# Clinical Reports

# Thoracic epidural analgesia via the caudal approach using nerve stimulation in an infant with CATCH22

Ban C.H.Tsui MSc MD,
Rob Seal MD FRCP,
Lucy Entwistle MD FRCP

**Purpose:** To illustrate insertion of an epidural catheter via caudal route in a small infant under electrical stimulation guidance.

**Clinical features:** A six month old boy, weighting 4.25 kg, with a diagnosis of CATCH22 (Cardiac abnormality/abnormal faces, T cell deficit due to thymic hypoplasia, cleft palate, hypocalcemia due to hypoparathyroidism resulting from 22q11 deletion) was scheduled for fundoplication and gastrostomy tube (G-tube) insertion. A combined light general anesthesia and continuous epidural anesthesia technique was selected. Following induction of general anesthesia and tracheal intubation with 1.5 mg midazolam, 10 $\mu$g fentanyl and 10 mg succinylcholine, a 16G intravenous catheter was inserted into the caudal space. A 19G epidural catheter (Arrow Flextip Plus) epidural catheter was then inserted up cranially. A low electrical current (1-10mA) was then applied through the catheter. The level of motor movement was advanced from the lower limb muscles to the upper abdominal muscles as the catheter was threaded cranially. After 19 cm of epidural catheter had been inserted, intercostal muscle movement ($T_{9-10}$ level) was observed at 4.2mA. The tip of the catheter was later confirmed to be at the $T_{9-10}$ interspace by radiographical imaging. The patient awakened without distress and the trachea was extubated the same evening. The infant was discharged to the ward next morning with good pain relief from a continuous epidural infusion of bupivacane 0.1% with 1 $\mu g \cdot ml^{-1}$ at 1.6 $ml^{-1}$.

**Conclusion:** Epidural stimulation may help placement of the epidural catheter at the appropriate dermatome for effective anesthesia and analgesia.

**Objectif :** Illustrer l'insertion, guidée par une stimulation électrique, d'un cathéter épidural par voie caudale chez un bébé.

**Éléments cliniques :** Un garçon de six mois, pesant 4,25 kg et atteint de CATCH22, devait subir une fundoplication et la mise en place d'un tube de gastrostomie. L'acronyme comprend une anomalie cardiaque/un faciès anormal, un déficit de cellules T dû à l'hypoplasie thymique, une fissure palatine (*cleft palate*), de l'hypocalcémie causée par l'hypoparathyroïdie résultant de la délétion de 22q11. Une anesthésie générale légère et une anesthésie péridurale continue ont été choisies. Après l'induction de l'anesthésie générale et l'intubation endotrachéale, utilisant 1,5 mg de midazolam, 10 $\mu$g de fentanyl et 10 mg de succinylcholine, un cathéter intraveineux de calibre 16 a été inséré dans l'espace caudal. Un cathéter épidural de calibre 19 (Arrow Flextip Plus) a été ensuite inséré en direction céphalique. Puis, un faible courant électrique (1-10 mA) a été appliqué au travers du cathéter. Le niveau de mouvement moteur s'est déplacé des muscles des membres inférieurs jusqu'aux muscles abdominaux à mesure que le cathéter était poussé en direction céphalique. Après une insertion du cathéter épidural de 19 cm, un mouvement du muscle intercostal (au niveau de $T_{9-10}$) a été observé sous une stimulation de 4,2 mA. L'imagerie radiographique a confirmé par la suite que la pointe du cathéter se trouvait dans l'espace intercostal $T_{9-10}$. Le patient n'a pas connu de détresse au réveil et sa trachée a été extubée le soir même. Le matin suivant l'enfant a quitté l'unité des soins intensifs pour l'unité des soins de court terme et a été bien soulagé grâce à l'usage d'une perfusion épidurale continue de bupivacaïne à 0,1 % avec 1 $\mu g \cdot ml^{-1}$ à 1,6 $ml^{-1}$ .

**Conclusion :** La stimulation électrique épidurale peut faciliter la mise en place du cathéter épidural à la hauteur du dermatome approprié à l'anesthésie et à l'analgésie efficaces.

From the Department of Anesthesiology and Pain Medicine, University of Alberta Hospitals, 3B2.32 Walter Mackenzie Health Sciences Centre, 8440-112 Street, Edmonton, Alberta, T6G 2B7 Canada.
*Address correspondence to:* Dr. Ban C.H. Tsui. Phone:780-407-8861; Fax:780-407-3200; E-mail: btsui@pop.srv.ualberta.ca
*Accepted for publication August 15, 1999*

THORACIC epidural anesthesia in infants and children has been well described.[1] However, the procedure can be technically difficult and hazardous in small infants, particularly when anesthetized.[2–5] Thus, controversy exists concerning the safety of placing lumbar and thoracic epidural under heavy sedation or general anesthesia as it entails the danger of lack of warning (e.g. paresthesia) of neurological complications.[6–7] The introduction and advancement of catheters from the lumbar and caudal epidural spaces to the thoracic level has been reported to be safer.[2–5] However, it has been suggested that it would be essential to verify placement of the tip catheter radiologically because of the possibility of the catheter coiling and failing to advance to the appropriate level.[2,5]

