A New Approach to Closure of Large Lumbosacral Myelomeningoceles: The Superior Gluteal Artery Perforator Flap

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The most common form of neural tube defect is the myelomeningocele, developing during the fourth week of gestation. The era of early closure of myelomeningoceles began in the sixties with the demonstration that these patients had a lower rate of mortality.[1] The goals of early surgical closure are to (1) prevent infection, (2) eliminate cerebrospinal fluid leaks, (3) preserve neural function, and (4) diminish negative late sequelae such as pain over the closure site and possibly even tethered cord.[2] After closure of the neural tube and dura, the majority of these patients have enough local skin to allow for simple closure of the skin over the dural closure. When the skin defect is large or the surrounding skin quality is poor, more elaborate methods of obtaining stable skin closure over the dural closure must be devised.[3]

Multiple methods of soft-tissue closure for larger lumbosacral myelomeningocele defects have been described, including skin grafting,[4] random flaps,[5] skin undermining with relaxing incisions,[6] and musculocutaneous flaps.[7,8] None of these approaches are ideal, however, particularly when the skin defect is large and/or the quality of the surrounding skin is poor. We have developed a new approach to closure of large lumbosacral defects with superior gluteal artery perforator flaps.

Patients and Methods

Six patients were operated on over an 18-month period. During this period, our neurosurgical group treated a total of 34 myelomeningocele patients. Plastic surgical consultation was initiated by the pediatric neurosurgeon when he felt the defect was too large for closure with simple skin advancement flaps. The average birth weight of the six patients was 3237 grams and the average cutaneous defect covered with the superior gluteal artery perforator flaps was 4.8 × 6.8 cm. The flaps were designed to match the cutaneous defect. Two of the patients were prenatally diagnosed with the myelomeningocele. All of the patients were operated on within 36 hours of birth. All patients were operated on in the prone position under general endotracheal anesthesia. The average blood loss during the procedures was 12 cc, and no patients required blood transfusions intraoperatively. The average operative time for the combined procedure was 190 minutes; the average plastic surgical operative time for flap elevation and insetting was 115 minutes. Neurosurgical management included initial placode dissection, spinal cord reconstruction and closure, and dural elevation and closure.[9] The first patient this approach was used on showed a very large myelomeningocele with very poor quality surrounding skin. Figure 1 demonstrates the flap design and marked perforators before the start of the operation; the neural tube has been imbricated and dural closure is about to be performed.

The plastic surgical component of the operation begins with Doppler identification and

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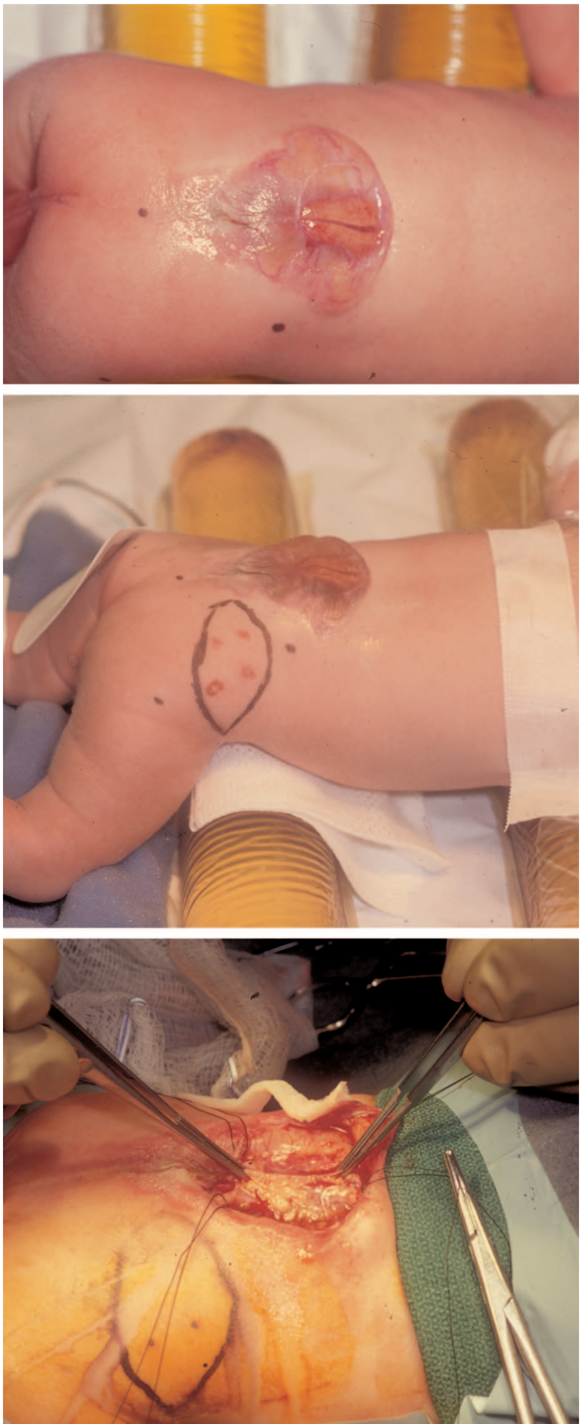

