Clinical Reports

Combined spinal and epidural anaesthesia for major abdominal surgery in infants

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Purpose: Subarachnoid anaesthesia is becoming increasingly popular in neonates and infants. However, single dose spinal anaesthesia is of limited value for major abdominal surgery in infants due to its short duration of action and inability to provide analgesia in the post operative period. A new technique of combined spinal and epidural anaesthesia for major abdominal surgery in the infant is described.

Methods: Data were gathered prospectively from 19 infants presenting for upper and lower abdominal surgery. Anaesthesia was induced with a subarachnoid injection of tetracaine. After the subarachnoid block was established, an epidural catheter was placed for further intraoperative and postoperative management. Data collected included age and weight of the patients, type and duration of the surgical procedure. Doses of local anaesthetics as well as the need for intraoperative and postoperative supplements were recorded. An illustrative case report is provided.

Results: Infants studied represented a wide range of weights (1520–7840 g). Spinal anaesthesia was successful in all 19 patients. A variety of extensive surgical procedures including small bowel resections and various genitourinary procedures were successfully performed. In 17 patients a functioning epidural catheter was in place postoperatively. In these patients effective analgesia was maintained with dilute solutions of epidural bupivacaine. Only three doses of narcotic were required for pain control. No patient required postoperative mechanical ventilation or tracheal intubation.

Conclusion: Combined spinal and epidural anaesthesia is a potential option to general anaesthesia for major abdominal surgery in infants.

Objectif : On administre de plus en plus fréquemment l'anesthésie sous-arachnoïdienne à de nouveau-nés et à des enfants. À cause de sa courte durée d'action et de son incapacité à procurer de l'analgésie postopératoire, la rachianesthésie en une seule injection a une valeur limitée en chirurgie abdominale majeure. Ce travail décrit une nouvelle technique d'anesthésie combinée rachidienne et épidurale adaptée à ce type d'intervention chez l'enfant.

Méthodes : Les données pertinentes à des interventions sur l'étage supérieur et inférieur de l'abdomen ont été recueillies prospectivement chez 19 enfants. L'anesthésie était induite par l'injection sous-arachnoïdienne d'une dose de tétracaïne. Une fois le bloc sous-arachnoïdien établi, un cathéter épidural était introduit pour la prise en charge peropératoire et postopératoire de la douleur. Les données recueillies incluaient l'âge et le poids du patient, le type et la durée de l'intervention. Les doses d'anesthésique local et les besoins de suppléments peropératoires et postopératoires d'anesthésiques étaient notés. Un cas typique est présenté pour illustrer cette technique.

Résultats : Le poids des enfants admis dans l'étude variait largement de 1520 à 7840 g. La rachianesthésie a bien fonctionné chez tous les patients. Les interventions réalisées avec succès étaient des interventions complexes dont des résections de l'intestin grêle et différentes interventions génito-urinaires. Chez dix-sept patients, le cathéter épidural a a été maintenu après l'intervention. Pour ces enfants, des solutions épidurales étendues de bupivacaïne ont procuré l'analgésie postopératoire. Seulement deux injections de morphiniques ont été requise pour traiter la douleur postopératoire. Aucun des patients n'a eu besoin de ventilation mécanique ni d'intubation endotrachéale postopératoire.

Conclusion : La rachianesthésie combinée à l'épidurale représente une solution de rechange à l'anesthésie générale valable pour la chirurgie abdominale chez l'enfant.

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This work was presented in part at the combined Winter meeting of the Society for Pediatric Anesthesia and the Section on Anesthesiology of the American Academy of Pediatrics; Scottsdale, Arizona, February 18, 1995.
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Accepted for Publication February 16, 1997.

OVER the past decade there has been a marked increase in the use of regional anaesthesia in children. Since the report from our group in 1984, spinal anaesthesia in infants has become commonly used for procedures in the inguinal region and lower extremities.[1,2] Spinal anaesthesia has also occasionally been used for upper abdominal and even thoracic procedures.[3–5] In many instances the use of spinal anaesthesia can obviate the need for general anaesthesia. This has important implications, particularly for the sick or high risk neonate. However, the utility of spinal anaesthesia in infants is limited by several factors. Despite the use of tetracaine and epinephrine, surgical anaesthesia is not uniformly reliable for periods of greater than 90 min.[1,6] This is often too brief a time to perform major abdominal surgery. In addition, analgesia is not extended into the postoperative period. Until recently, in order to obtain the benefits of postoperative epidural analgesia for infants undergoing major surgical procedures, it has been necessary to utilize a combined general and epidural anaesthetic technique. We have modified our technique to combine infant spinal and epidural anaesthesia and prevent the need for general anaesthesia and tracheal intubation for a number of these infants. A data base was assembled prospectively for this group of patients. We present an illustrative case report and a review of our experience with the technique to date.

