Extended Transverse-oblique Back Flap for Myelomeningocele Defect Closure: A Case Series of 10 Patients

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Background: Myelomeningocele is the most common phenotype of congenital neural tube defects. Various reconstructive techniques have been described for soft tissue coverage following myelomeningocele repair, one of which is the use of dorsal intercostal artery perforator based flaps. The aim of this study was to describe our experience with the use of a transverse-oblique back flap that can be reliably extended to the anterior axillary line for closure of myelomeningocele defect. This pedicle transposition flap is based on thoracic or lumbar paraspinal perforators that originate from the dorsal intercostal arteries.

Methods: This is a retrospective two center case-series where all patients who underwent myelomeningocele defect closure with extended transverse-oblique flap over three years period were included. Patients’ clinical data, surgical variables, and outcomes were documented and analyzed using descriptive measures. Flap harvest technique is also delineated in the present study.

Result: Ten newborns (7 baby girls and 3 baby boys) who underwent a surgical closure of the myelomeningocele defect with an extended transverse-oblique back flap during the first week of life were included in the analysis. The defect was most commonly located in the lumbosacral area (50%) followed by the lumbar area (40%), with an overall average surface area of 22 ± 8.32 cm². Common encountered complications include venous congestion to the distal part of the flap and minor wound dehiscence of less than 0.5 cm, all were managed conservatively. There were no incidences of flap loss or full necrosis. Primary closure of the donor site was possible in all cases.

Conclusions: In the current series, the extended transverse-oblique back flap provided a safe and reliable coverage for myelomeningocele defect. Such a flap does not jeopardize other regional fasciocutaneous or musculocutaneous flaps that might be needed for soft tissue coverage later in life for this population. It also obviates the placement of skin suture line over the repaired neural tube, thus yielding a durable coverage with no major complications or functional disability. (Plast Reconstr Surg Glob Open 2020;8:e3095; doi: 10.1097/GOX.0000000000003095; Published online 25 September 2020.)

INTRODUCTION

Neural tube defects (NTD) are the most common congenital anomalies affecting the central nervous system, being the second most common congenital anomalies following congenital heart defects.1 Myelomeningocele (MMC) is the most common type of NTD. Many environmental and genetic factors have been associated with the development of myelomeningocele.

Incidence varies between countries: in the UK, studies reported an incidence of 0.74–2.5/1,000 live births; in Scandinavian countries, 0.2–1.3/1,000; and in Italy, 0.26–0.57/1000. In the US, the incidence is 0.41 to 1.43/1000.2 In Saudi Arabia, the incidence of spina bifida varies ranging from 0.76 to 11,000 /live births.3 Myelomeningocele usually associated with sensory and motor impairment

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of the lower limbs, genitourinary, and gastrointestinal incontinence.6

Surgical techniques for myelomeningocele have gone through significant advancement over the past decades, reaching a state-of-art intrauterine repair at highly specialized facilities; nevertheless, surgical closure at the early neonatal period remains the standard of care. Urgent coverage of spina bifida is needed due to the high mortality rate that may reach 65%–75%.7,8 Therefore, good coverage of the repaired dural sac with well-perfused soft-tissue is critical to improve neurological outcomes and preserve the remaining functional neural tissue as well as to prevent infections.9

Despite all the advances that have been observed in myelomeningocele reconstruction since the 1990s, there is no ideal technique that fits all patients. The aim of this study was to describe our experience with the use of a simplified technique for a transvers-oblique back flap that can be reliably extended to the anterior axillary line for closure of myelomeningocele defect.

METHODS

This is a retrospective case-series study conducted in two tertiary care hospitals in the central region of Saudi Arabia. All patients who underwent myelomeningocele defect closure with extended transverse-oblique flap from January 2015 to March 2018 were included. A retrospective chart review of their medical records was performed; patients’ demographics, comorbidities, defect size, location, duration of surgery, surgical outcome and complications were documented and analyzed. Descriptive measures, including percentiles and means and standard deviations (SDs), were used to summarize categorical and continuous variables, respectively.

