Neurosurgical Techniques

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Surgical Repair of Myelomeningocele

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It is obvious that a standard operative procedure cannot be described which will be applicable to all patients with myelomeningocele. There is an almost infinite variety of these lesions, extending from a small parchment-like midline membrane covered by poorly developed squamous epithelium and accompanied by no neurological deficit, to extensive myeloschisis of many segments accompanied by total loss of neural function below this level. To illustrate our surgical method we have chosen an example that is somewhere in between, namely, a medium-sized lumbar myelomeningocele covered partially by skin of varying thickness and partially by a thin, poorly epithelialized membrane. In the lesion selected, it will be noted that most of the elements of the cauda equina are adherent to the inner surface of the myelomeningocele. This is extremely common, both in lesions accompanied by total loss of distal neural function and in those accompanied by moderate or negligible loss of function.

Certain general comments will first be made, with the suggestion that the reader interpret these as pertaining to the average lumbar myelomeningocele illustrated and adopt specific modifications for the individual patient.

Each patient with a myelomeningocele should be assessed carefully. Various considerations determine the type of operative procedure and the optimal time to carry it out. These include such variables as the spinal level of the lesion, size and shape of the lesion, the condition of the surrounding skin, the age of the patient, the neurological status, the adequacy of cerebrospinal fluid circulation, the presence of other congenital anomalies, the past family history, and the socio-economic status of the family.

Myelomeningoceles that occur in the cervical region as well as the rarer lesions along the thoracic spine are usually smaller, are apt to have a narrow dural neck, and seldom contain significant neural tissue. Technically, they are much less of a problem than the type of lesion in the lumbar and sacral areas to be described.

The optimal time for surgical repair of a myelomeningocele is during the first 24 hours of life. Every effort should be made to see these babies as soon as possible after delivery, and to carry out surgical repair if it is deemed technically feasible before there has been contamination of any unepithelialized surface. Newborn babies with myelomeningoceles should be given nothing by mouth except sterile water. Under these circumstances, there is little or no bacterial activity in the intestinal tract and the meconium remains essentially sterile.

It must be accepted that all incompletely epithelialized myelomeningoceles seen after 48 to 72 hours of life are superficially contaminated; sterilization of the surface of the lesion prior to operation then becomes a difficult problem. If surgical repair is not carried out in the first 24 hours of life, a time must be selected when, in the surgeon’s best judgment, the surface of the lesion has been made as clean as possible, and the baby’s general condition warrants going ahead. If surgery is not done during the first day or two of life, it may be wise to delay for a number of weeks, or even months, until the local and general situations become optimal. On the other hand, however, long delay in the presence of an ulcerated or leaking lesion may often increase the danger of meningitis.

A principal complicating factor of every myelomeningocele is inadequacy of the cerebrospinal fluid circulation. When myelomeningocele excision has been performed in the newborn period, a shunting procedure to treat hydrocephalus is done, if necessary, 3 or 4 weeks later. If the patient is first seen after the newborn period and progressive hydrocephalus is evident, it may be wise to per-
form a shunt for control of the hydrocephalus before attempting repair of the myelomeningocele.

Operative Position

In this clinic, all operations for myelomeningocele, even in the newborn period, are carried out under endotracheal inhalation anesthesia with the exception of an occasional premature or otherwise preorganic newborn infant with a small lesion, in which case local infiltration alone is used. Fig. 1A illustrates the position of the patient on the operating table ready for operation. It will be noted that the baby is in a prone position with rolls under the shoulders, hips, and ankles. Endotracheal anesthesia is being administered. A stethoscope is strapped to the patient's left chest; through this, both heart sounds and respiratory rate are easily monitored. An intravenous catheter has been inserted into the right antecubital area. A constant temperature thermocouple is placed in the rectum. The electro-cautery plate is under the right thigh. The left leg and both arms have been wrapped with sheet wadding to minimize loss of heat. In babies with large lesions, it is our custom to place a sterile towel underneath the body before the skin preparation has been started, so that preparation may be carried well around into both flanks. Any crusts on the myelomeningocele are mechanically debrided and the entire area washed thoroughly with Phiso-Hex. Routine skin preparation is then carried out; mechanical scrubs with alcohol and aqueous Zephiran are used alternately, and the entire area is painted with half-percent Iodine. Suitable skin drapes are applied, using an adhesive plastic drape to wall off the anus from the rest of the operative field.

Incision

Figure 1B illustrates the average incision used for this type of myelomeningocele. A transverse incision carried as far laterally as possible on either side is marked and carried closely around the base of the lesion. If it is anticipated that the closure with this incision will be difficult, a smoothly curved extension is tentatively outlined at either end of the transverse incision. This extends upward at one end and downward at the other. By using these extensions, the area of skin flaps underlined can be greatly increased. If the meningocele is longitudinally oriented, the axis of incision may be at right angles to that shown. Occasionally, a triangular incision around the base with extensions at each apex of the triangle may prove best-suited to the particular lesion. An effort is made to keep all incisions as far away from the anus as possible.

Exposure

The original skin incision is carried down to the fascial level at a convenient point. Dissection is then continued with scissors at this level, as shown in Fig. 1C, so that all tissues above the fascial level are cleanly separated and full-thickness cranial and caudal skin flaps developed. It is our practice to undermine these flaps widely at the time of the original incision, secure major bleeders, and then place gauze packs underneath the skin flaps. This will usually have controlled all bleeding by the time closure is performed. Attention is then turned to the base of the meningocele. Dissection at the fascial level is again developed at one convenient point until the membranous neck of the meningocele is identified (Fig. 1D).

