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Intrathecal baclofen therapy—how we do it

Technical note

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Intrathecal baclofen has become an invaluable tool to treat spasticity of various etiologies. Children who benefit from intrathecal baclofen are often significantly underweight due to underlying disease pathology, and they lack adequate soft-tissue mass to effectively provide cover to the pump. Thus, in this population, subfascial implantation is favored over the subcutaneous technique in view of the high frequency of wound dehiscence and subsequent explantation of the pump associated with the latter method.

The authors describe and review their unit's adapted subfascial implantation technique that has been performed over a period of 10 years in 182 children. This technique provides better tissue coverage for the pump and has resulted in lowering the risk of complications as compared with the subcutaneous technique.
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Key Words • **intrathecal baclofen** • **technique** • **spasticity** • **subfascial implantation** • **pediatric neurosurgery** • **functional neurosurgery**

Intrathecal baclofen has been established in the management of spasticity and dystonia in recent decades.[8,25,26] Continuous infusion of baclofen into CSF concentrates the drug locally where it achieves its therapeutic effect and also provides a constant concentration.[12]

Intrathecal baclofen pump implantation techniques have changed noticeably since the advent of the procedure in 1985.[19] Initially, the pump was implanted subcutaneously, but this technique was associated with poor healing and wound dehiscence, resulting in explantation of the pump.[17] In 1998, Grabb and Pittman[11] described a subfascial technique of inserting the pump.[15] This technique provides more coverage of the pump, lowering the risk of skin dehiscence, and enhancing the cosmetic appearance of the abdomen by reducing the pump profile in children who, due to underlying disease pathology, are significantly underweight and often lack adequate soft-tissue mass to effectively cover the pump.[15]

In the first 5 years of practice, we implanted our systems subcutaneously. However, because of a high rate of complications, we adapted the subfascial technique. We describe and review this technique that has been used in 182 children at the Department of Pediatric Neurosurgery, University of Nottingham, by a single neurosurgeon (M.H.V.) over 10 years of practice (October 1998–March 2009).

Modified Subfascial Implantation Technique

Cerebral palsy represents the main indication for intrathecal baclofen pump implantation in children in our group.[25] Therefore, perioperative factors considered include communication difficulties due to mental disability, gastroesophageal reflux with the risk of aspiration and chest infection, presence of a gastrostomy, and problems associated with malnutrition.[22,28]

Patient Positioning

The optimal patient position is facilitated by placing a vacuum pack underneath the patient to avoid movement during the procedure. The child is positioned in the left decubitus position with the hips and knees flexed to facilitate access to the thecal sac. Care is taken in the presence of scoliosis, which may restrict ventilation and joint contractures at all levels, thereby restricting access for positioning. A soft pillow is placed under the hips and between the knees to avoid pressure sores. Care is also taken to position the dependent arm so that the axilla is not compromised and the upper arm is supported and held away from the surgical field.

This article contains some figures that are displayed in color online but in black-and-white in the print edition.

Surgical Preparation

Antibiotics are administered at the time of anesthesia induction,[5] and the operating field is prepared with chlorhexidine and adhesive sterile draping. Double gloving techniques are used with frequent changes of the top gloves, especially before handling the pump and the catheter.[1,14,21,23]

Implant Site Selection and Incision

Scarring from previous abdominal surgery and the presence of a left-sided gastrostomy tube in children can complicate the location and laterality of the implant site. However, since most surgeons are right-handed, the preferred surgical side is the right. In smaller children, to avoid contact and subsequent irritation from the lower ribs, the pump is implanted inferiorly in the right iliac fossa.

A transverse skin incision is made in the right hypochondrium at the level of the upper third of a line running between the xiphoid process and the pubic ramus to allow fashioning of a pocket inferiorly and to avoid contact with the lower end of the rib cage.

Dissection

The incision is deepened through the subcutaneous fat, but care is made not to dissect it from the muscle fascia to avoid creating dead space, which may predispose to infection.[7] A single plane is created down to the rectus sheath, and both the lateral and medial edges of the rectus abdominis muscle are identified (Fig. 1). The fascia of the rectus sheath is incised horizontally and is continued laterally into the full thickness of the external oblique muscle (Figs. 2 and 3).

