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Reconstruction of Large Meningomyelocele Defects with Bipedicled Fasciocutaneous Flaps: Technical and Clinical Points

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ABSTRACT

AIM: To evaluate the bilateral vertical bipedicled procedure for the closure of large meningomyelocele defects and to emphasise some technical and clinical considerations.

MATERIAL and METHODS: This procedure was used to close large meningomyelocele defects in ten patients (six males and four females) between January 2016 and August 2020. Eight of the patients were operated on within the first 24 hours of birth, and the remaining two were operated on between 1-7 days from birth. The average defect size was 6 x 9 cm (5 x 7 and 8 x 13 cm). The location of the lesions was thoracolumbar in two patients and lumbosacral in eight patients. Patient demographics, including sex, gestational age, birth weight, age at operation, defect size, duration of the operation, intraoperative-postoperative blood transfusion, length of hospital stay and complications, were evaluated.

RESULTS: In all patients, closure was successful. Two patients required reoperation because of wound dehiscence, and healing was uneventful, without any complications. No patient experienced late breakdown of the wound during a mean follow-up period of 14.9 months (12-18 months).

CONCLUSION: Bipedicled fasciocutaneous flaps can be used as an alternative method to repair large meningomyelocele defects due to their simple and reliable nature, which also causes less haemorrhage, and can be used in selected patients.

KEYWORDS: Bipedicled flap, Meningomyelocele, Reconstruction, Repair

INTRODUCTION

Meningomyelocele (MM) is a congenital anomaly that is seen in 1 in 1000 births and affects the spinal canal, vertebral column, and skin (27). MM can be seen at any level of the spinal cord. When MM is not repaired, it results in death in more than half of the cases (3). Therefore, it is recommended to repair the neural structures and skin within 48 hours after birth. This reduces the progression of central nervous system damage and the risk of complications, such as leakage of cerebrospinal fluid (CSF) and meningitis, and thereby reduces mental and physical morbidity and improves survival rates (22).

In skin reconstruction, which is the last step of repair, the aim is to achieve the tension-free closure of neural structures with thick and well-vascularised tissue. Although primary closure is preferred as the first option in accordance with accepted

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plastic surgery treatment principles, wound closure using extensive undermining of the skin and closure under tension are associated with high failure rates. The use of single-session methods with a short operation time, a much lower risk of additional morbidities, minimal blood loss, and maximal tissue preservation would be the optimum procedure. However, when primary closure is not possible, more complicated procedures in which skin graft and flap techniques are used in defects larger than 5 cm may be required. The size and location of the defect, the general condition of the patient, and the surgeon's experience are other factors that affect the choice of the repair procedure. Various fasciocutaneous (23,30), muscle (10,31), muscle-skin flap (8,26), and skin graft (20) methods have been described, and these techniques have several advantages and disadvantages.

Bipedicled flaps (BPFs) are used in different parts of the body, and an axial pattern of blood supply is derived from both sides. Although it is not a new technique, it has been used confidently in different regions of the body (12,13). Since it has a dual blood supply, the flap is well vascularised, and the risk of necrosis is low. BPFs can be planned with larger length-to-width ratios than other local flaps. The increase in flap vascularity in the long term, due to the delay phenomenon, enables it to be harvested on an inferior or superior base and to be reused in MM patients in need of reconstruction in the future in the form of advancement, rotation, or transposition.

In this article, our clinical experience using a BPFs as an alternative method for the surgical closure of large MM defects is presented.

MATERIAL and METHODS

Newborn patients with MM defects in whom primary closure after neurosurgical repair was not an option underwent BPFs reconstruction between January 2016 and August 2020. All operative procedures were performed by a single surgeon. Patient demographics, including sex, gestational age, birth weight, age at operation, defect size, duration of the operation, intraoperative-postoperative blood transfusion, and length of hospital stay, were collected. In addition, any complications, including seroma, haematoma, wound dehiscence, cerebrospinal fluid (CSF) leakage, need for revision surgery and flap necrosis, were noted. Ethics committee approval was obtained by the ethics committee (Protocol no: 2021/13.01).

