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Our Clinical Algorithmic Approach for Meningomyelocele Defects Reconstruction with Fasciocutaneous Flaps

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ABSTRACT

AIM: To evaluate fasciocutaneous flaps used for reconstruction of meningomyelocele defects in our clinic and to suggest an algorithm for flap selection.

MATERIAL and METHODS: A retrospective analysis of 45 patients with meningomyelocele, who underwent repair with fasciocutaneous flaps, was carried out. Preoperative and postoperative photos were analyzed. The defect areas were measured by photoshop CC. Limberg flap, bilateral Limberg flaps, bilateral bipedicled advancement flaps, bilobed flap and reading man flap were performed.

RESULTS: Wound dehiscence and partial necrosis occurred in 8 patients. All wounds were managed conservatively and healed successfully. No other complications were observed. The mean defect size for all patients was 36 cm². The mean defect size was 45.3 cm² in bilateral bipedicled flaps cases; 33.5 cm² in bilateral Limberg flaps cases; and 19.6 cm² in the unilateral Limberg flap cases. According to the algorithm, a unilateral Limberg flap or bilobed flap or reading man flap can be used for the defects smaller than 25 cm²; bilateral Limberg flaps can be used for the defects between 25 and 35 cm²; and bilateral bipedicled advancement flaps can be used for the defects larger than 35 cm².

CONCLUSION: Fasciocutaneous flaps can be preferred in meningomyelocele defect reconstruction due to the easy planning of flaps, easy and fast flap elevation, and low complication rates due to their reliable circulation. The measurement of the defect area allows this algorithm selecting a flap in a more practical way.

KEYWORDS: Meningomyelocele, Fasciocutaneous flap, Bipedicled advancement, Limberg flap, Bilobed flap

INTRODUCTION

Spina bifida is one of the most common malformations due to the deficit of fusion in the caudal neural tube, with a rate of one case per 1000 births. While the cause is unknown in most cases, multifactorial and single gene disorders, chromosomal abnormalities, teratogen exposure and folic acid deficiency are factors associated with neural tube defects (19,21). Cellular proliferation, differentiation and migration are affected due to folate deficiency. Folic acid replacement and termination of pregnancies with intrauterine diagnosis have decreased meningomyelocele incidence (12,28). The goals of closing meningomyelocele defects are to prevent infection, inhibit leakage of cerebrospinal fluid, and preserve the function of nerves. Furthermore, the defect should be repaired with a tension-free soft tissue (8). Numerous flap techniques have been described to repair meningomyelocele

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defects (10,15,23,24,27). In 1986, Ramirez et al. first described myocutaneous flaps based on the gluteus maximus and latissimus dorsi muscles for the repair of large defects (23). Since the donor area is limited in infants, flap surgery should have a low complication rate, and avoid reoperation.

In this study, we aimed to facilitate flap selection according to the defect area by analyzing the results of fasciocutaneous flaps performed for meningomyelocele defects in our institution.

MATERIAL and METHODS

In the period between 2015 and 2020, forty-five patients with meningomyelocele underwent repair with fasciocutaneous flaps in the clinics of Plastic, Reconstructive-Aesthetic Surgery and Pediatric Neurosurgery, and were retrospectively evaluated. Preoperative and postoperative photos were analyzed with Adobe Photoshop CC. Twenty-five patients were female and 20 patients were male. In 62% of the patients (28 patients), the defect was in the thoracolumbal region and the rest was identified in the lumbosacral and lumbar region. The following operations were performed: Limberg flap in 22% of the patients (10 patients), bilateral Limberg flap in 28% (13 patients), bilateral bipedicled advancement flap in 33% (15 patients), bilobed flap in 3 patients, and reading man flap in 3 patients. For one patient, Limberg flap and bipedicled advancement flap were used together. When a bipedicled advancement flap was used, the donor area was repaired with a split thickness skin graft. Defect sizes ranged from 3.5x3.5 cm to 14x10 cm, and the average measured defect area was 36 cm^2. Except for three patients, who were operated in the first 24 hours.