Case report

The patient was a 29-wk gestational age girl with a birth weight of 1,520 g. Mild Respiratory Distress syndrome (RDS) was diagnosed and treated with oxygen 40% via 4 cm H_2O nasal CPAP. Blood cultures had been performed and antibiotics administered. She was brought to the operating room on the first day of life for laparotomy with a diagnosis of small bowel obstruction. Standard monitors including pre and post ductal SpO_2, ECG and noninvasive blood pressure cuff were placed. In anticipation of high insensible fluid loss during open laparotomy, a 15 ml bolus of Ringer's lactate was administered through a peripheral intravenous catheter. The infant was then placed in the lateral decubitus position and spinal anaesthesia with 1.25 mg tetracaine and glucose with 1/200,000 epinephrine was administered in a standard manner as previously described.[1] The patient was returned to the supine position. A sensory level of approximately T8 was confirmed. Several minutes after the subarachnoid injection was performed the infant was returned to the lateral decubitus position, being careful not to place the patient into Trendelenburg position. The infant appeared calm with complete motor block of the lower extremities. The lumbar and sacral areas were cleansed with an iodophor solution. The sacral area was anaesthetic to touch. An assistant held a pacifier for the infant and a 20 ga Crawford needle was used to penetrate the sacrococcygeal ligament and locate the caudal epidural space on the first attempt. A 24 gauge epidural catheter (Preferred Medical Products, Thorold, Ontario) was advanced to approximately the level of T8 and secured in place. The infant tolerated the procedure well without distress. Blood pressure and other vital signs remained stable and similar to levels recorded in the Neonatal Intensive Care Unit. An extensive laparotomy was performed via a transverse upper abdominal incision. A small bowel excision with primary repair of three discrete areas of jejunal atresia was performed uneventfully. During the first portion of the repair the infant was quiet and calm and occasionally sucked on a pacifier. Approximately one hour after injection of the subarachnoid solution, 0.5 ml bupivacaine 0.5% was given via the epidural catheter, although no obvious change in patient status was apparent. The remainder of the case proceeded uneventfully with the infant calm but responsive. Respiratory status remained stable and her supplemental oxygen was weaned to room air by the end of the operation.

After two hours and forty minutes in the operating room, the patient was transferred to the NICU awake, responsive and in no distress. Admission vital signs in the NICU were normal for gestational age and the serum Dextrostix was 80–120 $mg \cdot dl^{-1}$. A continuous infusion of 0.4 $ml \cdot hr^{-1}$ bupivacaine 0.0625% was begun. The infant was observed closely by the Anesthesia Pain Service and nursing staff over the next several days for evidence of distress. She appeared comfortable and although supplemental opioid and non-opioid analgesics were immediately available, none were required. She developed no evidence of motor block. Her respiratory status remained stable and CPAP was discontinued on the first postoperative day. The immediate postoperative course was uneventful aside from several episodes of mild self-correcting apnea and bradycardia. The epidural was discontinued two days after surgery. After the epidural was removed she required several doses of acetaminophen (15 mg per rectum) for pain control. Repeat laparotomy for repair of intestinal strictures was required three weeks later. A combined spinal and epidural technique was again performed successfully with similar results. Tracheal intubation and postoperative ventilation were not required. Postoperative pain was managed with infusion of bupivacaine 0.0625% and no supplemental analgesics were needed. The infant was discharged home on the 40th day of life doing well.

Institutional review

Over the past 15 yr our group has performed over 800 infant spinal anaesthetics. Data on these patients were gathered prospectively and organized in a computerized data base. The Committee on Human Research of the University of Vermont has approved review of these records for the purpose of publication. Nineteen patients received a combined spinal and continuous epidural technique as described above. The infants studied represented a wide range of weights (1520–7840g) and ages (29 wk PCA to seven months) (Table I). A variety of extensive surgical procedures was performed including 10 small bowel resections, ileo-caecal resection, colostomy, ureteral reimplantation, repair of bladder extrophy and salpingo-oophorectomy. Duration of surgery ranged from 50–200 min. Spinal anaesthesia was successful in all cases with a mean dose of 0.65 $mg \cdot kg^{-1}$ tetracaine. Most patients required no sedation other than stroking and soothing while sucking on a pacifier. One patient required several minutes of low dose (30 $\mu g \cdot kg^{-1} \cdot min^{-1}$) propofol and six received supplemental midazolam (avg. total dose 0.1 $mg \cdot kg^{-1}$). None of these patients developed postoperative apnea. No patient required intraoperative opioids or general anaesthesia. No patient required postoperative ventilation. Postoperative analgesia was maintained with bupivacaine 0.125% or 0.0625%. Maximum rates were limited to 0.25 $mg \cdot kg^{-1} \cdot hr^{-1}$ for neonates and 0.5 $mg \cdot kg^{-1} \cdot hr^{-1}$ for older infants as suggested by Berde.[7] Intravenous opioids were ordered on a *prn* basis and were readily available for all patients. Their administration was at the discretion of the NICU and PICU nursing staff which had extensive training and experience in the recognition and management of pain in neonates and infants. However, only three patients required supplemental opioids, with a maximum of two doses of *iv* morphine required by any patient. The epidural catheters remained in place an average of three days (range 1–5 days). Few complications were observed. We were unable to place one catheter, but the spinal was of sufficient duration for completion of the surgical procedure. This patient required postoperative *iv* opioids for pain control. No intravascular injections of local anaesthetics were observed. One patient had a high anaesthetic level immediately after the catheter was injected with bupivacaine. Subarachnoid injection was diagnosed and the trachea was intubated for respiratory support. The trachea was extubated without incident at the end of surgery and the catheter was removed. A second catheter was removed in the PACU after it became dislodged postoperatively.