SURGICAL TECHNIQUE

The extended transverse-oblique back flap is a pedicle transposition flap based on thoracic or lumbar paraspinal perforators that originate from the posterior intercostal arteries. The procedure is done under general anesthesia with the patient in prone position, with arms abducted 45 degrees. The entire back is prepared and draped, extending laterally to just beyond the anterior axillary line. The neural tube defect is repaired initially by the neurosurgical team, and then site marking for the flap is done. First, the midline of the back is marked, and then bilateral paramedian lines 2 cm lateral and parallel to the midline are marked. The thoracic and lumbar paraspinal perforators are usually located 1.5 cm from midline, which can be verified by a hand-held Doppler to ensure the consistency and reliability of the blood supply of the flap, although this is not usually necessary. The marked area represents the pedicle that should not be undermined. The dimensions of the flap are based on the width and length of the defect and can be replicated using a sterile gloves wrap as a template of the defect. The flap template is then used to mark the flap on the back with the base of the flap at the lateral line marked previously. The flap is directed in an inferior oblique manner towards the anterior axillary line with the inferior border of the flap begin just at the upper border of the defect. The width of the defect should equal the base of the flap and the length of defect should equal to the length of the flap. Pinch test is used to ensure that the donor site can be closed primarily without tension (Fig. 1A). The flap is then raised in the sub-fascial plane from the lateral to medial up to the marked area. The dissection is carried out with no attempts to identify or visualize the perforators. The tip of the flap can be extended all the way to the anterior axillary line if needed. During flap elevation, if the lateral edge of the latissimus dorsi muscle is encountered, it can be preserved, or it can be harvested with the flap to increase vascularity. The flap is then transposed and inset into the defect. Tension-free primary closure of the donor site is achieved with appropriate undermining of the skin and adducting the ipsilateral arm (Fig. 1B). In one center, the wounds are closed in a single layer with absorbable long acting sutures (3-0 polydioxanone) without using a drain. In the other center, a two-layers closure is done with 3-0 polyglactin 910 absorbable sutures and 4-0 polypropylene non-absorbable sutures for the deep layer and the skin, respectively, a size 5 French plaque surgical drain placed subcutaneously away from the dural repair. Bilateral flaps can be raised.

Fig. 1. A 2-day-old baby boy with lumbar defect. A, The flap marking, with the dotted line denoting the midline and the shaded area representing the area of perforators, and the flap tip was extended to the anterior axillary line. B, The flap after the closure, with a small dog ear deformity at the upper medial edge of the wound.
depending on the size of the defect, with the base of the flap equal to half the width of the defect, simple dressing with antibiotic ointment and non-adherence gauze is applied.

During the postoperative period, the patient is kept in a prone position for 3 weeks, with the arm adduction to minimize tension on the donor site closure. Daily dressing with antibiotic ointment and non-adherence gauze is continued until the wounds are healed. Non-absorbable sutures used for skin closure are removed at 2 weeks postoperative. All patients received intravenous antibiotics in the peri-operative period.

RESULTS

Ten newborns, 7 baby girls and 3 baby boys, underwent surgical closure of the myelomeningocele defect with extended transverse-oblique back flap from 2015 to 2018. Ninety percent of the patients were operated on at the first or second day of life. The remaining patient was operated on at the 6th day due to being transferred from another hospital. The birth weight ranged from 1.9 to 3.46 Kg with a mean weight of 2.57 Kg. Thirty percent of the patients had congenital cardiac anomalies, while all patients had type II Chiari malformation (Table 1). Ninety percent of the patients were paraplegic at the time of the surgery, with seventy percent exhibiting at least one skeletal deformity. The most common location of the defect was in the lumbosacral area (50%), followed by lumbar (40%) and thoracolumbar area (10%). The average surface area of the defect was 22 ± 8.32 cm². Five babies had disturbed meningeal sacs with CSF leak present at birth, with 3 of them having concomitant early signs of infection. Forty percent of the patients had a ventriculoperitoneal shunt inserted during the primary surgery, while it was delayed and done separately in the remaining 60% to decrease the anesthesia complications and operative time. The average operative time for the soft tissue reconstruction was 121.6 ± 22.58 minutes. Average intraoperative blood loss was 20 ± 8.13 ml. Thirty percent of patients received blood transfusions equivalent to their blood loss.

The most common complication, documented in 80% of the patients, was venous congestion to the distal part of the flap. Minor wound dehiscence (less than 0.5 cm) developed in 40% of the patients at the tip of the flap, 20% at the T junction of the donor site, and at both sites in 10% of the patients. The majority of these complications were in the first few days postoperatively and were managed non-operatively. Small partial flap necrosis (less than 2 cm) was only an issue in 20% of the patients, which was successfully treated conservatively (Fig. 2). None of the flaps developed hematoma; however, seroma at the donor site occurred in 10% of the patients. There were no incidences of flap loss or full necrosis in our series. Primary closure of the donor site was possible in all cases. None of the patients required reoperation for flap-related complications. Follow-up was 12–16 months (mean 14 months), which showed no late complications (wound dehiscence or sinus).