The operative wounds of the myelomeningocele patients are followed both by the neurosurgery and plastic/reconstructive surgery teams. The wounds are closely evaluated from the point of both neurosurgical complications mainly by the cerebrospinal fluid (CSF) leakage and reconstructive complications such as wound dehiscence and ischemic findings. Persistent CSF leakage is abandoned by inserting a ventriculoperitoneal shunt in cases of progressive hydrocephalus.

The average time of total anesthesia was 120 minutes, and the mean operation time of neurosurgery (50 min) and plastic surgery (40 min) was 90 minutes. The estimated mean blood loss was 20 cc and was measured by dressing a sponge count where each sponge meant a 5 cc blood loss. We generally use 6-8 sponge during the operation (all sponges were not fully bloody). No patients required blood transfusions caused by blood loss intraoperatively or postoperatively. In the postoperative period, patients were in the prone position until the wound healing was completed. Sutures were removed on 12–14 days postoperatively. All patients were discharged on the postoperative 14th day. The control examinations were performed every 2 weeks to assess the results in the long-term. Our average clinical follow-up period was one year as plastic surgery.

Surgical Techniques

Limberg flap: Limberg flap is a type of transposition flap. It is drawn in the form of rhomboid with two angles of 120° and two angles of 60°. After the evaluation of the size of the skin defect, the Limberg flap was planned. Flaps can be designed bilaterally depending on the size of the defect. After the incisions, the flap was dissected over the muscle fascia. After the flap elevation was completed, subcutaneous dissection was performed in the donor area due to the tension-free closure of the donor site. The flap was adapted to the defect. A thin penrose drain made from the edge of the glove was placed against the possibility of bleeding.

Bipedicled advancement flap: Advancement flap has a sliding movement towards the defect. After the dural defect was repaired by the neurosurgery team, the skin defect was evaluated and bipedicled advancement flaps were drawn. The flaps were designed adjacent to the defect and were elevated over the muscle fascia. The flaps were adapted to the defect. The edge of one flap was deepitelized up to 1 cm and placed at the base of the other flap in order to create a thick soft tissue support in the midline during adaptation. Advancement movements left secondary defects. The donor areas were repaired with split thickness skin grafts from the thigh, and dressing was performed.

Bilobed flap: Bilobed flaps are double transposition flaps. The first flap drawn adjacent to the defect was used to cover the defect. The second flap was used to repair the donor site of the first flap. Flaps were elevated over the muscle fascia. The donor area of the second flap was primarily repaired.

Reading man flap: It is a flap with two skin flaps designed as an unequal Z plasty (45°/60°). The flap should be carefully designed to avoid the placement suture lines of dural repair (22). The flaps were elevated over the muscle and adapted to the defect.

Case Reports

Case 1: A male patient, who was born by cesarean section at a gestational period of 41 weeks, weighing 3620 g with meningomyelocele defect in the thoracolumbal region, was repaired by the neurosurgery team. Bilateral limberg flaps were planned for a 6.5x7.5 cm skin defect. The flaps were elevated through the supramuscular plane and were adapted to the defect. Donor areas were primarily repaired (Figure 1A-C, 2A-D, 3A-D). A penrose drain was placed.

Case 2: Bilateral bipedicled advancement flaps were planned for the repair of a 6x8 cm defect in the thoracolumbal region of the patient born by cesarean section with a weight of 3020 g. The flaps were elevated over the muscle fascia. The edge of one flap was deepitelized and then adapted to each other in the midline. Split thickness skin grafts from the thigh were adapted to the donor sites (Figure 4A-D).

Case 3: A patient with meningomyelocele, born by cesarean section with a weight of 3250 g had a skin defect of 3.5x3.5 cm after dural repair in the thoracolumbal region. Reading man flap was planned. The flap was elevated and adapted to the defect. The donor area was repaired without tension (Figure 5A-C).

