

# Closure of a Large Thoracolumbar Myelomeningocele Using a Modified Bilateral Keystone Flap

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**Summary:** The keystone flap, an emerging reconstructive option that can be used in many parts of the body, is gaining popularity among reconstructive surgeons. These reliable and versatile flaps can be used for large myelomeningocele closure. A modified bilateral keystone flap was used to achieve tension-free closure of a large thoracolumbar myelomeningocele associated with severe kyphosis in a newborn girl. The flap was modified by undermining in the subfascial plane in the medial aspect of the middle third. This undermining was performed to facilitate flap movement while preserving random musculocutaneous perforators captured within the island of tissues. Laterally, we approached the border of the latissimus dorsi and dissected in the submuscular plane instead of the subfascial plane to preserve more muscular fasciocutaneous perforators. We achieved soft-tissue coverage that was durable, stable, and protective. Wound healing was prompt, and the patient had a satisfactory cosmetic result. No postoperative complications were observed, such as flap necrosis, dehiscence, leakage of cerebrospinal fluid, or infection. The proposed modified keystone flap is a promising addition to the armament of reconstructive surgeons that might improve outcomes and minimize complications in myelomeningocele repair. Keystone flaps provide an ideal reconstructive option for large thoracolumbar myelomeningocele repair. They are reliable, robust, and aesthetically acceptable. (*Plast Reconstr Surg Glob Open* 2016;4:e1114; doi: 10.1097/GOX.0000000000001114; Published online 13 December 2016.)

The keystone flap is a unique method used in reconstructive surgery. Introduced by Behan<sup>1</sup> in 2003, this method has become a workhorse for locoregional fasciocutaneous reconstruction because of its reliability, versatility, and robustness. It was named for its resemblance to the stone at the highest point of Roman archways. Four main types have been described:

- Type I: unilateral keystone flap
- Type IIA: with additional division of the deep lateral fascia
- Type IIB: with closure of the secondary defect using a split thickness skin graft
- Type III: double keystone flaps and
- Type IV: rotational keystone flap

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In myelomeningocele repair, the keystone flap is supplied by the dorsal intercostal artery perforators, musculocutaneous perforators of the latissimus dorsi, lumbosacral arteries, and superior gluteal arteries.<sup>2,3</sup>

In a case series of 3 patients, Gutman et al<sup>4</sup> safely and effectively demonstrated the use of keystone flaps for lumbosacral myelomeningocele closure. More recently, in a case series of 5 patients, Park et al<sup>5</sup> demonstrated the use of keystone flaps in lumbosacral myelomeningocele repair and concluded that it is an effective, reliable, and durable reconstructive option.

Here, we report a case in which a modified type III bilateral keystone flap was used to close a large thoracolumbar myelomeningocele in a newborn girl. In lumbosacral myelomeningocele, the intrinsic skin laxity of the lower back usually facilitates closure, but the less mobile skin of the upper back and the thoracolumbar kyphosis in this patient presented a challenge for the surgical team. To the best of our knowledge, this is the first reported case where this type of flap was used for the primary closure of a thoracolumbar myelomeningocele.

## CASE REPORT

On January 3, 2016, a baby girl was born to a healthy 27-year-old primigravida by elective caesarian section at King

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Abdulaziz Medical City in Jeddah. The neonate had been diagnosed antenatally by ultrasound with a large thoracolumbar myelomeningocele at 31 weeks. At birth, her gestational age was 39 weeks and 1 day, and her weight was 3,020 g, which was appropriate for her age. Her Apgar scores were 7 and 9 at 1 and 5 minutes, respectively. She moved her upper limbs but not her lower limbs, which were deformed. The myelomeningocele was at the level of T1–T2 and associated with an obvious congenital thoracic kyphosis.

The patient was treated surgically on the second day after birth. She was placed in the prone position under general anesthesia. The neurosurgery team achieved complete closure of the dura, and the plastic surgery team was left with a defect measuring 13×6 cm (76 cm<sup>2</sup>; fig. 1).

The design and marking were done according to the keystone design first described by Behan<sup>1</sup> in 2003. Because we were presented with a large thoracolumbar defect with significant kyphosis, certain modifications were done in the dissection. In contrast to the previously reported cases using keystone flaps, the subfascial plane in the medial aspect of the middle third was minimally undermined. This undermining was performed to facilitate flap movement while preserving perforators from the dorsal intercostal artery in addition to the thoracodorsal perforators and the superior gluteal artery perforators that were captured within the island of tissues. Laterally in the middle third, we approached the border of the latissimus dorsi and dissected in the submuscular plane to preserve more muscular fasciocutaneous perforators. The challenging closure was achieved using these modifications to create a robust keystone flap supplied by multiple perforators. The secondary defects on both sides were left to heal by secondary intention.