FIG. 1. (*Above*) Patient with a very large myelomeningocele with very poor-quality surrounding skin. The flap design and perforators were marked before the start of the operation (*center*); the neural tube has been imbricated and dural closure is about to be performed (*below*).

marking of the perforating vessels off the superior gluteal artery and designing the flap (Fig. 1, *center*). The dissection is done with 4.5-power loupe magnification and microsurgical instruments. The flap is elevated, based on the dominant perforator, in this case with a small amount (approximately 1 cm cuff) of surrounding muscle and then tunneled into the defect from the flap donor site (Fig. 2, *above* and *center*). The perforator bundle in these patients was approximately 1 to 2 mm (including one artery and one or two veins). The flap is then inset and the donor site is closed. A year after surgery, the flap provides durable coverage with a substantial amount of subcutaneous fat that has even hypertrophied (Fig. 2, *below*). The donor site healed well. These photographs are from the first child this approach was used on. We chose to harvest the flap with a small muscle cuff, as we were concerned that the perforator might not tolerate the twisting required to inset the flap. The five subsequent patients were dissected with very little (approximately 2 mm) muscle in two cases and no muscle in three cases.

A second patient with a large defect treated with the same approach is shown in Figure 3. Figure 4 depicts the stages of the operation.

RESULTS

All flaps survived, although venous congestion was common immediately following surgery. One patient did have moderate epidermolysis at the flap tip (farthest from the blood supply), but this healed completely without any tissue necrosis or revision surgery. No patients required any surgical revisions. There were no infections. All patients required subsequent ventriculoperitoneal shunts for hydrocephalus, and these procedures were uneventful; there were no shunt infections. All donor incisions healed without complication.

DISCUSSION

Perforator flaps are a relatively new concept in reconstructive surgery. These flaps were developed in an attempt to minimize morbidity at the flap donor site by leaving the underlying muscle and the nerve supply to the muscle undisturbed. The development and execution of these flaps depend on a thorough knowledge of perforator anatomy. These flaps can be transferred as pedicle flaps, as in the superior gluteal artery perforator flaps discussed in this report, or as microsurgical free tissue transfers for use on other regions of the body. For example, the superior gluteal artery perforator flap can be dissected out and used as a free tissue transfer to reconstruct the breast in adults.[10]

After the pediatric neurosurgeon has closed the neural tube, the role of the plastic surgeon

FIG. 2. (*Above* and *center*) The flap is elevated, based on the dominant perforator, in this case with a small amount (approximately 1 cm cuff) of surrounding muscle, and then tunneled into the defect from the flap donor site. (*Below*) One year after surgery, the flap provides durable coverage with a substantial amount of subcutaneous fat that has even hypertrophied.