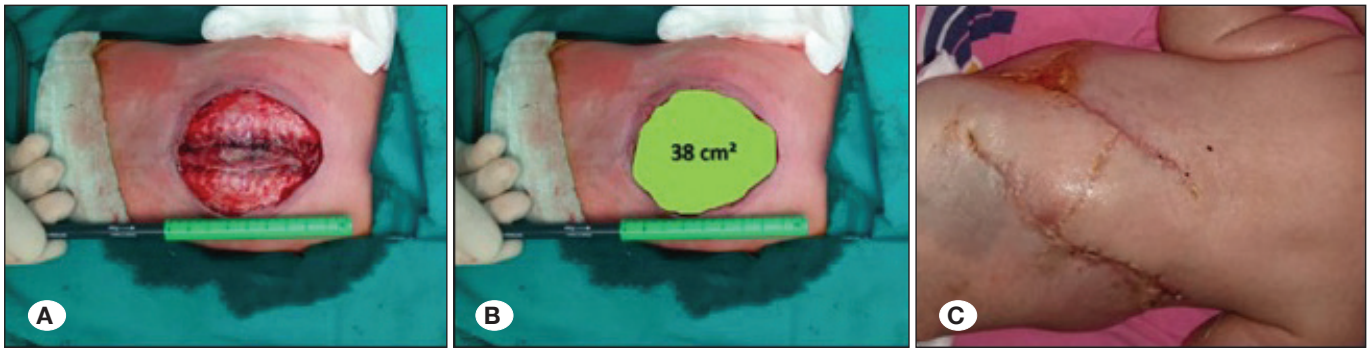

Figure 1: Bilateral limberg flap. **A)** Before the flap surgery. **B)** Defect size was measured. **C)** Postoperative first month.

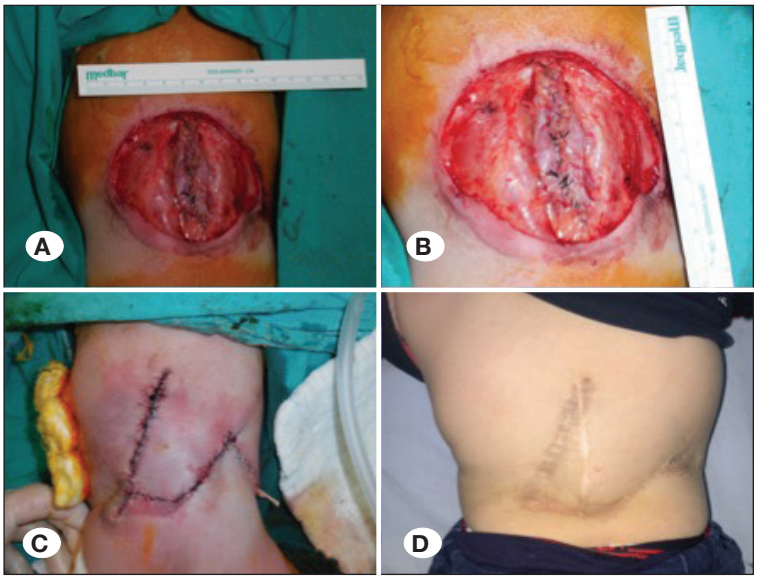

Figure 2: Unilateral limberg flap. **A, B)** The defects (20 cm^2), **C)** Repairing with unilateral Limberg flap, **D)** Postoperative 4th year. The view of vertical scar on the flap as a result of secondary revision surgery performed by neurosurgeons in the postoperative 1st year. Flap perfusion was not affected by secondary surgical intervention.

