

## Reconstruction of Broad-Based Myelomeningocele Defects: A Modified Technique

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### ABSTRACT

The closure of broad-based myelomeningoceles presents a challenging problem. Attempts at direct closure are associated with problems of wound breakdown, skin necrosis, and infective complications. In an effort to overcome these problems, a variety of reconstructive procedures have been described. We present a technique for the closure of broad-based low thoracolumbar and lumbosacral myelomeningocele defects using bilateral interconnected latissimus dorsi myocutaneous and gluteal region fasciocutaneous flaps without lateral relaxing flank incisions.

The technique was applied for 30 neonates and infants with broad-based myelomeningocele defects admitted to the Neurosurgery Department of the Alexandria Main University Hospital through the years 2003-2006.

The age of the patients ranged from 4 days to 3 months with a mean age of 13.6 days. The diameter of the defect ranged between 9x6 and 15x10cm with a mean of 10.2x7.7cm. The surface area of the defect ranged between 39.4 and 165cm<sup>2</sup>. The percentage of the defect to that of the thoracolumbar region ranged between 9.7 and 29% with a mean of 14.21%.

We did not encounter any major wound complications or cerebrospinal fluid leakage in any of our patients. Superficial wound dehiscence occurred in two patients (6.7%) and was managed conservatively. Long-term follow-up showed stable, durable soft tissue coverage with no recurrence of the dural sac herniation.

### INTRODUCTION

The appropriate methods and timing for the management of the myelomeningocele defect have prompted considerable discussion. Infection-free closure is the key in reconstruction of myelomeningocele defects. Primary wound healing has been shown to be a significant determinant in neurologic outcome by preservation of functioning neural tissue and prevention of infective complications [1,2].

In small myelomeningocele defects, a direct approximation of the margins without tension is possible with uncomplicated healing. Patterson & Till [3] estimated that 25% of myelomeningocele defects can not be repaired by simple direct closure and require more elaborate closure techniques. A variety of reconstructive procedures have been described for the closure of broad-based myelomeningocele defects [4-6].

The technique we describe is a modification of that originally described by Ramirez et al. [7] utilizing the en bloc advancement of bilateral interconnected latissimus dorsi and gluteus maximus myocutaneous units. In the present study the gluteus maximus myocutaneous unit was replaced with a gluteal region fasciocutaneous unit.

### PATIENTS AND METHODS

We have utilized this approach in the last three years (2003-2006) in 30 patients with broad-based myelomeningocele defects. All patients with defects involving more than 8% of the thoraco-lumbar region were considered broad-based and included in the study [8]. Patients with defects covering less than 8% of the thoraco-lumbar region in whom direct primary closure could be accomplished were excluded.

All patients were subjected to thorough history taking and complete neurological assessment. Local examination involved the site and dimensions of the defect, its lie (vertical or transverse), and associated kyphus. The percentage of the size of the myelomeningocele defect to that of the thoracolumbar region was calculated as follows:

- The size of the defect was calculated from the formula.

$\pi \times r^2$  (where r is the radius) for circular defects.

$\pi \times D \times d$  (where D is the long diameter and d is the short diameter) for elliptical defects.

- The total body surface area of the patient (TBSA) was calculated from the formula.

$$\text{TBSA (m}^2\text{)} = \{[\text{body weight (Kg)} \times 4] + 7\} / \{\text{body weight (Kg)} + 90\}$$

- The total area of the thoraco-lumbar region was calculated according to the “rule of nines”. The thoraco-lumbar region constitutes 18% of the total body surface area.

Routine laboratory work-up and plain X-ray of the dorso-lumbar spine were performed. CT brain and MRI spine were done when hydrocephalus was suspected.

#### *Surgical technique:*

All patients were operated in the prone position under general endotracheal anaesthesia. Core temperature was carefully maintained by warming the intravenous fluids, by warm air conditioner, and by wrapping all extremities.

During the neurosurgical closure of the dural defect, undermining of the skin was avoided. The initial incision follows the circumferential white line formed by the junction of the arachnoid and the skin (Figs. 1,2). Following water tight closure of the dura (Figs. 3,4), flap dissection was begun by incising the thoraco-lumbar fascia over the paraspinal muscles and carrying the dissection under the latissimus dorsi (LD) to its free border laterally (Fig. 5). The perforating vessels were cauterized and divided in the process to achieve adequate medial advancement. The LD was freed from its attachments to the external oblique and serratus posterior muscles by sharp dissection. The entire LD was then based on the thoracodorsal vessels, which were maintained (Fig. 6).