Excision

Starting at this point and working first in one direction and then the other, all superficial tissues between the membranous neck of the meningocele and the surrounding fascia and muscle are divided. In Fig. 2E this dissection has been completed, and a rather broad-necked meningocele sac is seen arising from the dural envelope, completely separated from all surrounding attachments. The sac is then opened at a convenient point, which usually should be in the midline superiorly. This is the safest point to open the dura without injuring any neural contents. As the neck of the sac is opened, care must be taken to leave enough margin so that dural closure can be carried out (Fig. 2F). It is convenient to place hemostats or stay sutures in the margins of the dura, as the neck is incised. There may be multiple filmy adhesions and layers of arachnoid, which should be separated carefully as the neck of the sac is opened.

With release of the cerebrospinal fluid, the
FIG. 2. Dissection of the meningocele.  
E. Separation of the meningocele from its membranous attachments. 
F. Incision of the neck of the meningocele sac. 
G. Separation of neural elements from inner membrane of sac. 
H. Final adhesion divided and sac removed.
Fig. 3. Closure.  I. Dural closure.  J. Creation of flap of fascia from the paraspinal muscles.  K. Swinging of flaps to opposite side for suture to the paraspinal fascia.  L. Closure of the skin.  *Insert:* alternate (plastic) closure of skin flaps.
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skin and membranous covering becomes relaxed. It is convenient then for the surgeon to turn the meningocele inside out over the fingers of his left hand, thus evverting the inner surface as shown in Fig. 2 G. With extreme care, all of the neural elements adherent to the undersurface of the myelomeningocele sac are then dissected free. This is often most conveniently done by incising the thin inner membrane with a scalpel and wiping the neural elements downward with gauze. If there is any question about any particular tissue possibly containing functional neural elements, this tissue should be preserved. Faradic stimulation with a bipolar electrode may be useful at this point to identify any filaments of motor nerve roots. Magnification may also be helpful. Dissection of all the neural elements is finally completed, as shown in Fig. 2 H, and these are allowed to drop back into the spinal canal as the covering of the myelomeningocele is excised. Liberation of fibrous adhesions to the neck of the sac will often allow the neural tissue to drop back into position more easily.

Closure

Watertight closure of the dura with interrupted sutures of fine silk is then carried out (Fig. 3 I). Fontanelle compression or jugular compression may be used to test the suture line and show sites for placing additional sutures to obtain the tightest possible closure. Occasionally, the dural defect may be of such a nature that an adequate neck is not present and dural closure is impossible.

A flap of fascia is fashioned from the paraspinal muscles, as shown in Fig. 3 J, swung on a hinge over the defect and sutured to the paraspinal fascia on the opposite side (Fig. 3 K). It is particularly important to carry out this maneuver if a tight dural closure has not been possible. Occasionally, particularly in large defects in small infants, it may be necessary to swing a fascial flap from one side over the upper or rostral part of the defect and a fascial flap from the opposite side to cover the lower or caudal half of the defect.

When this has been completed, the gauze packs underneath the skin flaps are removed, the wound is irrigated thoroughly with saline solution, and meticulous hemostasis carried out. Two-layer closure of the skin is then performed. It is our custom to place two stitches, as shown in Fig. 3 L, which pick up the deep fascia or muscle on either side of the central repair. The rest of the wound is closed with interrupted inverted sutures to the subcutaneous fascia and fine silk or, more often, fine stainless steel wire to the skin.

If it is not possible to carry out direct approximation of the skin flaps without tension, an alternate method of modified Z-plasty may be used as shown in the lower right insert in Fig. 3. The rostral extension at one end of the transverse incision and the caudal extension at the other end are made. This creates two large flaps with very broad bases. These are widely undermined, taking care to maintain full thickness of the skin. The flaps are brought together in the midline as indicated in Fig. 3. The center of this skin repair should always be closed first, working from there toward either extremity of the wound.

Meticulous attention to the best skin closure possible is extremely important to minimize the danger of subsequent infection from the outside. If very wide undermining of flaps has been performed, a small catheter or Hemovac apparatus is inserted through a stab wound for mild wound suction during the first few postoperative days. A firm, but not tight, pressure dressing is applied over all of the area which has been undermined.

Postoperative Care

Postoperatively, the baby is put on a Bradford frame in the prone position. An adhesive plastic sheet is placed at the caudal extremity of the wound dressing, so as to exclude fecal material and urine from contaminating the area of the wound.

If a shunt procedure has not already been performed, the baby is watched very carefully during the postoperative period for evidence of acute increased intracranial pressure. If normal wound healing appears to be threatened by an accumulation of spinal fluid beneath it, constant ventricular drainage is instituted until wound healing has been completed and intracranial pressure has either stabilized spontaneously or been treated by a subsequent shunt.

The neurosurgeon’s responsibility does not
cease when these patients leave the operating room. It is imperative that he supervise or arrange for continuing follow-up observations relative to: 1) skin care, 2) adequacy of cerebrospinal fluid circulation and absorption, 3) physical therapy and orthopedic rehabilitation, and 4) management of urinary and gastrointestinal complications.