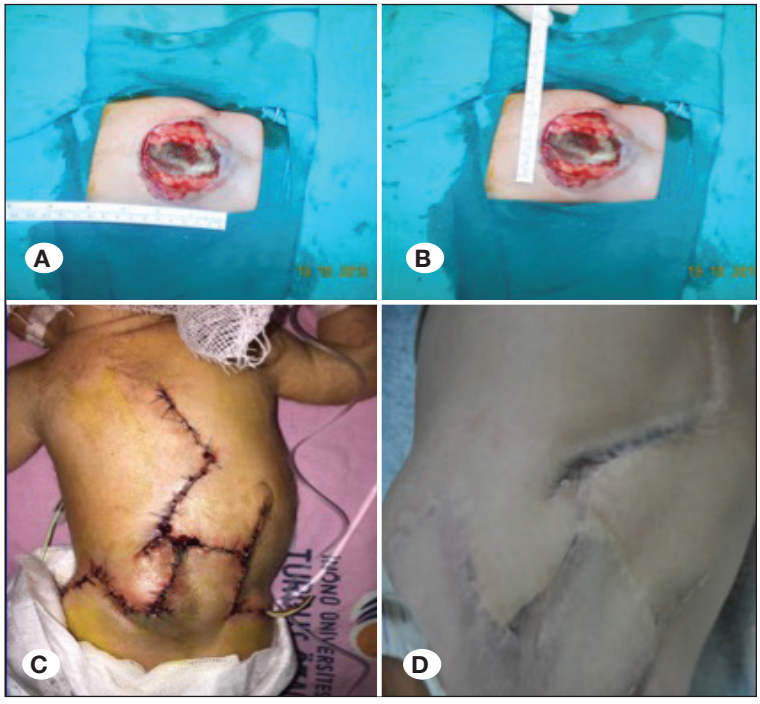

Figure 3: Triple limberg flap. **A, B)** The defects (24 cm^2), **C)** Repairing with triple Limberg flap, **D)** Postoperative 2nd year.