At the medial side of the wound, the anterior layer of the fascia of the internal oblique muscle merges with its posterior fascial layer over the lateral edge of the rectus abdominis muscle at a variable distance along the line of linea semilunaris (Figs. 1 and 3). Cutting in between these internal oblique layers (Fig. 4) helps to open a natural plane between the external oblique muscle anteriorly and the internal oblique, transversus abdominis, and peritoneum posteriorly (Fig. 5). These planes are usually avascular and easily dissectible unless there is scarring from previous surgery.

The tendinous intersections of the rectus abdominis muscle form horizontal adherences of the muscle to the fascia. It is usually necessary to release at least one of these intersections from the anterior fascia (Fig. 6). These are very vascular, and thus hemostasis is crucial to prevent a hematoma that could lead to infection.

The rectus muscle is not dissected from the internal fascia, particularly in the medial rim below the arcuate line (the lower limit of the posterior layer of the rectus sheath, which lies in the upper third distance between umbilicus and pubic crest). Here the fascia is relatively thin and close to the peritoneum, and the inferior epigastric vessels perforate the rectus abdominis. Hence, this avoids peritoneal migration of the pump or erosion of epigastric vessels.[18,24]

In summary, a space is created starting beneath the anterior rectus sheath medially, continuing laterally under the external oblique. The internal oblique, the transversus abdominis, and the peritoneum constitute the posterior wall of this pouch (Fig. 7).

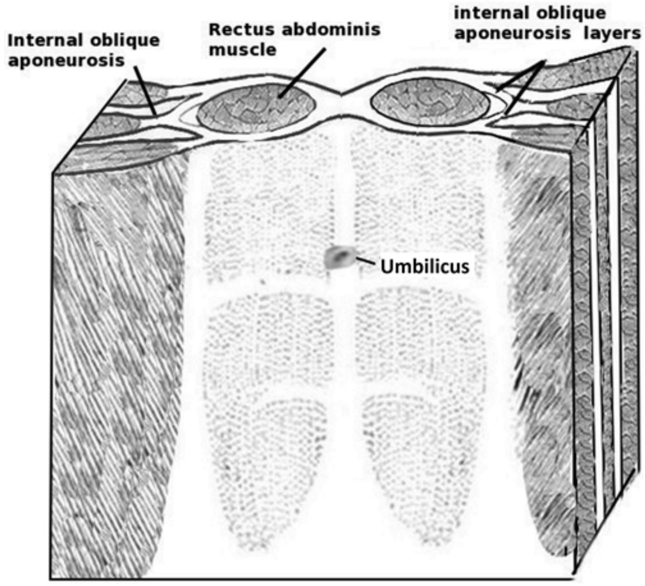

Fig. 1. Diagram showing the abdominal muscle and fascial layers.

Once the pouch has been fashioned, the following checks are made: that the pump will fit inside the pouch, that the fascia will close easily over the entire pump and connector (Fig. 8), that there is sufficient place to connect the catheter, and finally that there is no bleeding.

The subfascial implantation technique is not novel and has been described with its outcomes and complications.[3,4,6,13,27]

Albright et al.[2,3] described incising the covering fascia of the external oblique muscle laterally and the fascia of the rectus abdominis muscle medially, and then degloving the fascia to fashion a subfascial pocket cranially and more caudally to the transverse fascial opening. This would leave the suture line of the fascia crossing over the pump at risk of infection and dehiscence.

Kopell et al.[15] modified the same technique by cutting the linea semilunaris, which provides an adequate pouch for the pump below the fascia, but we assume this could interrupt the integrity of the anterior wall of the pouch.

In our technique, the transverse opening of the fascia is extended more laterally to incise the red muscle fibers of the external oblique to allow dissection of the space between external and internal oblique muscles. This provides complete coverage of the pump by the muscle below the level of the fascial opening. Furthermore, cutting the anterior lamella of the internal oblique aponeurosis in a caudal direction under the external oblique muscle helps preserve the integrity of the external oblique muscle anteriorly.