Dissection was continued inferiorly deep to the lumbar fascia, including the fascia overlying the gluteus maximus muscles (GM) but without raising the muscles (Fig. 7). The perforating vessels from the GM were also cauterized and divided. Dissection was carried out laterally and inferiorly as necessary to achieve tension-free closure of the defect.

After the completion of the dissection, the reconstruction of the defect was achieved through en bloc medial advancement of bilateral interconnected latissimus dorsi myocutaneous, and gluteal region fasciocutaneous units. Kyphectomy was

performed in patients with significant kyphotic deformity of the underlying vertebral bodies.

The flaps were approximated in the midline with minimal tension and the wound was closed in three layers (fascia, subcutaneous layer, and skin) without drainage. No lateral relaxing incisions or back-cuts were needed.

In the immediate post-operative period the wounds were inspected for any wound dehiscence or infection, or CSF leakage. Patients who developed hydrocephalus were treated with ventriculoperitoneal shunt placement either at the same time or in a separate operative session after the myelomeningocele repair. Long-term follow-up to assess the durability of the repair and the absence of late skin breakdown or ulceration ranged from 1-3 years.

## RESULTS

The study included 30 neonates and infants with broad-based myelomeningocele defects admitted to the Neurosurgery Department of the Alexandria Main University Hospital through the years 2003-2006. The age of the patients ranged from 4 days to 3 months with a mean age of 13.6 days. Twenty eight patients presented as elective cases (Fig. 8), while two patients presented with ruptured myelomeningocele (Fig. 9).

Thirteen patients had low thoracolumbar; while 17 had lumbosacral myelomeningoceles. The myelomeningocele was elliptical in 22 patients and rounded in 8 patients. In patients with elliptical myelomeningoceles, the defect had a vertical lie in 18 patients and a transverse lie in four. The diameter of the defect ranged between 9x6 and 15x10cm with a mean of 10.2x7.7cm. The surface area of the defect ranged between 39.4 and 165cm<sup>2</sup>. The percentage of the defect to that of the thoracolumbar region ranged between 9.7 and 29% with a mean of 14.21%.

In all patients the myelomeningocele defect was managed with bilateral interconnected latissimus dorsi myocutaneous and gluteal region fasciocutaneous flaps (Figs. 8,9).

We did not encounter any major wound complications or cerebrospinal fluid leakage in any of our patients. Superficial wound dehiscence occurred in two patients (6.7%) and was managed conservatively. Long-term follow-up showed stable, durable soft tissue coverage with no recurrence of the dural sac herniation.

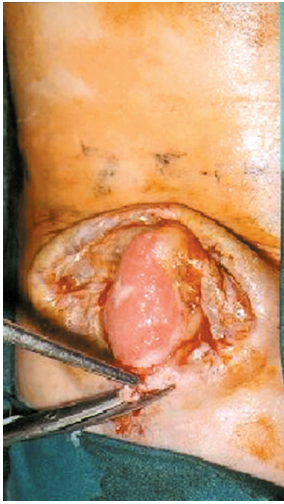


Fig. (1): Neural elements are freed from the cutaneous elements.

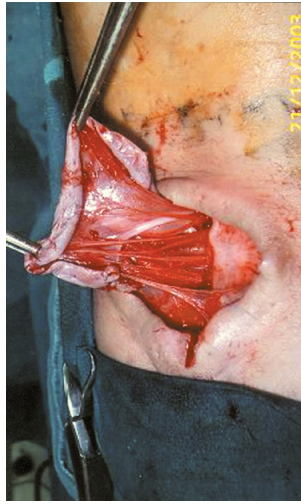


Fig. (2): Neural elements are freed from the cutaneous elements (continued).

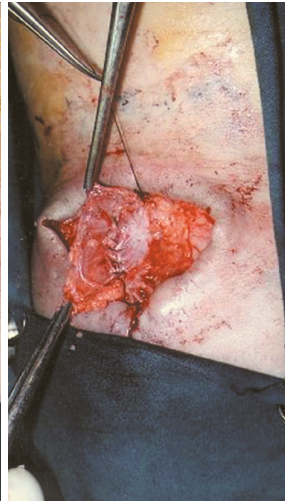


Fig. (3): Watertight closure of the dura.