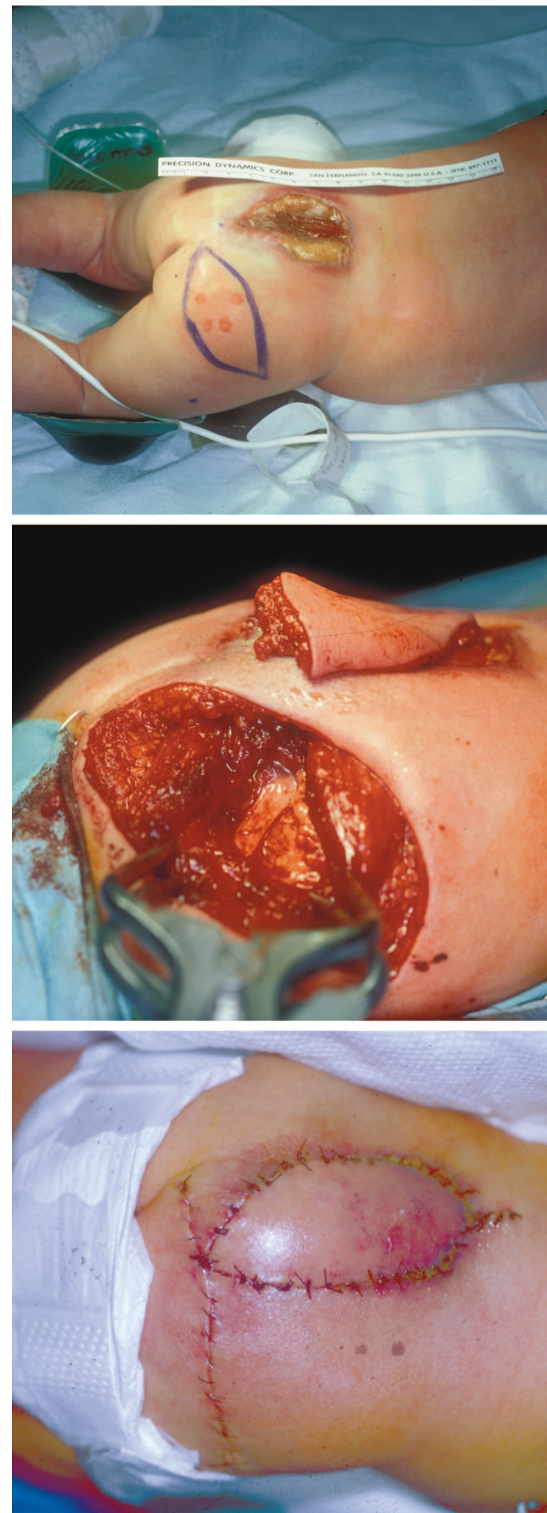

FIG. 3. A second patient with a large defect was treated with the same approach illustrated in Figures 1 and 2.

in these larger defects is to provide durable coverage of the neural tube to prevent damage to or infection of the neural structures.[11] Luce et al.[4] suggested that the best technique for closure of these defects would be capable of covering the entire defect, sufficiently vascular to guarantee survival, provide a supporting rest for the contacting surfaces, preserve the functional integrity of the structures included in the flap, ensure long-term durability of the closure, be aesthetically acceptable, and represent the least threat to the patient's life. We suggest that the superior gluteal artery perforator flap addresses Luce et al.'s criteria for the best technique better that any existing technique when considering very large lumbosacral skin defects. In addition, true to the perforator approach to flap harvest, most or all of the gluteus muscle is left behind and theoretically functional. Innervation of the gluteus maximus is variable in these patients, but given the importance of this muscle in helping to transfer and get out of a wheelchair, it clearly should be preserved, if possible, and harvest of the superior gluteal artery perforator flap preserves the underlying gluteus muscle.

We believe one of the most promising features of this approach is the coverage of the dural closure with well-vascularized tissue with a healthy subcutaneous fat layer for padding over the dural repair. Most of the other approaches involving skin flaps result in a suture line being directly over the dural closure, which would seem to increase the likelihood of a dural leak or infection.[12,13] Even if the dural closure leaks, if there is a continuous layer of healthy, vascularized tissue over the dura, cerebrospinal fluid leaks and infections should be significantly less frequent. This small series of superior gluteal artery perforator flaps certainly compare favorably to previous studies that have documented minor wound complications of 20 percent and major complications of 10 percent in a group of patients with myelomeningoceles that required plastic surgical involvement to achieve wound closure.[14]