Given the large number of cases in this series and a long duration of follow-up of up to 9 years, we have not found that the additional thickness of the muscle covering interferes with refilling the pump, and there have not been any infections related to refills.

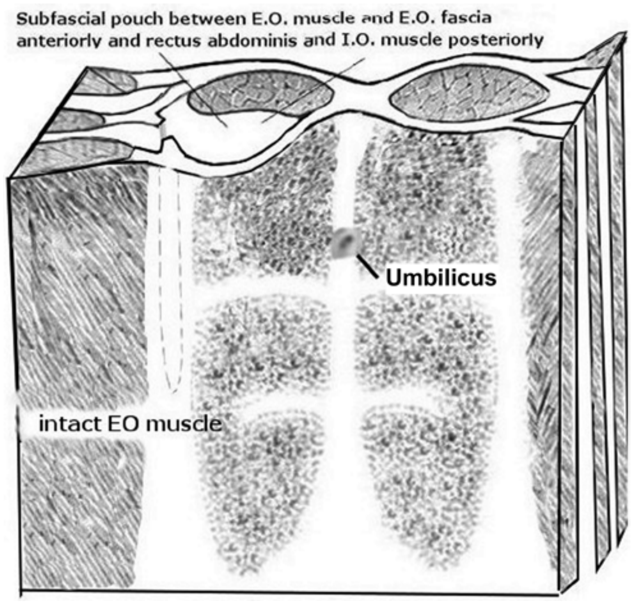

Fig. 2. Diagram showing the location of the subfascial pouch. E.O. = external oblique; I.O. = internal oblique.

Spinal Access

The usual level for insertion is L3–4, as it is less mobile than L4–5 and still below the conus medullaris. The skin is incised 2 cm over the lumbar spine down to the supraspinous fascia in the interspinous space and a 14-gauge Tuohy needle is used to access the thecal sac. The entry point is made 1.0–1.5 cm from the midline (paraspinal), away from the interspinous ligament to avoid fracture of the catheter after insertion.[9] Care is taken not to enter too laterally beyond the pedicle to avoid catheter migration as the thin fascial layer and increased muscle bulk laterally could potentially increase the differential motion and lead to subsequent migration of the catheter.[10]

After ensuring that the Tuohy needle is in the thecal space by CSF back flow, the catheter is introduced through the cannula and is advanced cranially. Occasionally, a laminotomy is required to gain access to the thecal sac.

Tunnelling of the Catheter

A 1-piece catheter is used to avoid posterior disconnection. Tunnelling is performed from the fashioned subfascial pouch in the abdomen and is directed to the lumbar incision. The tunnelling device leaves the pump site from inside the subfascial pouch by passing between the muscle layers and then piercing the external oblique muscle and its fascia to end up in the subcutaneous tissue. This technique has many advantages. 1) The catheter and the connector of the pump are completely buried under the muscular layer as the fascial incision will be completely closed upon them. In addition, it prevents the risk of catheter occlusion during fascial suturing or fracture of the subcutaneous connector. 2) Initiating the tunnelling at the abdominal end traversing through the muscular layers under direct vision before taking a subcutaneous route avoids accessing the wrong planes from a reversed approach. 3) Catheter migration is less common in subfascial techniques than in subcutaneous techniques, as the anterior half of the catheter tunnel passes between the muscles before it arrives in the subcutaneous tissues. We assume that the muscular cover restricts catheter movement and decreases the incidence of migration, while fatty slippery tissue in subcutaneous technique may increase migration risks. In addition, at the midaxillary line, where the catheter changes its plane from intermuscular to subcutaneous tissue, we believe that this point acts a natural anchor of the catheter to prevent its migration.