All operations were performed under general anaesthesia in the prone position. The surgery was started after the neurosurgical part of the operation was completed. After the dural repair was performed by the neurosurgeon, the flap preparation, adaptation and closure was performed by a single plastic surgeon. Relaxation incisions were planned along the posterior axillary line in the craniocaudal direction, and the length of the flaps was slightly longer than the vertical length of the defect. The incision could be extended up and down enough to allow tension-free closure. Flap dissection started at the lateral side of the flaps, which were along the posterior axillary line, and the dissection continued up to the defect margins. After the incision, the latissimus dorsi muscle and the gluteus maximus muscle fascia were incised and included in the flap. The BPF was harvested by proceeding with a sharp dissection medially in the subfascial-supramuscular plane and proceeding to the latissimus dorsi muscle cranially and to the gluteus maximus muscle caudally. Medially, the thoracolumbar fascia was included in the flap. Bleeding was stopped with the help of cautery. A flap similar in size to the defect was also harvested from the other side. By approximating flaps at the midline, skin and subcutaneous layer closure was performed en block using 3.0 polypropylene and horizontal mattress sutures (Figure 1). Donor site defects were closed via both primary closure and with split-thickness skin grafts (STSGs). The grafts were monitored with a tie-over dressing in the first 5 days. The flap that remained lateral to the incision was medialised by undermining. After it was sutured to the latissimus dorsi muscle, the skin was closed with 3.0 polypropylene sutures (Video 1). If the defect remained, closure was performed with STSGs. Hemovac or penrose drains were placed under the flap donor sites. Patients were maintained in a prone position in the postoperative period for 7-10 days. Sutures were removed 14 days after surgery. All other flaps recovered properly, and satisfactory results were obtained in all patients. The technical details of the procedure are illustrated in Figure 2.

RESULTS

Eighteen newborn patients, with an MM defect were treated with this technique. Ten of these patients (55.5%) who could be reached at least one year after surgery were included in the study. Six of the patients were male (60%) and four female (40%). The mean birth weight of the patients was 2677 (range 2500-2900) grams, and the mean gestational age was 37.1 (range 34-42) weeks. Eight of the patients (80%) underwent surgery within the first 24 hours of birth, and the remaining two underwent surgery between 1-7 days (mean: 1.8) from birth. The mean follow-up period was 14.9 months (range 12-18). Hydrocephalus was present in all patients. A ventriculoperitoneal shunt (VPS) was inserted in all patients with symptoms of increased intracranial pressure. VPS was inserted at the same surgical stage in two patients, and in the postoperative period in eight. One patient underwent surgery on the third day after primary closure was performed and wound dehiscence developed. In eight (80%) patients, the defect was in the lumbosacral area, and in two (20%) patients, the defect was in the thoracolumbar area. The size of the defects ranged from 5x7 to 8x13 cm, with mean dimensions of 6x9 cm. A bilateral BPF was used in all patients. The donor site was closed via primary closure in eight patients (80%) and with STSGs in two (20%). No patients received a perioperative or postoperative blood transfusion. The mean operation time, excluding neural closure, was 56 (range 40-70) minutes. The mean length of hospital stay was 6.4 (range 5-12) days. One patient died one month after the operation due to causes unrelated to the surgery. Complications including seroma, haematoma, CSF leakage, and flap necrosis did not occur in any patient. However, wound dehiscence developed in two patients. One patient required reoperation and debridement, and primary closure was performed. In the second patient,

Figure 1: (Patient 1) After neurosurgical repair, an intra-operative view showing that the defect measured 6 x 9 cm, that is, a defect size of 54 cm² (top-left). A relaxation incision was marked between the posterior axillary fold and iliac crest on the back-abdominal border (top-right). The flaps were harvested on the subfascial plane with careful dissection proceeding to the latissimus dorsi muscle and the gluteus maximus muscle. Skin and subcutaneous layer closure was performed en block using 3.0 Polypropylene sutures with a horizontal mattress. Primary closure of the donor site (below-left and middle). Final result (below-right).