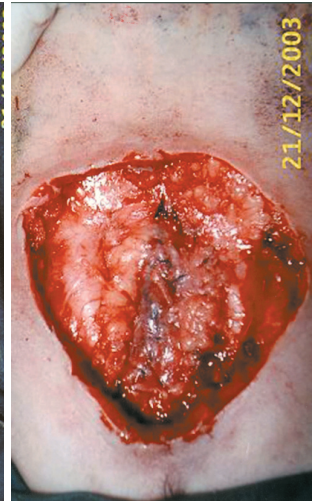


Fig. (4): Neurosurgical repair completed.

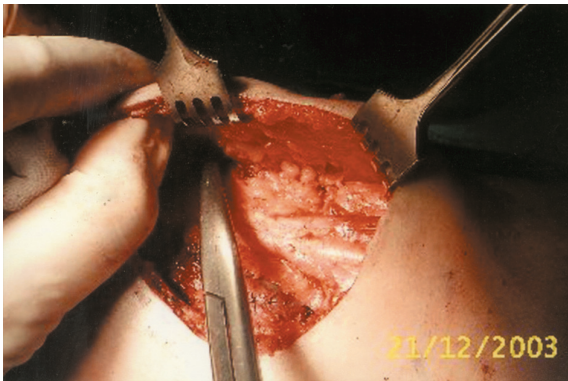


Fig. (5): Flap dissection was begun by incising the thoracolumbar fascia over the paraspinal muscles and carrying the dissection under the latissimus dorsi (LD) to its free border laterally.

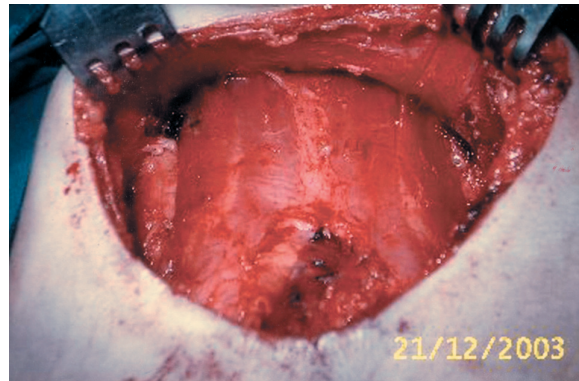


Fig. (6): Dissection of the bilateral latissimus dorsi musculocutaneous flaps completed.

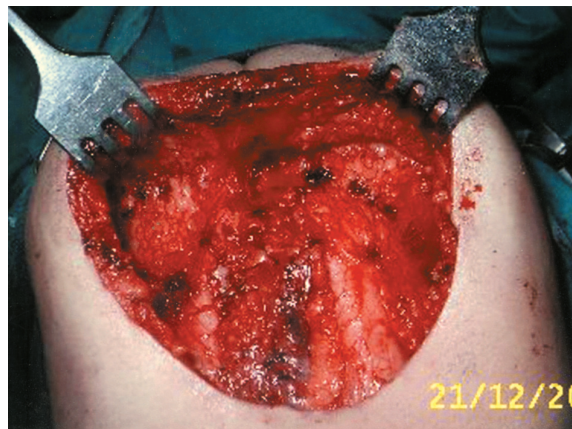
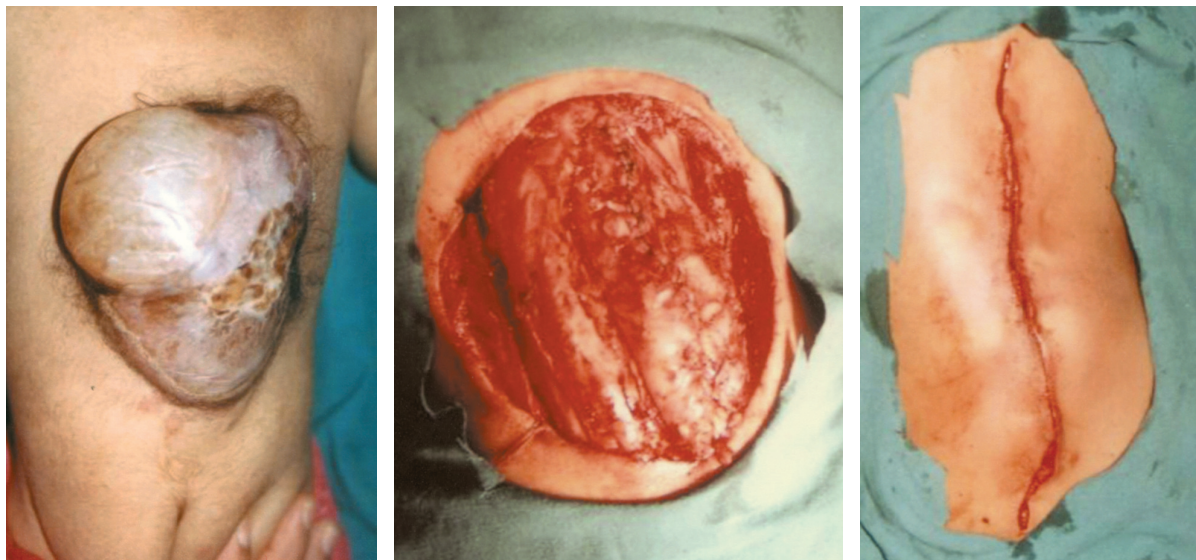