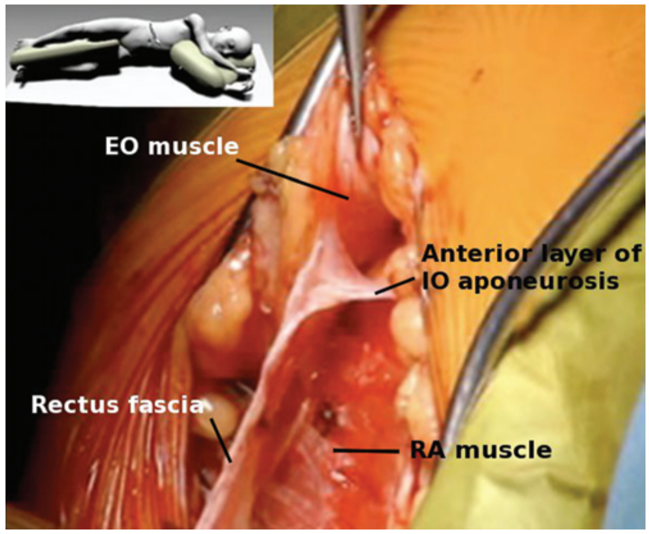

Fig. 3. Intraoperative photograph of the anterior rectus sheath medially and external oblique muscle laterally. Note the anterior layer of the internal oblique aponeurosis. RA = rectus abdominis.

Before attaching the catheter to the pump connector, we check that the CSF is draining and that the catheter is secured to the connector with silk ties. The full length of

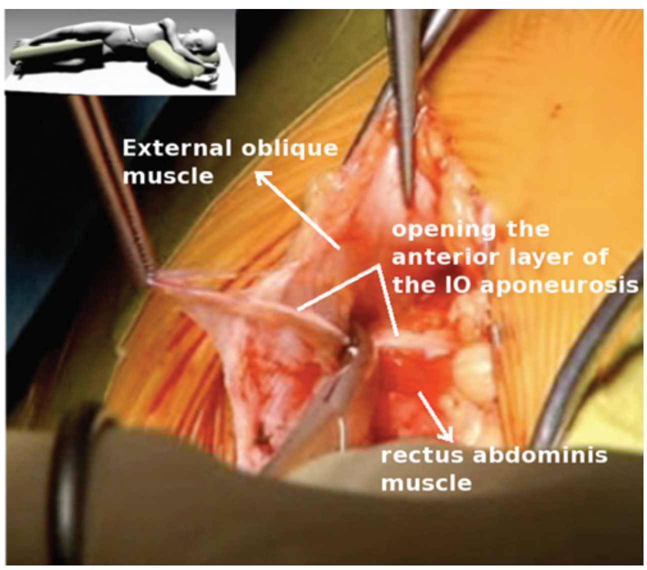

Fig. 4. Intraoperative photograph demonstrating cutting of the anterior layer of the internal oblique aponeurosis to create the subfascial pouch.

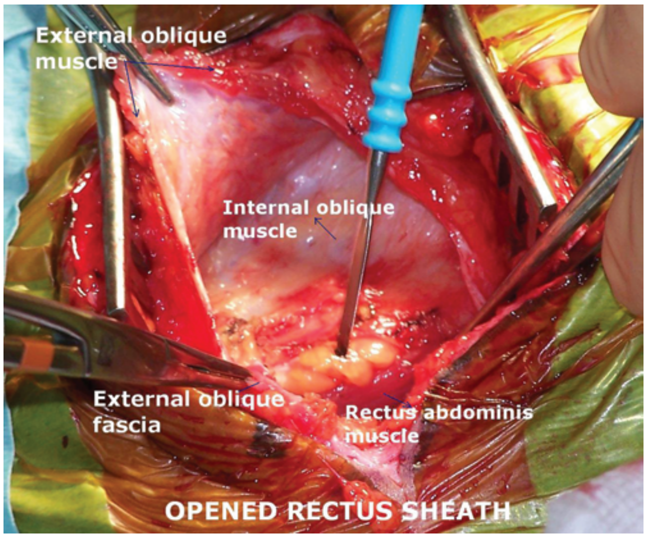

FIG. 5. Intraoperative photograph of the opened subfascial pouch.

the single-piece catheter is left without shortening. The remaining tube is coiled behind the pump and over the lumbar fascia. This allows some sagging of the tube between the pump and spine during movement.

