import. The benefits of stable wound coverage, resolution of infection, hygiene, and resumption of activities of daily living are readily evident. Risks that are to be expected include the need for blood transfusion and wound healing complications, most commonly wound dehiscence. 7 In both our case series and systematic review, we have not found patients to have difficulty with maintaining balance with or without hip disarticulation.

In addition to using a posterolateral incision for access to the femur, a critical element in designing this flap is the anterior extension of the incision just superior to the fibular head, which allows for the preservation of the perforating vessels supplying the skin territory from the peroneal artery. This also permits preservation of the deep and superficial branches of the peroneal nerve to avoid neuroma formation. The inferior length of the incision is carried distally until sufficient soft tissue is obtained to meet the demands of the wound. The posterior muscle bulk (bicep femoris, semitendinosus, and semimembranosus) may be separated from the cutaneous flap distally at the level of the knee for several centimeters to allow custom inset of these muscles into the dead space; taking down multiple perforators should be avoided to preserve adequate blood supply, however. We do not recommend extensive splitting of the flap for independent tailoring because it can compromise the blood supply of the flap. An alternative in some patients is to proceed with a fillet flap from the contralateral leg in a staged manner. A second flap will also provide sufficient tissue that can be readvanced in the event of ulcer recurrence. The optimal length of femur to preserve has not been quantified; however, our approach has been to remove only as much femur as needed to advance the flap into the wound. At a minimum, the femoral head and neck should be preserved to serve as a post to pivot upon if the flap is to be safely rotated over the stump without tension at the suture line. If a patient has had a girdlestone procedure, then preservation of the distal femur is not needed as it would not contribute to pivot function.

Alternatives to using the ipsilateral lower extremity for reconstruction of an ischial and/or midline sacral ulcer include using the contralateral lower extremity for contralateral ischial ulcer reconstruction. A pedicled vertical rectus (vertical rectus abdominis muscle) brought through the abdomen could also be used for reconstruction of pressure ulcers void of local options; however, for extremely large de-

### Table 1. Case Series Patients

| Age (yr) | Sex | Underlying Condition | No. Prior Flaps | Unilateral/Bilateral Fillet | Complications | Complication Type | Follow-up (mo) |
|---------|-----|----------------------|----------------|-----------------------------|---------------|------------------|----------------|
| 44      | F   | Traumatic paraplegia | 3              | Unilateral, hip disarticulation | 0            | Superficial necrosis, not requiring surgery | 19             |
| 38      | M   | Traumatic paraplegia | 4              | Bilateral, hip disarticulation | 1            | Recurrence       | 12             |
| 56      | M   | Traumatic paraplegia | 3              | Unilateral, hip disarticulation | 2            |                  | 20             |
| 41      | M   | Traumatic paraplegia | 2              | Unilateral, hip disarticulation | 0            |                  | 15             |

### Table 2. Systematic Review Outcomes

| Reference     | Age (yr) | Sex | Underlying Condition | No. Prior Flaps | Unilateral/Bilateral Fillet | Complications | Complication Type | Follow-up (mo) |
|---------------|---------|-----|----------------------|----------------|-----------------------------|---------------|------------------|----------------|
| Menzoian et al | 45      | M   | Multiple sclerosis   | 0              | Bilateral, staged           | 0            |                  | 7              |
| Chen et al    | 22      | M   | Traumatic paraplegia | 0              | Unilateral free flap        | 0            |                  | NA             |
| Jandali and Low | 25   | F   | Transverse myelitis  | 2              | Unilateral, hip disarticulation | 0 |                  | 84             |
| 60            | M   | Traumatic paraplegia | 0              | Unilateral, hip disarticulation | 1 | Dehiscence requiring reoperation | 48             |
| 20            | F   | Spina bifida         | 2              | Unilateral, hip disarticulation | 1 | Dehiscence requiring reoperation | 24             |
| 48            | M   | Paraplegia           | 1              | Unilateral, hip disarticulation | 1 | Venous congestion, flap failure | NA             |
| Verveld et al | 42      | M   | Traumatic paraplegia | >3             | Unilateral                  | 1            |                  | NA             |
| 68            | M   | Marjolin ulcer s/ p radiation therapy | 0 | Unilateral                  | 1            | Abscess requiring drainage | NA             |
| 43            | M   | Multiple sclerosis   | 3              | Unilateral                  | 1            | Adductor contracture requiring reoperation | 24             |
| 69            | F   | Traumatic paraplegia | >3             | Unilateral                  | 0            |                  | NA             |
| 26            | F   | Spina bifida         | >3             | Unilateral                  | 0            |                  | NA             |
effects, a single vertical rectus abdominis muscle is unlikely to provide sufficient soft-tissue coverage, especially for ischial and trochanteric ulcers given their very inferior location, and has the risk of ventral hernia. A theoretical disadvantage associated with this fillet flap technique includes the possibility of destabilizing the pelvis when sitting and leads to a high-pressure location on the contralateral hip. Referral to a physical therapist may be needed for pressure mapping and fabrication of an appropriate wheelchair cushion.

In summary, a fillet flap technique is a safe and overall effective treatment of recalcitrant and large end-stage pressure ulcers allowing patients to resume their activities of daily living and use their wheelchairs.

James Edward McCarthy, MD
Division of Plastic and Reconstructive Surgery
University of Wisconsin-Madison
600 Highland Avenue
Madison, WI
Email: Rao@surgery.wisc.edu

REFERENCES
1. Georgiade N, Pickrell K, and Maguire C. Total thigh flaps for extensive decubitus ulcers. Plast Reconstr Surg. 1956;17:220–225.
2. Royer J, Pickrell K, Georgiade N, et al. Total thigh flaps for extensive decubitus ulcers. A 16 year review of 41 total thigh flaps. Plast Reconstr Surg. 1969;44:109–118.
3. Menzoian JO, Brook DL, Deckers PJ, et al. Bilateral hip disarticulation with total thigh flaps for extensive decubitus ulcers: a case report. R.I. Med. J. 1972;55:251–255.
4. Cheng HC, Weng CJ, Nordhoff MS. Coverage of multiple extensive pressure sores with a single filleted lower leg myocutaneous free flap. Plast Reconstr Surg. 1986;78:396–398.
5. Berger SR, Rubayi S, Griffin AC. Closure of multiple pressure sores with split total thigh flap. Ann Plast Surg. 1994;33:548–551.
6. Jandali S, Low DW. Pedicled fillet of leg flap for extensive pressure sore coverage. Eplasty. 2009;9:e50.
7. Verveld CJ, Fuchs SP, Buncamper ME, et al. The tunnelled lower leg fillet flap, a reconstructive salvage option in patients with severe pressure ulcers. J Plast Reconstr Aesthet Surg. 2014;67:427–428.