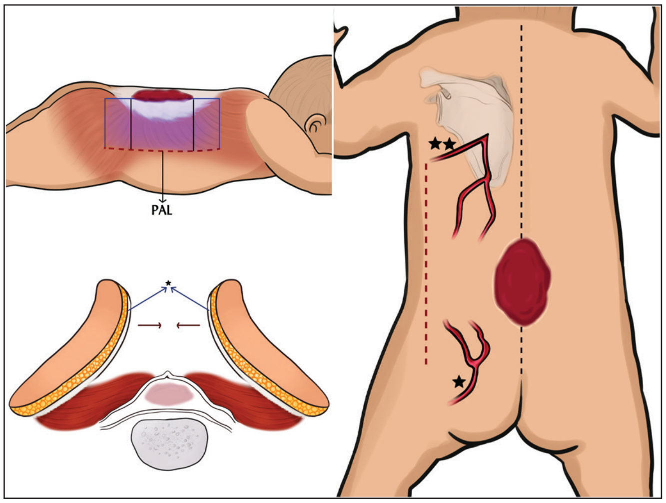

Figure 2: Preoperative markings. Bilateral fasciocutaneous flaps were planned on both sides of the defect. Incisions were marked along the posterior axillary line in the craniocaudal direction. The length of the flap was planned to be slightly longer than the vertical length of the defect. The flaps were harvested by proceeding with dissection medially in the subfascial-supramuscular plane. The dissection area is shown in the blue area (PAL: posterior axillary line) (top-left). Diagram showing the axial section of flap anatomy. The muscle fascia and the thoracolumbar fascia were included in the flap. Mutual suturing of the fascia creates a strong physical barrier over the defect (* thoracolumbar fascia) (below-left). Diagram showing blood supply of the flaps. The bipedicled flaps have a dual blood supply from inferior and superior aspects. These flaps are nourished from circumflex scapular arterial branches in the superior aspect and from superior gluteal arterial branches in the inferior aspect (* superior gluteal artery ** circumflex scapular artery) (right).

the right-sided BPF was incised at the superior border and reelevated as an inferior pedicle fasciocutaneous flap and transposed into the defect. There were no further complications during the long-term follow-up of these two patients (Table I). Post-operative views are shown in Figures 3 and 4.

DISCUSSION

The last step in the surgical treatment of MM patients is tension-free closure of the neural structures with a well-vascularised soft tissue cover after dura repair. While primary closure can be used to repair defects with a width of less than 5 cm (5), complex procedures using skin, skin-muscle, muscle flaps and skin graft techniques are required to close larger defects (24,26,28,30). The use of single-session techniques with a short operation time both reduces the risks of complications and blood loss and accelerates the healing process. In addition, maximum protection of the back tissues facilitates planning by preserving flap alternatives for any subsequent revision surgery.

Repair with skin grafts is an easy-to-apply procedure with a low risk of complications in the early period (20), but the thinness of the graft may disrupt neural structures by causing compression-related wound problems in the long term. In cases of ulceration and infection, secondary intervention will be required. During the healing process, a skin graft may lead to contour defects due to contraction, with undesired aesthetic outcomes. Therefore, the use of thin skin grafts in MM defect repair is limited, and techniques providing bulky, soft-tissue cover are preferred instead.

Table I: Detailed Characteristics of the Patients

Patient	Sex	Birth Weight (grams)	Birth Week	Age at operation (day)	Size of Skin Defect (cm)	Duration of operation (minutes)	Region	Blood transfusion	Length of hospital stay (days)	Donor site closure	Complication	Follow-up period (month)
1	M	2600	36	1	6x9	70	LS	no	12	primary	no	12
2	M	2800	38	7	6x9	65	LS	no	7	primary	wound dehisence *	14
3	M	2770	42	1	5x8	60	LS	no	7	primary	no	16
4	F	2670	36	3	6x8	40	TL	no	5	primary	no	15
5	M	2600	34	1	7x10	60	LS	no	6	STSG	no	16
6	F	2780	34	1	5x9	40	LS	no	5	primary	no	13
7	F	2600	36	1	5x7	50	LS	no	7	primary	no	18
8	F	2550	38	1	6x8	50	LS	no	5	primary	wound dehisence **	18
9	M	2500	38	1	6x9	60	LS	no	5	primary	no	15
10	M	2900	39	1	8x13	65	TL	no	5	STSG	no	12
mean		2677	37.1	1.8	6x9	56			6.4			14.9

***TL:** Thoracolumbar; **LS:** Lumbosacral; **STSG:** Split thickness skin graft*
***** Succesfull wound healing after debridement and primer suturation; ****** Succesfull wound healing after debridement and transposition of superior based fasciocutaneous flap.*

