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Standard protocol for closure and repair of post-meningocele and meningomyelocele back skin defect

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Background
Neural tube defects (NTDs) occur because of a defect in the neurulation process. Meningocele and meningomyelocele are the most common forms of spinal dysraphism. Most cases of myelomeningocele and meningocele can be closed by direct repair, but sometimes a problem is faced intraoperatively during skin closure in some cases. The aim of our work is to describe and make a plan for proper operative management during the clinic visit for ideal repair and closure of the back skin defect. This depends on the area of the defect measured preoperatively to close the defect by properly designing the method of closure by either a flab or a graft.

Patients and methods
This is a prospective hospital-based study that included 60 patients. According to the defect size (we measured the defect preoperative and intraoperative by sterile ruler), we classified the patients into three groups. The first group was closed directly by simple repair, the second group was closed by local skin fasciocutaneous flap (either by two rhomboid flaps or one rotational flap), and the third group was closed by skin graft (split-thickness skin graft) owing to a large defect with immobile skin-for-skin flap.

Results
In 75% of cases, closure was done by direct repair, in 16.7% by rotational flap, and in 8.3% by skin graft. According to the size of the defect, we found that a defect with a total surface area of 18 cm^2 and less was closed by simple direct repair, that with a total surface area of 18–80 cm^2 was closed by rotational flap, and that with a total surface area of more than 80 cm^2 was closed by a skin graft.

Conclusion
Good preoperative assessment is needed for every patient with spina bifida skin defect. Choice of coverage depends on the surface area and the extent of the lesion, which help in getting the best results for skin repair.

Keywords:
flap, graft, meningocele, meningomyelocele

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Introduction

Meningocele and meningomyelocele are the most common forms of spinal dysraphism. The exact cause of this malformation is still not known, but it could be multifactorial, involving genetic, racial, and environmental factors; nutrition (particularly decrease folic acid intake during pregnancy); gestational diabetes; maternal obesity; and antiepileptic drugs, particularly valproate and carbamazepine [1,2].

Neural tube defects (NTDs) occur because of a defect in the neurulation process. Because the anterior and posterior neuropores close last, they are the most vulnerable to defects. Consequently, most NTDs arise in these areas [3,4].

NTDs can be classified, based on embryological considerations and the presence or absence of exposed neural tissue, into open or closed types.

Open NTDs frequently involve the entire central nervous system and may be associated with hydrocephalus owing to failure of primary neurulation. Neural tissue is exposed with associated cerebrospinal fluid (CSF) leakage [5].

Closed NTDs are localized and confined to the spine (brain rarely affected) and result from a defect in secondary neurulation. Neural tissue is not exposed, and the defect is fully epithelialized, although the skin covering the defect may be dysplastic [6].

Cranial presentations include the following: anencephaly, encephalocele (meningocele or meningomyelocele), craniorachischisis totalis, and congenital dermal

sinus [7]. Spinal presentations include the following: spina bifida aperta (myelomeningocele, meningocele, and myeloschisis) and spina bifida occulta (congenital dermal sinus, lipomyelomeningocele, split-cord malformations, diastematomyelia, diplomyelia, and caudal agenesis) [7].

Most cases of myelomeningocele and meningocele can be closed by direct repair in small defects. This has many advantages such as it is easy and fast technique with less blood loss and needed time. However, sometimes we face a problem intraoperatively during skin closure of some cases. Fasciocutaneous flaps are used to provide coverage in larger defects when the skin is insufficient for coverage. They are simple to elevate, quick, and fairly reliable [8]. Skin grafting is used when other methods of reconstruction such as primary closure, second-intention healing, or local skin flaps are inappropriate, or unavailable, or would produce a suboptimal result [9].

Aim

The aim is to describe and make a plan for proper preoperative planning during the clinic visit for ideal repair and closure of the skin defect according to the area measured provisionally preoperatively and to close the defect by properly designing the method of closure by either a flab or a graft.

Patients and methods

This is a prospective study that included all patients with meningocele and myelomeningocele presented to Neurosurgery Department in Assiut University Hospital from January 2016 to December 2016. Every patient was diagnosed prenatally and delivered by caesarian section, mostly in the hospital to protect the spinal cord from injury and to prevent possible rupture of meningeal sac, and they were referred directly to Neurosurgical Department, Assiut University Hospital.

This study included 60 patients, where 10 patients had ruptured meningomyelocele and 50 patients had an intact sac.