Operation Duration

The duration of the operation varies between 50 and 150 minutes, with an average of 70 minutes in most cases. Factors such as previous operations or adhesions and extremes of weight and height have often prolonged the procedure. With the latter, more time is required for meticulous dissection and fashioning the subfascial pouch. The presence of orthopedic deformities and contractures can interfere with the exposure.

Postoperative Course

Postoperatively, the child stays in the hospital for at least 48 hours to make sure there is no wound leak or postlumbar puncture syndrome.

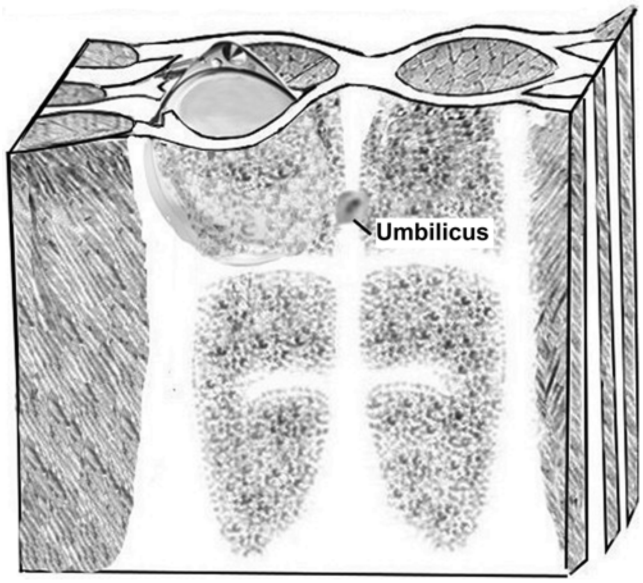

FIG. 7. Diagram showing the final location of the intrathecal baclofen pump.

Special Considerations

Children with cerebral palsy usually develop spinal deformities, such as scoliosis, and thus they undergo spinal correction surgery. Insertion of an intrathecal catheter in this group of patients may present challenges related to distorted anatomy by severe scoliosis or presence of bony fusion mass that develops after thoracolumbar fixation. In addition, metal spinal instrumentation may complicate the approach to the dural sac.[16] Even if tunnelling the catheter through the fusion mass were possible, it is difficult to treat any CSF leaks.[4,20] Using the thoracocervical

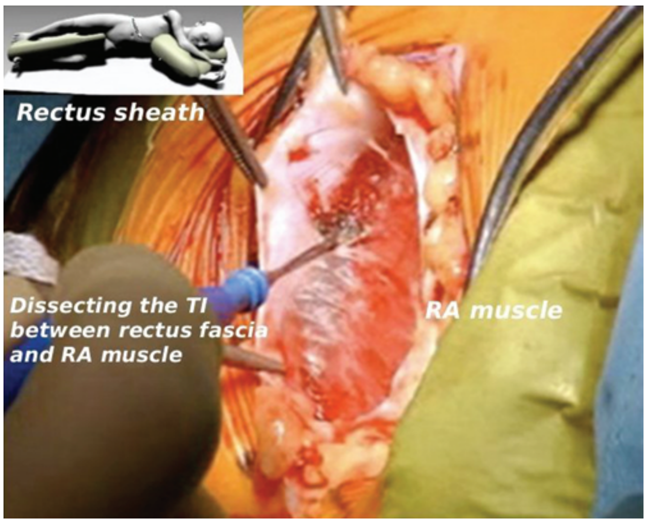

FIG. 6. Dissection of the tendinous insertions (TI) from the rectus abdominis muscle.