Troublesome late side effects of myelomeningocele closure include chronic pain over the closure site and the tethered cord, which occurs in 11 percent to 27 percent of cases.[15,16] The signs and symptoms include back and leg pain, change in bladder tone, incontinence, change in motor or sensory level in the lower extremities, spasticity of the lower extremities, and rapid progression of scoliosis.[17] Symptomatic tethering of the cord in myelomeningocele patients is most frequently associated with scarring or adhesive arachnoiditis involving the neural placode adhering to the dura or overlying skin,[18] and it also appears to be related to traction on the cord, which could be worsened by external scarring.[19] Although the long-term benefits of superior gluteal artery perforator closure in these patients are unknown, we are hopeful that the superior gluteal artery perforator flap vascularity and durability may decrease the chronic pain that some patients have at the closure site and possibly even diminish the incidence of tethered cord. The small sample size of this study and short follow-up of this problem that can present years later precludes us from making any definitive statements, however.

We believe it is important to stress that the dissection of this flap is technically challenging and there is a definite learning curve, as is true with any new procedure. We chose to harvest the first flap with a small muscle cuff, as we were not certain the small perforator size would tolerate the twisting required to inset the flap. We then used very little muscle on two patients and, subsequently, no muscle on three

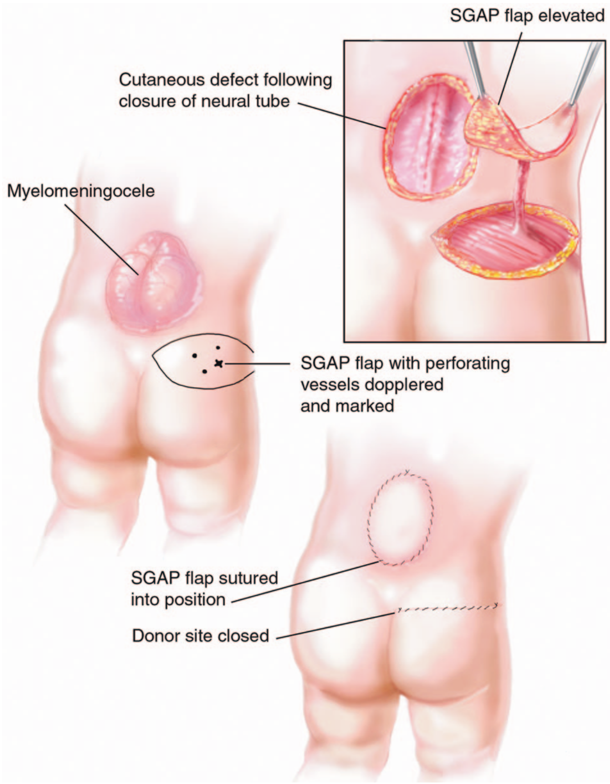

FIG. 4. Stages of the operation using the superior gluteal artery perforator (*SGAP*) flap.

patients. Although one could argue that several of these flaps were not true perforator flaps, we were primarily concerned with flap viability rather than semantics. The muscle harvested was such a small amount as to be clinically insignificant. Indeed, assessing long-term gluteal function in these patients is difficult because they have variable gluteal innervation when born. Superior gluteal artery perforator flap coverage of adult lumbosacral defects has proven to be successful,[20] and we certainly would recommend the technique to individuals in units that work with this patient population.

Summary

We believe the superior gluteal artery perforator flap represents a useful tool in the management of soft-tissue defects associated with large lumbosacral myelomeningoceles. The procedure allows for the transfer of healthy, vascularized tissue over the dural closure, likely diminishing both cerebrospinal fluid leaks and cerebrospinal fluid infections. Because the dural repair is covered with well-padded tissue using this flap, we are hopeful that this approach will diminish the chronic pain at the closure site that many of these patients have later in life. Although we are hopeful that this approach might also diminish the rate of symptomatic tethered cord, it will be many years and require many more patients before that question is definitively answered. The procedure is technically challenging and should be performed by individuals with significant experience with this patient population.

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