Inclusion criteria

All cases with meningocele and meningomyelocele that were presented at the time of study were included.

Exclusion criteria

Unfit cases for surgery were excluded.

Ultrasound is the noninvasive screening modality of choice for the detection of fetal anomalies including NTDs because of its safety, cost efficiency, and detection sensitivity.

All patients were assessed for the condition of the coverage of the sac and the mobility of the surrounding skin and measurement of the expected skin defect. We measured the expected skin defect by two lines – diameter 1: craniocaudal plane and diameter 2: transverse plane. Both lines start and end at the healthy skin (Fig. 1a).

For all patients, we dressed the back defect by sterile gauze, warm saline, and nonpermeable covering dressing.

Each baby was examined neurologically regarding the motor power of the lower limbs, the sphincteric tone, the site and size of the meningocele, and any other spinal deformity. Moreover, the head size and anterior fontanelle were examined. Neuroimaging studies including computed tomography on the brain and MRI on the spine were done for some patients.

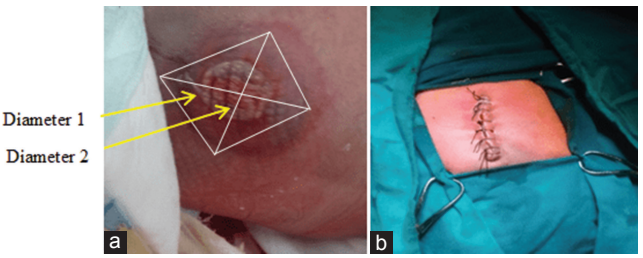
We examined each baby for possibility of presence of any other congenital anomaly.

For every patient, we discussed with the parents the current condition of their baby regarding the motor power, the sphincteric condition, if the patient is associated with hydrocephalus or liable to develop it postoperative, and other associated congenital anomalies like talipes and cardiovascular anomalies.

We explained the surgical technique and the expected complications. Formal consent was written and signed by the parents.

Patients with ruptured sac (10 cases) were considered as emergency, and the surgeries were done within 24 h. Patients with intact sac (50 cases) were scheduled

Figure 1



(a, b) Show a case of meningocele closed by direct repair D1, craniocaudal line D2, transverse line. (a) Shows the preoperative measurements of the expected defect of a case of meningocele closed by direct repair. (b) Shows a case of meningocele closed by direct repair.

for elective surgery at the nearest operative day after exclusion of hydrocephalus by computed tomography scan and cardiovascular anomaly by echocardiography.

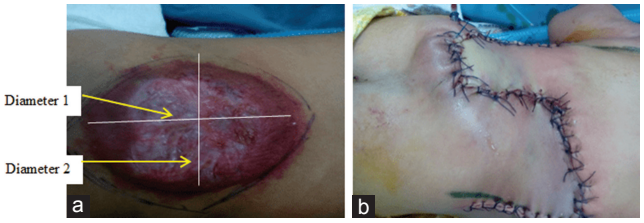
All patients received general anesthesia. They were intubated in supine position and then turned into prone position. Broad-spectrum antibiotic and analgesic agents were given at the start of operation.

Incision of the skin is done in the margin between the neural placode and the dystrophic epidermis. A deep incision is made till reaching the white glistening dura and performed circumferentially around the placode, and the skin is sharply excised from it, so the placode becomes free. Reconstruction of the placode was done to avoid tethering by making it like tube using (4/0 vicryl). The dura is then dissected and mobilized from the underlying fascia far enough to allow good mobilization and close it watertight by 4/0 vicryl. We induce Valsalva maneuver to be sure that there is no CSF leakage.

According to the defect size and mobility of the surrounding skin after the repair of the dura, we classified the patients into three groups. The first group was closed directly by simple repair as shown in Fig. 1a and b, the second group was closed by local skin fasciocutaneous flap (either by two rhomboid flaps or one rotational flap with drain insertion), as shown in Fig. 2a and b, and the third group was closed by skin graft (split-thickness skin graft taken from both thighs of the baby) owing to a large defect with immobile skin-for-skin flap, as shown in Fig. 3a–c.

Postoperatively, patients were followed up on the day of operation (for development of hematoma), after 2 days (for development of seroma, CSF leakage, or signs of wound ischemia and removal of drain, if any), on the fourth day (the first dressing in cases of skin graft and for confirmation of graft being accepted or not), and after 1 week (first dressing on donor site). On discharge, all parents were advised to change dressing every 2 days by disinfectant and sterile dressing and to keep wound clean till stiches removal, which was done after 2 weeks. Then patients were followed up within 3 months (for development of pseudomeningocele, hydrocephalus, and for aesthetic appearance of the flap).