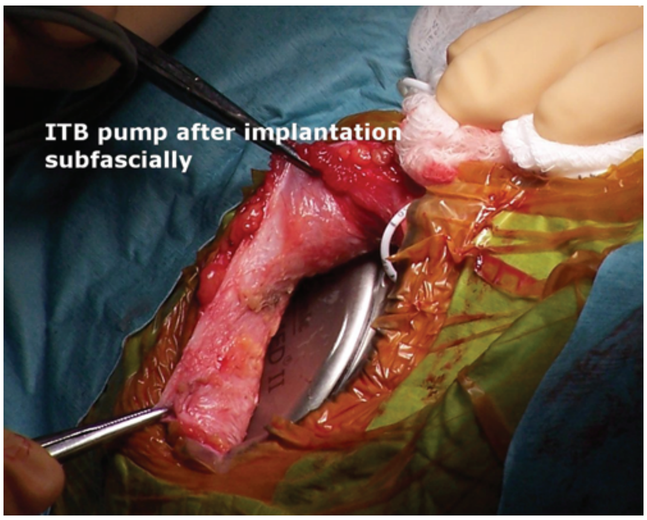

FIG. 8. Intraoperative photograph of the subfascial pouch demonstrating adequate coverage of the intrathecal baclofen (ITB) pump and catheter.

approach to insert the catheter intrathecally is an alternative to lumbar insertion of the catheter.[20]

Complications

To date, we have undertaken 182 subfascial implantations using this technique, and we have not encountered any significant intraoperative complications. Catheter complications (for example, fracture and kink) occurred in 15 cases (8%), while catheter migration occurred in 4 (2.2%). Intrathecal baclofen pump infection requiring total implant removal occurred in 10 cases (5.5%), minor wound infection in 13 cases (7.1%), and wound dehiscence causing explantation occurred in 3 cases (1.6%).

Table 1 compares the rates of complications between the subcutaneous and subfascial techniques. A clear improvement in complications is noted in the subfascial cohort with regard to catheter complications ($p = 0.013$, chi-square test), although increased experience probably contributed to this. Although pump infections were relatively higher in the subfascial group, this complication did not reach statistical significance ($p = 0.209$, chi-square test). As our experience with this technique has increased, we are able to treat younger children with smaller birth weights (Table 2), which may explain the higher rate of infection in the subfascial cohort. These infections were not related to refills as all infections occurred within 44 days of the implantation, that is, prior to the first refill. Subsequent to these findings, the subfascial method has become our preferred method of implantation.

Conclusions

Intrathecal baclofen is a recognized treatment modality for spasticity. As our experience has increased, implantation procedures have developed to reduce the rate of complications and increase survival of the delivery system. We have described a subfascial technique used in our practice for more than 10 years that has reduced complication rates compared with subcutaneous implantation.

Disclosure

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper. Medtronic has in the past supported a research program for an outcome study on intrathecal baclofen in children. The funds were used to support the salary of a research physiotherapist. None of the authors have or will financially benefit from the use of Medtronic equipment.

Author contributions to the study and manuscript preparation include the following. Conception and design: Ammar, Vloeberghs. Acquisition of data: Ammar, Vloeberghs. Analysis and interpretation of data: Ughratdar, Ammar, Sivakumar. Drafting the article: Ughratdar, Ammar, Sivakumar. Critically revising the article: all authors. Reviewed submitted version of manuscript: all authors. Approved the final version of the manuscript on behalf of all authors: Ughratdar. Study supervision: Vloeberghs.

TABLE 1: Comparison of rate of complications between subcutaneous and subfascial techniques

	No. of Patients (%)	
Variable	Subcutaneous	Subfascial
no. of implants	36	182
catheter complications (kink, fracture)	8 (22)	15 (8.2)
catheter migration	7 (19)	4 (2.2)
wound infection (antibiotics)	4 (11.1)	13 (7.1)
pump infection requiring removal	0 (0)	10 (5.5)
wound dehiscence	4 (11.1)	3 (1.6)

TABLE 2: Demographic comparisons of the subcutaneous and subfascial groups

Parameter	Subcutaneous	Subfascial
diagnosis	cerebral palsy	cerebral palsy, dystonia
M/F	20/16	111/69
age		
range	6.4–18.7 yrs	9 mos–19 yrs
mean	12.73 yrs	9.85 yrs
median	12.9 yrs	10.7 yrs
SD	3.06 yrs	4.32 yrs
weight (kg)		
range	13–58	7–65
mean	37.9	27.12
median	35.7	25
SD	12.3	11.02
practice duration	October 1998–October 2003	October 2000–March 2009
follow-up (yrs)	5–12	1–11

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