Fig. (7): Dissection was continued inferiorly deep to the lumbar fascia, including the fascia overlying the gluteus maximus muscles (GM) but without raising the muscles.



(I)

(II)

(III)

Fig. (8): Thoracolumbar myelomeningocele.

I- Preoperative.

II- After neurosurgical repair.

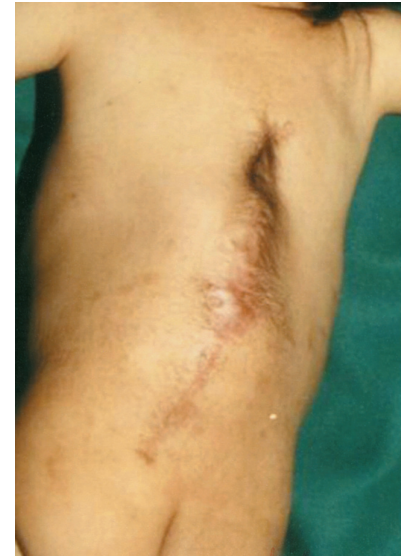
III- After flap advancement and closure of deep layers.

IV- Closure of the skin without tension.

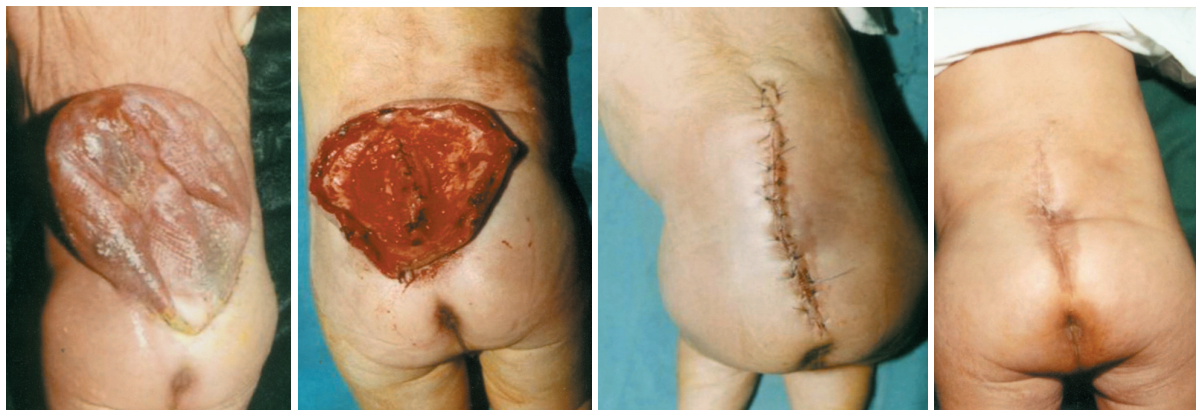
V- Late postoperative.



(IV)



(V)



(A)

(B)

(C)

(D)

Fig. (9): Ruptured broad-based lumbosacral myelomeningocele.

A- Preoperative.