TABLE 1 Patient Characteristics

Number of Patients	19
Weight at Time of Surgery	1520–7840g
Age at Time of Surgery	1 day–7 mo
Premature Infants	5
Gestational age	27–36 wk
Post conceptual age	29–42 wk

Discussion

Management of the high risk neonate undergoing major surgery presents a number of challenges. Respiratory status is often tenuous and respiratory depression and postoperative apnea are well known complications of general anaesthesia in this group of patients. Major abdominal surgery with general anaesthesia often requires a period of postoperative ventilation in the NICU. The infant in the case report illustrates these difficulties. The combination of low birth weight (LBW), prematurity, extensive upper abdominal surgery and preexisting respiratory compromise presents a number of formidable problems. Regional anaesthesia offers several options to aid perioperative management.

Post operative analgesia via an epidural catheter is attractive because of its ability to diminish or avoid postoperative opioids and associated respiratory depression. The use, in neonates, of continuous epidural infusions of local anaesthetic alone or in combination with opioids, via either the sacral or lumbar/thoracic route has been well described in combination with general anaesthesia.[8,9] In addition, recent interest has focused on controlling the postoperative stress response in infants.[10,11] Epidural analgesia offers an excellent method of blocking this response. For these reasons we are very aggressive in utilizing epidural analgesia via the caudal, lumbar or thoracic approach whenever feasible. However, even with the aid of an epidural catheter we would have found it difficult to extubate the trachea of this patient at the end of the procedure.

Spinal anaesthesia, for neonates and infants, also decreases the incidence of postoperative hypoxaemia and bradycardia.[12] Accordingly, spinal anaesthesia has been increasingly used for surgical procedures involving the upper abdomen and even thorax by our group and others.[3–5] Unlike adults, infants tolerate very high thoracic levels of spinal anaesthesia with minimal cardiovascular changes.[5,13] However, for reasons that remain unclear, the duration of action of a single dose spinal in infants is considerably shorter than in adults. In many cases this precludes its use as the sole anaesthetic in infants for longer procedures. We have been reluctant to rely upon a single dose technique for complicated abdominal procedures that may last over 60–90 min. Tobias reported the use of continuous caudal anaesthesia in several

neonates for less complicated urological surgery.[14] Potentially, for these more extensive procedures, we could have chosen to use only a caudal epidural catheter, inserted under local anaesthesia. However, our impression has been that major procedures, particularly those involving the upper abdomen may be tolerated better by beginning with the dense block of a spinal anaesthetic and adding to the block via the epidural catheter as appropriate. In addition, by performing the spinal first, we have the advantage of inserting the catheter in a cooperative, non-struggling infant with a good motor block of the lower extremities and well anaesthetized sacral region.

By combining spinal and epidural anaesthesia, we were able to avoid tracheal intubation in the case described. By avoiding intubation we were able to follow the respiratory status closely and intervene only if her underlying prematurity required it. We believe we were able to avoid several days of mechanical ventilation and its associated cost and morbidity.

Although this series is not a controlled trial of the benefits of general *vs* regional anaesthesia in neonates, several observations are possible. It demonstrates the feasibility of utilizing a purely regional anaesthetic technique in small infants for procedures more complicated than has been used previously. Normally, several of the infants in this series would have required postoperative ventilation and/or postoperative opioids. If postoperative ventilation can be avoided or minimized in these high risk infants, the potential for decreased morbidity and considerable cost savings may be significant. Complications associated with the technique have been minimal. A randomized controlled trial would be of benefit to explore further the potential benefits of this approach.

Acknowledgment

The authors would like to gratefully thank Thomas J. Poulton, M.D. for his critical review and advice in preparation of this manuscript.

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