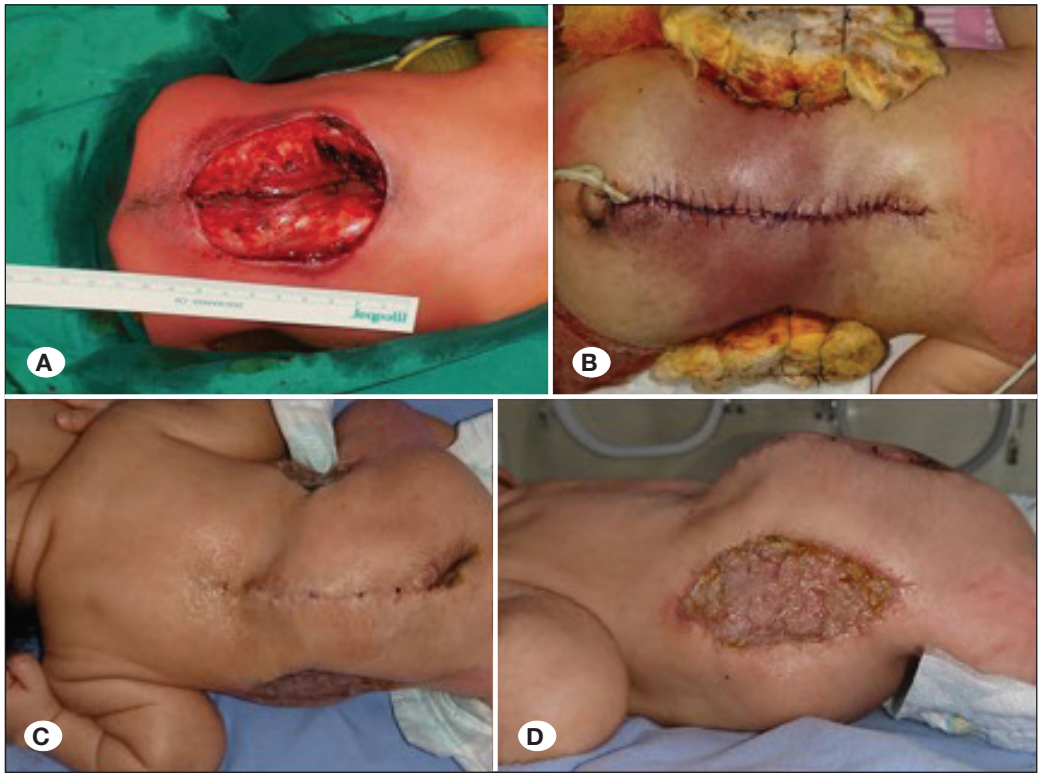

Figure 4: Bilateral bipedicled advancement flap. **A)** Before the flap surgery, **B)** Postoperative immediately, **C, D)** Postoperative first month, flap and donor site.

Figure 5: Reading man flap. **A)** Before the flap surgery, **B)** Postoperative immediately, **C)** Postoperative first month.

Case 4: A baby girl weighing 3120 g with meningomyelocele was born by cesarean section at the 38th gestational week. On the first day of life, the patient was operated on for meningomyelocele repair. The neural placode and dural repairing was performed by neurosurgery team. The defect was 4,5x5 cm. Bilobed flap was planned. Flaps were elevated and transferred to their new locations respectively (Figure 6A-F).

RESULTS

In the early period, flap congestion was observed in 33% of patients (15 patients). In these patients, no circulation problems were observed (Figure 7A-F). Wound dehiscence and partial necrosis occurred in 8 patients. These areas were managed with regular dressing and epithelized without any problem.

Partial necrosis occurred in 4 patients, who underwent Limberg flap. No major complication requiring re-surgery occurred in any patient. When the Limberg flap was used in large defects, wound dehiscence was noticed in the donor area due to primary closure in two patients. These two wound dehiscences were managed conservatively and healed secondarily. Four patients died of pneumonia during a long-term follow-up.

Mean blood loss was 20 cc. Since the blood loss phenomenon during surgery is very important for neonatal metabolism, hemodynamics and also wound healing, we tried to keep blood loss as low as we could. In shunted patients, no persistent CSF leakage is observed. Minor problems of CSF leakage are treated with compressive dressings with no extra complications. Neonates with large ventricles coincident with myelomeningoceles are shunted in the same session of

Figure 6: Bilobed flap. **A)** The defects (22,5 cm^2), **B)** Height of the defect in lateral view **C)** Planning of the bilobed flap, **D)** Repairing with bilobed flap, **E, F)** Postoperative 2nd month.