Figure 2



(a, b) Show a case of large lumbosacral meningomyelocele closed by two rhomboid flaps with drain. (a) Shows the preoperative measurements of a case of large lumbosacral meningomyelocele. (b) Show a case of large lumbosacral meningomyelocele closed by two rhomboid flaps with drain.

Ethical consideration

The data that were obtained from the participants are confidential. The study participants would not be identified by name in any report or publication concerning this study. Before the participants were admitted in this study, the purpose and nature of the study as well as the risks–benefit assessment were explained to the parents. An informed consent was obtained from the parents.

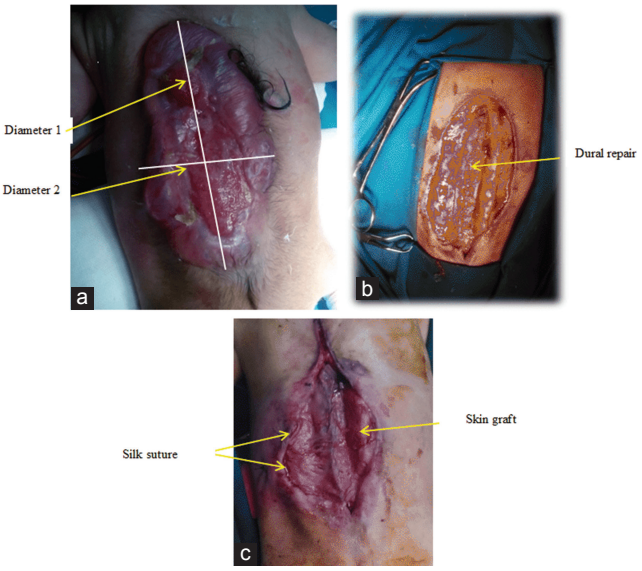
Statistical analysis

Data were collected and analyzed using statistical package for the social sciences (SPSS, version 20; IBM, Armonk, New York, USA). Continuous data were expressed in the form of mean ± SD or median (range) whereas nominal data were expressed in the form of frequency (percentage). χ^2-Test was used to compare the nominal data of different groups in the study, whereas Student's *t*-test was used to compare mean of different two groups. *P* value was significant if less than 0.05.

Results

In this study on 60 patients, we found the mean age group was 42.8 ± 6.58 days (the youngest patient

Figure 3



(a–c) Show case of dorsolumbosacral meningomyelocele closed by skin graft preoperatively, intraoperatively, and postoperatively. (a) Shows the preoperative measurements of a case of a large meningocele. (b) Show the intraoperative repair of the dura in a case of a large meningocele before the graft. (c) Show the case postoperatively after putting the graft.

was 2 days old and the eldest was 270 days), and the percentage of male patients was 48.3% and of female patients was 51.7%. Clinical pathological variants (meningomyelocele was 80%, meningocele was 16.7%, and lipomyelocele 3.3%). The lumbosacral area was the most common site for meningocele and meningomyelocele (56.7%), followed by dorsolumbar area (18.3%), dorsolumbosacral area (15%), lumbar area (5%), and then sacral area (5%).

In 75% of cases, closure was done by direct repair, in 16.7% by rotational flap, and in 8.3% by skin graft. There were two cases associated with kyphosis (without scoliosis) and large skin defect, in which, bone nibbling was done and the defect was covered by rotational flap. There were complications in nine (15%) cases. In direct repair group, there were four cases in the group of direct repair (two developed CSF leak, one had gapped wound, and one develop pseudomeningocele). In rotational flap group, there were five cases that had partial flap necrosis and ischemia.

According to the surface area of the defect, we found that a defect with a total surface area of 18 cm^2 and less was closed by simple direct repair (provided that both diameter 1 and diameter 2 do not exceed 4 cm), that with a total surface area more than 18–80 cm^2 was closed by rotational flap, and that with a total area more than 80 cm^2 was closed by a skin graft, as shown in Table 1.

Discussion

In most myelomeningocele cases, the skin defects are not large and can be closed primarily by approximating the skin edges. However, closure is more challenging and has some complications in wider defects.

Recently, intrauterine fetal surgery for myelomeningocele repair has been introduced in some institutions and has been shown to result in improved neurological function and decreased morbidity. However, intrautrine fetal surgery is not preferred in many institutions owing to the concerns of the parents or financial problems. For these reasons, the postnatal closure of myelomeningocele is still considered the primary option for repairing myelomeningocele defects [10–12].