After the operation, the patient was admitted to the neonatal intensive care unit. Immediately postoperatively, venous congestion was observed in the center and lower third of the flap. On postoperative day 3, the venous congestion started to improve noticeably. At postoperative day 21, no signs of necrosis, ischemia, dehiscence, cerebrospinal fluid leakage, or infection were observed.

The myelomeningocele was associated with Chiari malformation type II and hydrocephalus. A ventricular-peritoneal shunt was inserted 21 days after the myelomeningocele repair.

The patient did not require any further operative intervention for the defect closure. She was discharged from the hospital on February 21, 2016, and continues to have multidisciplinary follow-ups at King Abdulaziz Medical City in Jeddah, Saudi Arabia.

The cosmetic outcome was satisfactory both at the time of discharge and at the 3-month follow-up examination. No early or late postoperative complications were observed, and the wound healed promptly.

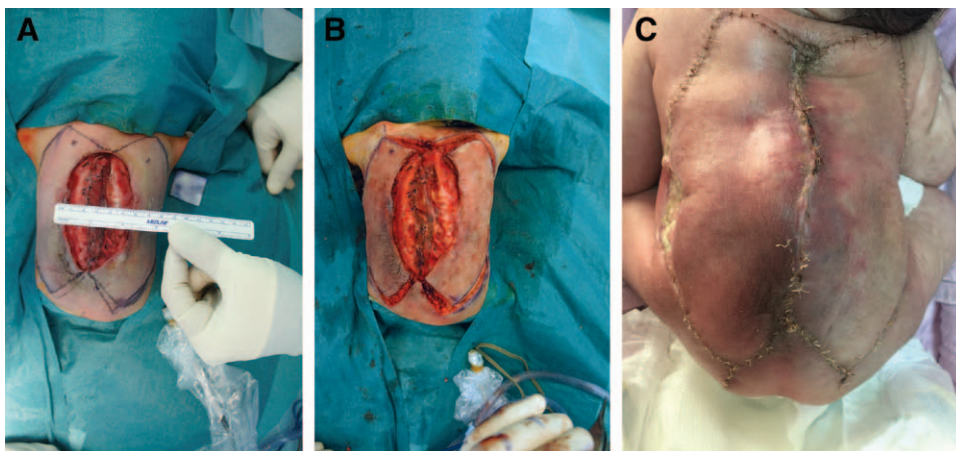
## DISCUSSION

Myelomeningocele is a congenital abnormality of the central nervous system that involves multiple tissue layers. It results from failed fusion of the vertebral arches.<sup>6,7</sup> Myelomeningocele typically occurs in the lumbosacral region. It is one of the most common birth defects of the central nervous system, with an incidence of 0.5 to 1 per 1,000 pregnancies in the United States.<sup>8,9</sup>

The main objectives of surgical intervention for myelomeningocele are to preserve existing function and provide durable tension-free coverage of the exposed spinal cord while eliminating cerebrospinal fluid leakage and preventing infection. It is also desirable to minimize morbidity secondary to local rearrangement of muscle and soft tissue.

Myelomeningocele repair is best attempted in the first 2 days of life to minimize the risk of injury or central nervous system infection.<sup>10</sup>

After analyzing the large defect, we considered 2 options other than our chosen flap; the first option was a bilateral bipediced fasciocutaneous flap. In this case, significant subfascial dissection would be necessary, which could sacrifice some perforators and potentially compromise the flap given the complexity and size of the defect. In this modified keystone flap, a tight skin closure was avoided, and multiple fasciocutaneous perforators were preserved by dissecting in the submuscular plane on lateral aspect of the middle third.



**Fig. 1.** A, Intraoperative marking and measurement. B, Intraoperative dissection. C, The flap 3 weeks postoperatively.

A bilateral latissimus dorsi musculocutaneous flap was the other alternative. However, this modified keystone flap will allow more advancement by utilizing the advantage of the V-Y advancement of the 4 angles plus the limited medial subfascial dissection. By performing a partial latissimus dorsi dissection, we may preserve some of its function.

In contrast to the originally described fasciocutaneous keystone flap, this modified flap was raised partially as a musculocutaneous flap in the middle third to overcome a potentially tight closure while preserving multiple perforators to supply this large flap.

### CONCLUSIONS

This modified keystone flap provides a promising addition to the armament of reconstructive surgeons that could improve outcomes and minimize complications in myelomeningocele repair. Keystone flaps provide an ideal reconstructive option for large thoracolumbar myelomeningocele repair. They are reliable, robust, and aesthetically acceptable.

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