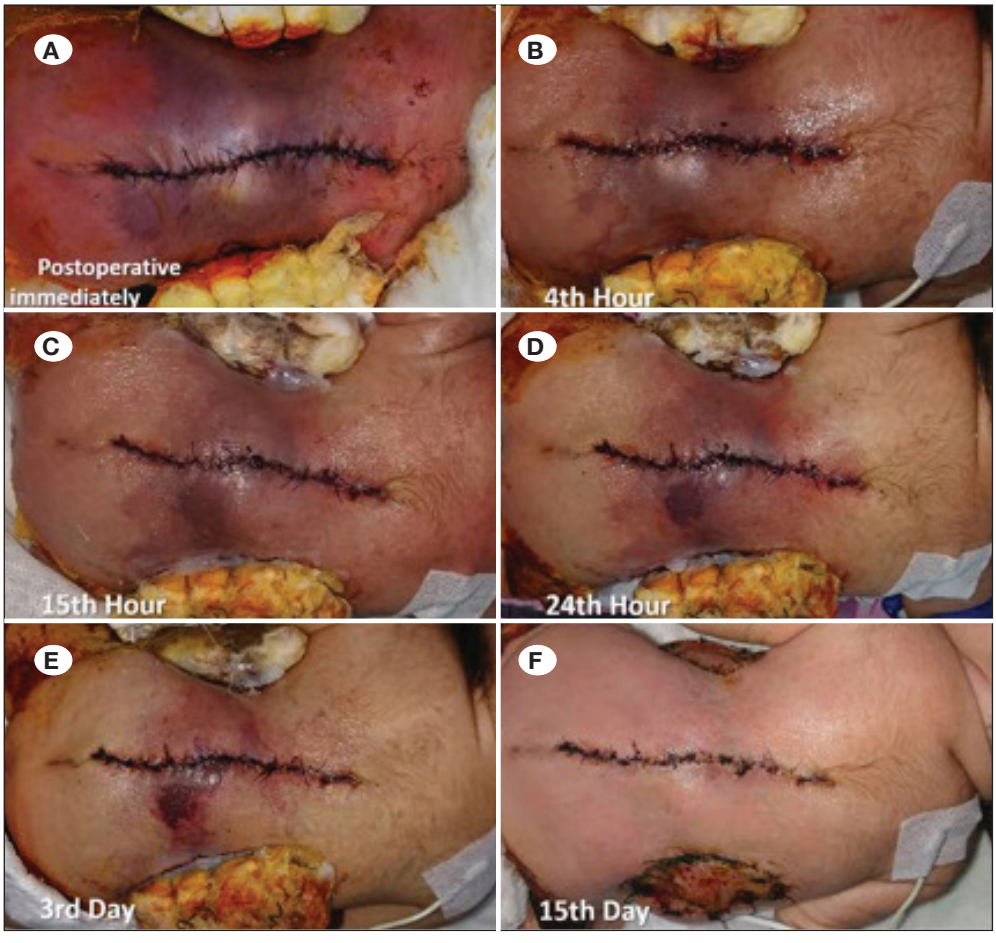

Figure 7: Flap congestion. **A)** Postoperative immediately, **B)** 4th Hour, **C)** 15th Hour, **D)** 24th Hour, **E)** 3rd Day, **F)** 15th Day.

myelomeningocele repair, which is performed within the first twenty-four hours of the birth.

The mean defect size was measured as 45.3 cm^2 in patients, who underwent bilateral bipedicled flaps surgery. Partial necrosis or wound dehiscence was not observed in this group. The mean defect size was 33.5 cm^2 in the cases reconstructed with bilateral Limberg flaps and 19.6 cm^2 in the unilateral Limberg flap cases. Based on these findings, an algorithm was created according to the defect size (Figure 8). Depending on the size of the defect, different flaps can be chosen for reconstruction without an algorithm. According to the algorithm we propose, one of the Limberg flap (unilateral), bilobed flap or reading man flap for the defects smaller than 25 cm^2; bilateral Limberg flaps for defects between 25 cm^2 and 35 cm^2; and bilateral bipedicled flaps for defects larger than 35 cm^2 can be chosen. There are no sharp boundaries between the algorithm's suggestions. For the defects smaller than 25 cm^2, we used three different flaps according to the defect size, vertebral kyphotic bony height, defect distances from perforators, and also flap compatibility such as healthy skin remaining, blood flow and perfusion power of the flap, and easy transfer of the flap.

It should be kept in mind that the area increases in three dimensions by considering the defect, especially in patients with kyphosis in the defect area. Besides that, the kyphotic protrusion may cause circulation problems for flaps. Therefore, flaps should be planned slightly larger in patients with kyphosis. Thus, the defect is repaired without any tension.

DISCUSSION

Evaluating the patient before the surgery will help to estimate the defect area and choose the necessary flap. Preoperative planning and working in harmony with the neurosurgery team will shorten the operation time. Various surgical techniques have been described for reconstruction of meningomyelocele defect. Primary closure is preferred for small defects; however, there is necrosis risk for large defects (20).