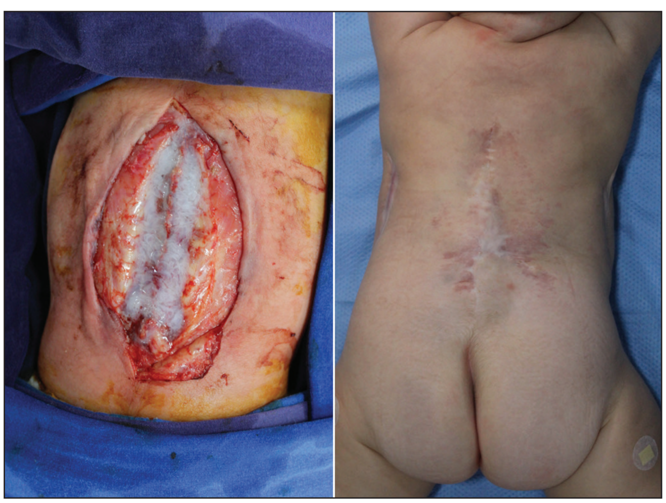

Figure 3: (Patient 5) A newborn presented with lumbosacral meningomyelocele. An intra-operative view showing that the defect measured 7 x 10 cm, with a defect size of 70 cm². Primary closure of the donor site (left). Final view shows good coverage 16 months after surgery (right).

Fasciocutaneous flaps harvested from the paraspinal area, in which blood flow is obtained from the three dominant vascular territories, have been safely used to repair MM defects (14,17). Procedures such as rotation (29), transposition (4), modified V-Y advancement (1), and double Z-rhomboid (7), according to the repositioning of the flap, have been described. These procedures are easier to plan and harvest than those involving muscle and perforator flaps. Since the dissection area is narrow, blood loss is low, and the operation time is short, if correctly planned, successful soft tissue closure with safe blood flow is virtually ensured. Protecting muscles prevents loss of function and preserves muscle flap alternatives if required in the future. For these reasons, local fasciocutaneous flaps are frequently used to repair MM defects. The main disadvantage of local fasciocutaneous flaps is that skin grafts are sometimes needed to close the donor area when repairing large defects. The defect width and the wideness of the patient's back are critical points for closure of the donor site. In our study, eight donor sites were closed via primary closure, and two donor sites were closed with STSGs. The transverse defect sizes of these two patients were 7 and 8 cm. It should be noted that the flap on the abdominal side of the incision is medialised after undermining and sutured to the tissues on the ground. This aids in preventing the development of wound problems by reducing tension in the flap. However, when closure is performed with STSGs, there may be contour defects in the flank area in the long term. This outcome is generally acceptable, as MM defect closure is a life-saving and life-prolonging procedure in most cases. Two of our patients who underwent primary closure of the donor site underwent reoperation due to wound dehiscence. In our opinion, this was due to tension in the suture lines. In these patients, the mean transverse diameter of the defect was 6.5

Figure 4: (Patient 10) A newborn presented with thoracolumbar meningomyelocele. An intra-operative view showing that the defect measured 8 x 13 cm, with a defect size of 104 cm². The donor site was closed with a split-thickness skin graft (top-left). Final view shows good coverage 12 months after surgery (top-right). Stable wound healing of the donor area is demonstrated (below).

cm. Therefore, we recommend that the donor site be repaired with a skin graft for defects larger than 5 cm.

If bedsores occur in MM patients long term, additional surgical intervention may be required. In particular, in cases where more than one flap was used, excessive scarring of the back due to an increased number of incisions may reduce future flap alternatives and make the management of the disease more difficult. Therefore, maximum protection of the back tissues is desirable. Therefore, we do not prefer other fasciocutaneous flap techniques (keystone, reading men) in our patients, as they may cause large scars on the back and reduce possible flap alternatives that can be used in the future. In the BPF technique, since the incisions are made over the posterior axillary line, the scar remains at the abdominal-dorsal junction. All incisions are made at the same place, with a length approximately 4-6 cm longer than the vertical distance of the defect. This procedure had two advantages. First, hiding the scar prevents a poor appearance. Second, protection of the back skin allows the easy planning of new flaps should any secondary procedure be required. In our study, two patients underwent reoperation after wound dehiscence. After debridement, the superior border of the BPF was incised and reformed into an inferior-based unipedicled flap in one patient. This flap was easily transposed to the defect and provided tension-free closure because of its long length. In the other patient, primary closure was performed. There were no complications during the long-term follow-up of these patients.