B- Neurosurgical repair completed.

C- Intraoperative view after closure of the skin.

D- Late postoperative view.

## DISCUSSION

Much of the discussion regarding patients with myelomeningoceles has focused on the long-term sequelae and survival, but the focal point of controversy is the decision when to operate and how to close the defect [9].

Currently, because a consensus cannot be established on the ultimate quality of life of the myelomeningocele patient, most neurosurgeons will probably elect to treat the condition within the first 24-48 hours of the postnatal period. The urgent closure maximizes the neurological salvage by preventing both infection and neural desiccation [10,11].

Primary closure in cases of meningocele and myelomeningoceles has been reported at rates of 75-95%. This primary wound healing can be attained in small myelomeningocele defects with wide undermining of the wound edges and direct closure of the wound [2,12].

The closure of broad-based myelomeningoceles presents a challenging problem. Attempts at direct closure are associated with problems of wound breakdown, skin necrosis, and infective complications. Patterson and Till [3], in a series of 130 infants with myelomeningoceles observed that only 25% required more elaborate closure techniques than primary closure.

Ozveren et al. [8], classified meningoceles and myelomeningoceles in terms of defect area as a percentage of the thoraco-lumbar region to make it possible to select the closure technique. Any defect smaller than 8% of the thoraco-lumbar region was classified as grade 1 and can be closed primarily, while those occupying more than 8% are classified as grade 2 and were not amenable to direct closure. In this study, all myelomeningocele defects were of grade 2, requiring some sort of reconstruction.

Several variations of skin flaps have been described to close larger myelomeningocele defects. Advancement flaps [13], bipedicle flaps [14] local transposition flaps [15], rotation flaps [16], and Limberg type flaps [17] have all been utilized successfully in achieving closure of large myelomeningocele defects. These flaps, however, have random blood supply, require extensive skin undermining and involve a 20% risk of necrosis with an inherently greater incidence of wound edge failure [7,18].

Luce and Walsh [19] reported satisfactory results with the use of split thickness skin grafts with low morbidity and mortality. However, a long-term follow-up by the same authors revealed a 23% incidence of chronic and/or severe skin ulceration requiring secondary surgery [20].

The advent of myocutaneous flaps has allowed for the use of compound tissue flaps with dependable blood supply to promote early and predictable healing. Utilization of muscle tissue provides additional padding in the repair of large defects [21].

Mustarde' [22] utilized the paraspinous osteo-muscular flap for soft tissue closure of the difficult meningomyelocele defect. This procedure however, is complex and the blood loss is considerable. In addition, disruption of the paraspinous muscles may add to the structural instability of the spinal column [23].

There are several descriptions of bilateral latissimus dorsi musculocutaneous flaps for the reconstruction of thoracolumbar defects. McCraw and associates [21] used bilateral bipedicle flaps without lateral relaxing incisions. On the other hand, Moore et al. [24] stated that relaxing flank incisions were necessary for primary closure without creating undue tension on the midline wound in the majority of their cases. Hayashi and Maruyama [25] described bilateral latissimus dorsi V-Y musculocutaneous flap for closure of large meningomyelocele defects.

Clark et al. [26] and Scheflan and co-workers [27] reported on the use of "reversed" or distally based latissimus dorsi muscle flaps, employing the deep paraspinous perforators for their blood supply. The procedure is associated with the major disadvantage of destroying the insertion of the latissimus dorsi muscle which is valuable in the paraplegic patient, especially in transferring [18].

Meningomyelocele defects in the lower sacral area are more difficult to close than defects in the thoraco-lumbar area because the latissimus muscle is anatomically insufficient to provide total muscular coverage of the meninges in the sacral area. McCraw et al. [21] advocated elevation of the origin of the external oblique and its advancement as a part of the musculocutaneous unit but stated that inclusion of the external oblique muscle for low-lying defects restricts in part the advancement of the flap.

McDevitt and associates [28] and Moore et al. [24] suggested closure of thoracolumbar and lumbosacral defects with bilateral bipedicle flaps

consisting of latissimus dorsi myocutaneous and extended gluteal fasciocutaneous units. However, they utilized lateral relaxing incisions with skin grafts of the flank incisions.