Meningomyelocele defect in the newborn is recommended to be repaired as early as possible in the postnatal period in order to prevent the development of the neurological deficit, since it may cause infection (13). In our study, all patients (except one) were operated in the first 24 hours together with the neurosurgery team.

Shim et al. primarily repaired small defects (mean 9.4 cm^2) in 12 cases and used Limberg flap in 2 cases (26). Complications such as wound dehiscence, infection, and necrosis developed in both patients using Limberg flap, but complications occurred in only two patients, who underwent primary repair. When meningomyelocele defects can be primarily closed, they are usually repaired by the neurosurgery team.

The literature review showed that meningomyelocele defects can be repaired with rotation-transposition fasciocutaneous flaps. In a study, a superior-based rotation-transposition fasciocutaneous flap was used in patients without kyphosis, while an additional inferior-based flap was used in patients with kyphosis (24). One of the 20 patients had a 2 cm-wide necrosis, whereas other patients had no complications. On the other hand, the technique leaves a widespread scar on the back (24). In our study, patients who underwent bilateral bipedicled flaps surgery had a scar formation on the back. This can be considered as a disadvantage.

A triple rhomboid flap can be used for reconstruction of large defects (5,15). In a study, wound dehiscence occurred in 2 patients with this technique, which was also used in 7 patients without kyphosis (15). Modification in the shape of honeycomb made the drawing easy to understand. By the same token, practical elevation of the flap, the safety of the circulation and a not required skin graft are advantages.

The choice of the flap may vary depending on the shape of the defect. According to an algorithm with 22 patients, if the shape of the defect is a rhombus, Limberg flap is recommended; if it is round shape, double or triple rotation is suggested and if it is triangular or square, a transposition flap can be the choice (25). In a study with 77 patients, round defects were reconstructed with O-S flap; elliptical defects were repaired with Emsen 1 flap (rotation and advancement flaps); triangular defects were repaired with Emsen 2 flap (rotation flaps) (10,11).

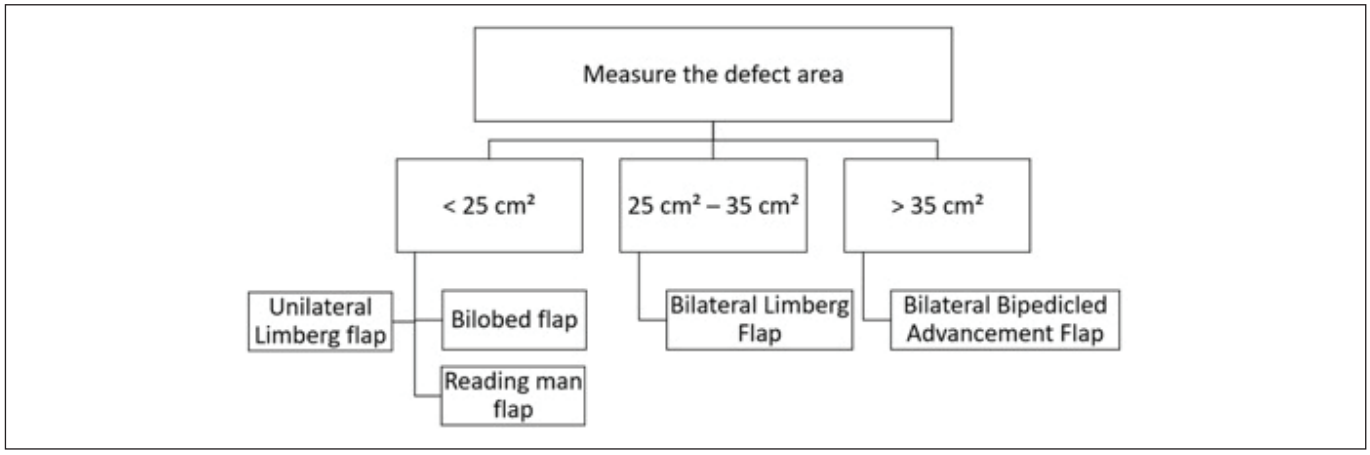

Figure 8: Algorithm for surgical approach.