Muscle flaps provide safe blood flow and excellent soft tissue coverage over neural structures. Ramirez et al. (26) described a technique that closed the midline by the medial advancement of musculocutaneous flaps involving the latissimus dorsi-gluteus maximus muscles. Desprez et al. (8) described a technique in which bilateral, bipediculated musculocutaneous flaps containing the latissimus dorsi and trapezius muscles were sutured close to the midline. Subsequently, several variations of muscle and muscle-skin flaps have been used to cover MM defects (15,21,28). However, muscle flaps have some disadvantages: the dissection area is wider, the operation time is longer, and the amount of blood loss is often higher than those of fasciocutaneous flaps. Although muscle flaps provide solid closure, the risk of long-term complications is high (32). In addition, a decrease in muscle movements may cause loss of function over time. It has been reported that the risk of developing scoliosis was increased in patients in whom the latissimus dorsi muscle was used (2). Patients with some degree of paralysis may experience bedsores if their back and/or sacral area is exposed to lifelong compression. These wounds may need repair with soft tissue. If possible, when repairing MM in newborns, keeping muscle flaps in reserve for the long term will increase future surgical alternatives. In the BPF technique, since the dissection area is narrow and muscle sacrifice is not required, the amount of bleeding is low, and the operation time is short, the risk of morbidity due to an extended operative time and blood transfusion is low. In addition, closure with flaps based on the thoracolumbar fascia has been reported to provide reliable coverage and may be as effective as muscle flaps (3).

With the development of microsurgery techniques, the use of perforator flaps in reconstructive surgery has recently become widespread and can provide successful, tension-free closure. Dorsal intercostal and superior gluteal artery perforator flaps have been used successfully to repair lumbosacral defects (9,18). Techniques using a lumbar artery perforator flap to repair thoracolumbar defects have also been described (6). However, it can be difficult to standardize the perforator flap technique, as the size and method of transposition of the flap are decided according to the location of the perforator, and its planning requires experience. It is important that the pedicle does not kink or compress during transfer, as this will compromise the blood supply, and preventing this requires microsurgical experience and very careful attention. This extra care will prolong the operation time. Closure of the donor site in large defects may increase morbidity by requiring secondary intervention, such as a secondary flap. In the event of an open wound in the future, local flaps may be difficult to plan. In this case, a muscle or distant flap is required for reconstruction. BPFs are easy to plan for and dissect, and the blood supply is derived from both sides so that, unlike traditional fasciocutaneous flaps, BPFs are vascularised from both borders, which greatly improves flap survival. Blood supply in these flaps is nourished from circumflex scapular arterial branches in the superior aspect and from superior gluteal arterial branches in the inferior aspect (16,19,25). An additional benefit is the low risk of necrosis in the distal region of the flap and at the suture lines. In our series, it was possible, in the event of early or late complications, to convert the BPF into an extended (greater length to width) unipedicled flap for movement. The efficacy of this procedure is thought to be mediated by ischaemic pre-conditioning, the dilatation of choke vessels, vessel reorientation, and neoangiogenesis (11).

It is not desirable for suture lines to be on neural structures. In the case of CSF leakage, wound dehiscence may occur. This method does use a suture that is placed directly onto the neural structures, but mutual suturing of the flap fascia in subcutaneous closure creates a solid physical barrier to the neural structures. Elevation of the wound edges with horizontal mattress sutures acts as a second barrier against fluid leaks. In our technique, the aim was to discharge the fluid through hemovac or penrose drains in the donor areas, and no patient experienced CSF leakage.

CONCLUSION

The bipedicle flap is a method that has been used for at least half a century and provides several advantages when used to close MM defects. These include tension-free closure without the need for muscle sacrifice and a single, short operation time without the need for a pre- and post-operative blood transfusion. Additional advantages include a better choice for donor sites should secondary interventions become necessary, and when revision is required, it is possible to convert into an inferior- or superior-based unipedicled flap. BPFs are also easy to plan for and apply, and post-operative scarring is minimised. In our experience, a BPF can be used safely for MM defects up to 8 cm in width and provides a good alternative to other previously described techniques.

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AUTHORSHIP CONTRIBUTION

Study conception and design: CID, MSA

Data collection: CY, EKY

Analysis and interpretation of results: CID, EKY, CY

Draft manuscript preparation: CID

Critical revision of the article: CID, MSA

Other (study supervision, fundings, materials, etc...): CY, EKY

All authors (CID, EKY, CY, MSA) reviewed the results and approved the final version of the manuscript.

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