DISCUSSION

Surgical intervention in early neonatal life remains the mainstay of treatment. This entails conserving the neural tissue covered by the closure of dura, fascia, subcutaneous tissue, and skin. In small skin defects, primary closure offers a reasonable approach to attain tension-free closure, with a minimal risk of local complications. Patterson and Till observed that primary closure was not possible in 25% of 130 surgical cases, which increases the need for local or regional flaps for coverage. Kocak and Demir suggested that primary repair for defect with a diameter equal to or larger than 5 cm would impose tension, thus potentially compromising the neural repair line. Over the past years, variable reconstructive techniques for soft tissue coverage of MMC defect have been described. Such techniques, based on understanding the anatomy of the vascular perforators and the concept of angiosomes, were utilized to avoid the high failure rate of traditional closure in the past with extensive undermining and closure under tension. Therefore, flap reconstructive procedures are preferred to minimize the risk of high complications associated with primary closure in large

Table 1. Patient Demographics and Medical Comorbidities

| Pt. | Gender | Defect Location | Defect Size, cm | Neural Deficit | Congenital Heart/Vascular Anomalies | Skeletal Deformity | Presence of Lordosis |
|-----|--------|----------------|----------------|----------------|----------------------------------|-------------------|---------------------|
| 1   | Girl   | Thoracolumbar  | 6 x 6          | Paraplegic     | ASD type II                      | None              | Present             |
| 2   | Girl   | Lumbar        | 7 x 6          | Paraplegic     | PFO                              | None              | None                |
| 3   | Boy    | Lumbar        | 6 x 6          | Paraplegic     | None                             | Right talipes equinovarus | Present |
| 4   | Girl   | Lumbar        | 5 x 5          | Paraplegic     | None                             | None              | None                |
| 5   | Girl   | Lumbar        | 8 x 5          | Paraplegic     | Small PFO                        | None              | None                |
| 6   | Girl   | Lumbosacral   | 6 x 6          | Paraplegic at the hip level | PFO       | Bilateral calcaneovalgus deformity and rocker bottom deformity | Present |
| 7   | Girl   | Lumbosacral   | 6 x 4          | Good anal tone Moving all limbs | None       | None              | None                |
| 8   | Boy    | Lumbosacral   | 7 x 5          | Paraplegic     | Aberrant right subclavian artery | Arthrogryposis    | None                |
| 9   | Boy    | Lumbosacral   | 7 x 6          | Patulous anus  | None                             | Bilateral DDH     | Present             |
| 10  | Girl   | Lumbosacral   | 6 x 6          | Paraplegic     | None                             | Hip dislocation   | Present             |

ASD, atrial septal defect; PDA, patent ductus arteriosus; PFO, patent foramen ovale.
defects. Local flaps have been commonly described\(^\text{14,15}\); however, one of the main issues that may arise is inadequate blood circulation associated with these random pattern flaps. Musculocutaneous flaps were also reported to be successful alternatives for larger defects\(^\text{9,16,17}\); nonetheless, well-known disadvantages of such modality include prolonged operative time and increased blood loss. Moreover, the normal function of the involved muscle is compromised, putting the patient at a functional disadvantage. Musculocutaneous flaps might not be preferred as the initial modality and could rather be preserved for potential future need for another reconstruction.

Perforator-based flaps provide a reliable and aesthetic coverage. The great advancements in medical imaging and anatomical studies allowed for the description of a wide array of perforator flaps. Dorsal intercostal artery perforator (DICAP) flaps provide a viable alternative for myelomeningocele reconstruction. The use of DICAP flaps in MCC closure was first described by Daghan Isik et al.,\(^\text{18}\) where a series of 27 patients were treated with DICAP flaps limited to the posterior axillary line. Kcoak and Dimer presented a larger series of 52 patients with DICAP flaps limited also to posterior axillary line.\(^\text{18}\) A modification of the DICAP flaps was described by Althubaiti et al.,\(^\text{19}\) in which an extended oblique thoracic or lumber pedicle back flap was harvested without islanding the flap or without skeletonizing the perforators. We used the same technique in our series, in which we extended the flap up to the anterior axillary line if needed to increase the length of the flap and decrease the tension on flap inset in case of a larger defect. No major complications were observed in our series. Furthermore, the rate of minor complications encountered in the present series is comparable to that reported in the literature.

**CONCLUSIONS**

We believe that DICAP flaps, whether limited to posterior or extended to anterior axillary line, are safe and reliable to be used for myelomeningocele defects. Such flaps do not jeopardize other regional fasciocutaneous or musculocutaneous flaps that might be needed for soft tissue coverage later in life for this population and it obviates the placement of skin suture line over the repaired neural tube, thus yielding a durable coverage with no major complications or functional disability.

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![Fig. 2. Photographs of the same baby after coverage of the lumbar defect with the flap. A, The flap with venous congestion, and change of color at the distal part of flap at day three post coverage. B, Photograph of the flap at day seven post coverage with a small partial flap loss that was treated conservatively.](image-url)
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