Approximately 10- 15% of infants born with myelomeningocele will also have a kyphotic deformity of the spine (7). More care should be taken when planning flaps in these patients. Kankaya et al. specified that 17 patients were repaired with V-Y rotation and advancement flaps. Quaternary flaps are recommended for large defects. For medium-sized defects, double flaps are recommended, but quaternary flaps are proposed if the patient has kyphosis (14). The researchers recommended using the double flaps technique if there is kyphosis in small defects. Minimal wound dehiscence occurred in one patient; partial necrosis occurred in one patient; and other patients recovered without any problem. The use of a fasciocutaneous flap can be a good alternative because of the preservation of muscle function, the short time of the operation, and the closure of large defects without using a skin graft (14). In addition, defects can be repaired with modified V-Y advancement flaps (1,18,29).

There are also cases, in which bilobed flaps were used to repair meningomyelocele defects (2,19). A bilobed flap can be elevated quickly; it is easy to plan; it is a tension-free repair, and the adaptation sutures of the flap do not overlap with the midline dural repair sutures.

Kemaloğlu et al. previously reported their closure approach according to the defect size measurement (16). The defect width (x), defect height (y), and posterior axillary lines (2z+x) values were used to measure the defect size. They determined the technique they will use in the repair of the defect according to the ratio they obtained regarding the size of the defect. These calculating ratios were used as a decision-making guide.

In a study, in which the Ramirez technique was used in 35 patients, wound dehiscence occurred in 2 patients (3). The defects of size up to 8x10.8 cm were repaired. The use of this technique in the lumbosacral region increases the risk of complications. On the other hand, the complication rate is typically low because the circulation of myocutaneous flaps is safe (3). Comparing the Ramirez technique with alternative fasciocutaneous flaps, there was no significant difference between them in terms of minor complications (wound dehiscence, minor skin necrosis) and major complications (scar formation requiring surgery). Thirty percent of patients in the Ramirez technique and fifty-two percent of patients in alternative techniques had complications. In addition, hospitalization was significantly lower in patients, who underwent the Ramirez technique. Since the average of defect sizes in the two groups is 26 cm^2 and 21.4 cm^2 respectively, it is observed that these techniques were not used in large defects (17). Furthermore, considering that these patients will need back muscles in elder ages to maintain their trunk posture, it is important to protect these muscles. Preservation of the muscle is an important advantage of fasciocutaneous flaps.

Dorsal intercostal artery and lumbar artery perforator propellar flaps can also be used (4,6,27). Donor sites should be repaired primarily; however, an effective planning in large defects is important. The flap edge should not overlap with the dural sutures. Direct repair of the donor site and the safe circulation are important advantages of perforator propellar flaps. Dorsal intercostal perforator propellar flaps may be clinically prominent in terms of complications compared to rotation fasciocutaneous flaps, but no statistically significant difference was found (23). The study on the use of the amniotic membrane under the perforator flap highlighted that it can be used both as a bacterial barrier and as a factor, increasing the viability of the flap (8). In a perforator flap surgery operation, time and anesthetic time are prolonged. Preoperative perforator marking and perforator flap dissection require experience (9). We did not use free style perforator flaps for meningomyelocele defects so far. Free style flaps can significantly increase the operation time and blood loss, and flap loss increases the morbidity in the newborn group.

CONCLUSION

Although many different techniques have been defined in the repair of meningomyelocele defects, the dissection of bipedicled advancement and Limberg fasciocutaneous flaps are the methods that should be emphasized because of rapid dissection, easy elevation, easy learning, reliable circulation, low complication rate, and bilateral planning in large defects. We think that this algorithm will be useful in choosing a flap according to the defect size. Closure of the donor site with a skin graft is a significant disadvantage in bipedicled advancement flaps.

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