In this study, 60 patients were operated. The mean age was 42.8 days. In the study by Shim *et al.* [13] from January 2004 to December 2013, myelomeningocele defects underwent repair, and they found the mean age was 67.4 days.

In this study, 75% of cases were closed by direct repair, 16.7% by rotational flap, and 8.3% by skin graft. This agrees with Shim *et al.* [13], who reported that in general, direct repair of myelomeningocele defects is performed in ~75% of cases, with the remaining 25% representing large myelomeningocele defects that require other methods of reconstruction.

Ozcelik *et al.* [14] found that direct approximation of the cleft margins for minor defects (<18 cm^2) is described through careful dissection and undermining of the surrounding healthy skin. In our study, direct approximation of the cleft margins was done for minor defects (<18 cm^2). Wide defects (>18 cm^2) needed fasciocutaneous rotational flaps.

In this study, the defect of ~18–80 cm^2 was closed by rotational flap. In the study of Sarifakioglu *et al.* [15], they found that wide defects (>18 cm^2) need muscular or myofasciocutaneous pedicled flaps.

In a study by Shim *et al.* [13], there were 14 patients who underwent surgical closure of myelomeningocele defect, 12 were closed by direct repair, and the other two cases needed two Limberg flaps. The mean defect size was 9.4 cm^2 in the direct repair cases and 64 cm^2 in the Limberg flap cases. In the 12 cases of direct repair, 10 of them had no complications and the wound healed successfully, and two cases had wound infection, but the two cases of Limberg flaps developed marginal flap necrosis and wound dehiscence at two different sites.

Wound site infection and CSF leak are the most common short-term complications of myelomeningocele repair [16].

In this study, there were no wound complications in the group covered by skin graft. This agrees with Muskett *et al.* [12] who reported that skin graft of all wounds eventually healed completely.

In the direct repair group in our study, four (8.88%) cases had complications: the first case developed little CSF leak, which stopped spontaneously within 5 days;

Table 1 Relation between surface area of the defect and the procedure

Size	Direct repair (n=45)	Rotational flap (*n*=10)	Skin graft (*n*=5)	*P*
Diameter 1 (minimum-maximum) (mean±SD)	3.60±1.71 (1.0-8.0)	6.40±1.71 (2.0-8.0)	7.60±0.89 (6.0-8.0)	<0.000***
Diameter 2 (minimum-maximum) (mean±SD)	4.48±2.00 (1.0-10.0)	7.10±2.23 (2.0-10.0)	10.20±1.09 (1.00-12.00)	<0.000***
Total surface area cm^2 (minimum-maximum) (mean±SD)	16.12±2.16 (1.0-18.0)	45.44±3.67 (2.0-80.0)	77.52±5.67 (6.0-96.0)	<0.000***

***Statistically highly significant. There were highly significance differences (*P*<0.000) between procedures with different areas.

the second case had CSF leak and the third case had a pseudomeningocele, both of them had hydrocephalus and were treated by insertion of a ventriculoperitoneal shunt; and the fourth case had a gapped wound, which was treated by a rotational flap.

Moreover, in rotational flap, there were five (8.33%) cases that had ischemic edges that healed by daily dressing by povidone-iodine ointment. The flap group patients have the highest complication rate, and this was approved clinically and statistically ($P < 0.05$).

This agrees with Shim *et al*. [13] who reported 50% of flap patients developed marginal necrosis, which was a flap-related complication; however, it was easily reversed, and complete healing was eventually achieved.

Simple closure should be the treatment of choice for small myelomeningocele defects. However, single or multiple rhomboid (Limberg) flaps can be applied very safely to treat larger defects (≤80 cm^2). Extremely large defects may, however, require more complicated surgical procedures, involving musculocutaneous flaps.

Conclusion

In all cases of meningocele and meningomyelocele, the choice of coverage is dependent on the surface area of the defect. Preoperative measurement of the expected skin defect extremely helpful in deciding the ideal method of skin repair. The use of good vascularized rotational local flap is considered a good tool for coverage of a large defect. Expected skin defect less than 18 cm^2 can be closed directly by simple repair, from 18–80 cm^2 closed by rotational flap, and more than 80 cm^2 can be closed (covered) by skin graft.

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Nil.

Conflicts of interest
There are no conflicts of interest.

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