Ramirez et al. [7] described the technique of en bloc medial advancement of the combined interconnected latissimus dorsi and gluteus maximus myocutaneous units without lateral relaxing incisions. The basis for this technique was derived from injection studies of the gluteal arterial system in 20 adult and neonate cadavers. A rich anastomotic plexus exists between the vasculature of the skin overlying the gluteus maximus and the latissimus dorsi muscles [29].

Ramasastri and Cohen [18] further elaborated on the technique and stated that it provides a tension-free, durable and viable soft tissue coverage over the dural repair. They stated that the flaps do not compromise muscle function but merely redefine the muscle origins. In a previous study we have applied the same method in 10 neonates and infants with broad-based myelomeningocele defects with considerable success and minimal complications [30].

The technique, however, is more complex requiring more extensive dissection than the previously described methods. It involves detaching the gluteus maximus muscle from the iliac crest and the sacrum. The dissection is then carried in the plane between the gluteus maximus and medius taking care to preserve the superior and inferior gluteal vessels [18].

The technique described in this study is a modification of that of Ramirez et al. [7], replacing the gluteus maximus myocutaneous unit with a gluteal region fasciocutaneous unit. The vascular bases of the procedure have been previously reported [31]. The skin of the gluteal region is supplied by 20-25 perforators arranged in three rows and involves a rich fascial plexus. Care was taken to incorporate the fascia overlying the gluteus maximus muscle to maintain optimum blood supply to the compound flap.

The procedure has been applied for 30 neonates and infants with broad-based myelomeningocele defects. The procedure is relatively simple and involves less extensive dissection than that described by Ramirez et al. [7]. The gluteus maximus muscle is maintained intact thus eliminating any further functional deficit that may result from detaching the origin of the muscle.

We did not encounter any major wound complications or cerebrospinal fluid leakage in any of our patients. Superficial wound dehiscence occurred in two patients (6.7%) and was managed conservatively. Long-term follow-up showed stable, durable soft tissue coverage with no recurrence of the dural sac herniation.

The procedure provides a relatively simple and reliable option for reconstruction of low thoracolumbar and lumbosacral broad-based meningomyelocele defects.

## REFERENCES

- 1- Perry V.L., Albright A.L. and Adelson P.D.: Operative nuances of myelomeningocele closure. *Neurosurgery*, 51: 719-23, 2002.
- 2- De Chalain T.M., Cohen S.R., Burstein F.D., Hudgins R.J., Boydston W.R. and O'Brien M.S.: Decision making in primary surgical repair of myelomeningoceles. *Ann. Plast. Surg.*, 35: 272-8, 1995.
- 3- Patterson T.J. and Till K.: The use of rotation flaps following excision of lumbar myelomeningoceles. *Br. J. Surg.*, 46: 606-12, 1959.
- 4- Lanigan M.W.: Surgical repair of myelomeningocele. *Ann. Plast. Surg.*, 31: 514-21, 1993.
- 5- Seidel S.B., Gardner P.M. and Howard P.S.: Soft-tissue coverage of the neural elements after myelomeningocele repair. *Ann. Plast. Surg.*, 37: 310-6, 1996.
- 6- Blanco-Davila F. and Luce E.A.: Current considerations for myelomeningocele repair. *J. Craniofac. Surg.*, 11: 500-8, 2000.
- 7- Ramirez O.M., Ramasastri S.S., Granick M.S., Pang D. and Futrell J.W.: A new surgical approach to closure of large lumbosacral meningomyelocele defects. *Plast. Reconstr. Surg.*, 80: 799-807, 1987.
- 8- Ozveren M.F., Erol F.S., Tiftikci M.T. and Akdemir I.: The significance of the defect size in spina bifida cystica in determination of the surgical technique. *Childs Nerv. Syst.*, 18: 614-20, 2002.
- 9- Menzies R.G., Parkin J.M. and Hey E.N.: Progress for babies with myelomeningocele in high lumbar paraplegia at birth. *Lancet*, 2: 993-12, 1985.
- 10- Oakes W.J.: Spinal dysraphism. In: Serafin D., Georgiade N.G., eds. *Pediatric Plastic Surgery*. St. Louis: Mosby, 634-8, 1984.
- 11- McLone D.G.: Results of treatment of children born with a myelomeningocele. *N. Engl. J. Med.*, 312: 1590-4, 1985.
- 12- Thomas C.V.: Closure of large spina bifida defects: A simple technique based on anatomical details. *Ann. Plast. Surg.*, 31: 522-7, 1993.
- 13- Zook E.G., Dzenitis A.J., Bennett J.E.: Repair of large myelomeningoceles. *Arch. Surg.*, 98: 41-5, 1969.
- 14- Habal M.B., Vries J.K.: Tension free closure of large meningomyelocele defects. *Surg. Neurol.*, 18: 177-84, 1977.

- 15- Bajaj P.S., Welsh P.S., Shadid F.A.: Versatility of lumbar transposition flaps in the closure of meningocele skin defects. *Ann. Plast. Surg.*, 3: 114-9, 1979.
- 16- Davies D., Adendorff D.J.: A large rotation flap raised across the midline to close lumbosacral meningocele. *Br. J. Plast. Surg.*, 30: 166-72, 1977.
- 17- Ohtsuka H., Shinoya N., Yada K.: Modified limberg flap for lumbosacral meningocele defects. *Ann. Plast. Surg.*, 3: 114-7, 1979.
- 18- Ramasastry S.S., Cohen M.: Soft tissue closure and plastic surgical aspects of large open myelomeningoceles. In: Pang D., ed. *Neurosurgery Clinics of North America. Spinal Dysraphism*. Philadelphia: WB Saunders, 279-91, 1995.
- 19- Luce E.A. and Walsh J.W.: Wound closure of the meningocele defect. *Plast. Reconstr. Surg.*, 75: 389-93, 1985.
- 20- Luce E.A., Stigers S.W., Vandenbrink K.D. and Walsh J.W.: Split-thickness skin grafting of the myelomeningocele defect: A subset at risk for late ulceration. *Plast. Reconstr. Surg.*, 87: 116-21, 1991.
- 21- McCraw J.B., Penix J.O. and Baker J.W.: Repair of major defects of the chest wall and spine with the latissimus dorsi myocutaneous flap. *Plast. Reconstr. Surg.*, 62: 197-204, 1978.
- 22- Mustarde J.C.: Meningocele: The problem of skin cover. *Br. J. Surg.*, 53: 36-9, 1969.
- 23- Ramasastry S.S., Cohen M. and Radhakrishnan J.: Congenital back defects. In: Bentz M.L., ed. *Pediatric Plastic Surgery*. Stamford, Connecticut: Appleton & Lange, 757-81, 1998.
- 24- Moore T.S., Dreyer T.M. and Bevin A.G.: Closure of large spina bifida cystica defects with bilateral bipediced musculocutaneous flaps. *Plast. Reconstr. Surg.*, 73: 288-92, 1984.
- 25- Hayashi A. and Maruyama Y.: Bilateral latissimus dorsi V-Y musculocutaneous flap for closure of a large meningocele. *Plast. Reconstr. Surg.*, 88: 520-3, 1991.
- 26- Clark D.H., Walsh J.W. and Luce E.A.: Closure of myeloschisis defects with reverse latissimus dorsi myocutaneous flaps. *Neurosurgery*, 3: 423-7, 1982.
- 27- Schefflan M., Mehrhof A.I.Jr. and Ward J.D.: Meningocele closure with distally based latissimus dorsi flap. *Plast. Reconstr. Surg.*, 73: 956-9, 1984.
- 28- McDevitt N.B., Gillespie R.D., Woolsey R.E., Whitt J.J. and Bevin A.G.: Closure of thoracic and lumbar dysraphic defects using bilateral latissimus dorsi myocutaneous flap transfer with extended gluteal fasciocutaneous flaps. *Child's Brain*, 9: 394-8, 1982.
- 29- Ramirez O.M., Swartz W.M. and Futrell J.W.: The gluteus maximus muscle: Experimental and clinical considerations relevant to reconstruction in ambulatory patients. *Plast. Surg. Forum*, 7: 27-32, 1984.
- 30- Ahmed A.S.: Evaluation of the role of bilateral latissimus dorsi and/or gluteus maximus myocutaneous flaps in reconstruction of broad-based meningocele defects. MS Thesis, University of Alexandria, 2004.
- 31- The superior gluteus maximus musculocutaneous island flap for the coverage of large sacral pressure sores. Anatomical and clinical study. *Egypt. J. Plast. Reconstr. Surg.*, 25: 97-107, 2001.