Recently, the use of low current epidural stimulation to confirm the location of epidural catheters has been described.[8–10] This technique may have the ability to detect the myotome level of the epidural catheter tip. This report describes the application of this new test to guide a thoracic epidural catheter via the caudal approach in an infant with CATCH22.[11]

## Case report

A six month old, 4.25 kg boy, with a diagnosis of CATCH22 was scheduled for fundoplication and gastrostomy tube (G-tube) insertion. Congenital abnormalities included VSD, mitral valve prolapse, moderate mitral regurgitation, torticollis and submucous cleft palate. The child had repeated previous admissions for congestive heart failure, sepsis, aspiration pneumonia, gastroesophageal reflex and failure to thrive. His medications included captopril, furosemide, cisapride, ranitidine, salbutamol and lactulose. A combined light general anesthesia and continuous epidural anesthesia technique was selected. Pediatric intensive care admission was planned for postoperative management. General anesthesia was induced with 1:5 mg midazolam, 10 μg fentanyl and tracheal intubation was facilitated with 10 mg succinylcholine. General anesthesia was maintained with isoflurane, 0.9% to 1.2% end-tidal.

For epidural catheter placement, the child was turned to the lateral decubitus position. Following sterile preparation, a 16G intravenous catheter was inserted into the caudal space. The length of a 19G epidural catheter (Arrow Flextip Plus, Arrow International, Inc., Reading, USA) was estimated from the skin overlying the sacroccygeal ligament to the desired level ($T_{7-8}$) for the catheter tip. The epidural catheter was then inserted to the estimated length.

Using the previously described procedure (Figure 1),[8–10] a nerve stimulator (Dakmed model 750 digital, C.R. Bard, Inc., Tewksbury, USA) was connected to the epidural catheter via an adapter (Johans ECG Adapter, Arrow International, Inc., Reading, USA). The epidural catheter and ECG adapter were primed with sterile normal saline. The anode lead of the nerve stimulator was connected to an electrode over the upper extremity as the grounding site and the cathode lead was connected to the metal hub of the adapter. A low current (1-10mA) was applied through the catheter using this procedure. The output was increased from zero until motor activity was visible. Based on the observations from previous clinical trials,[8–10] test criteria are summarized in the Table. A positive motor response (truncal or limb movement) indicated that the catheter was in the epidural space. A negative response indicated that it was not.

Despite easy threading of the measured length of epidural catheter into the caudal space on the first attempt, the desired level was not reached as the stimulation test elicited only bilateral lower limb movement (hip flexion) at 4.0mA. The epidural catheter was then withdrawn and reinserted. On the second attempt, the level of motor movement was observed to advance from the lower limb muscles to the upper abdominal muscles as the catheter was threaded cranially. After 19 cm of epidural catheter had been inserted, intercostal muscle movement ($T_{9-10}$ level) was observed at 4.2mA.

Intra-operatively, the patient received an infusion of bupivacane 0.1% with 1 $\mu g \cdot ml^{-1}$ fentanyl at 1.6 $ml \cdot hr^{-1}$ following a 1.6 ml bolus of the same mixture via the

TABLE Simplified guide for confirming of epidural catheter placement (Adapted from Tsui *et al.*, Can J Anaesth 1998; 45: 640–4, and Tsui *et al.*, Reg Anaesth and Pain Med 1999; 24: 17–23)

| *Epidural location* | *Test result* |
|---|---|
| Subarachnoid | positive bilateral motor response (<1mA) |
| Epidural space | positive motor response |
| Nonintravascular | - Threshold current (1- 10mA) increased after local anesthetic injection |
| Intravascular | - remain or return to baseline positive motor response(1-10mA) even after local anesthetic injection |
| Against nerve root | - unilateral motor response (<1mA) |
| Subcutaneous | negative response or local muscle twitch under grounding electrode |

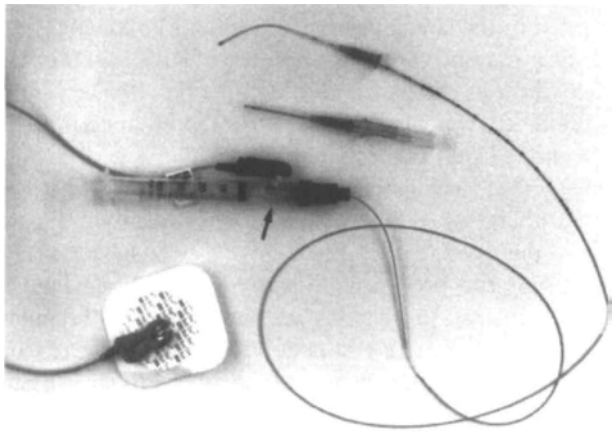

FIGURE 1 Equipment required. The setup consisted of connecting a nerve stimulator through a Johans ECG adapter to the epidural catheter connector. A 19G epidural catheter (Arrow Flextip Plus) epidural catheter was passed through a 16G intravenous catheter. The negative lead of the nerve stimulator was connected to the metal hub of ECG adapter. The positive grounding lead was attached to a regular ECG monitoring electrode. *Black arrow* shows an Arrow-Johns ECG Adapter connected to snap-lock connector of the epidural catheter.

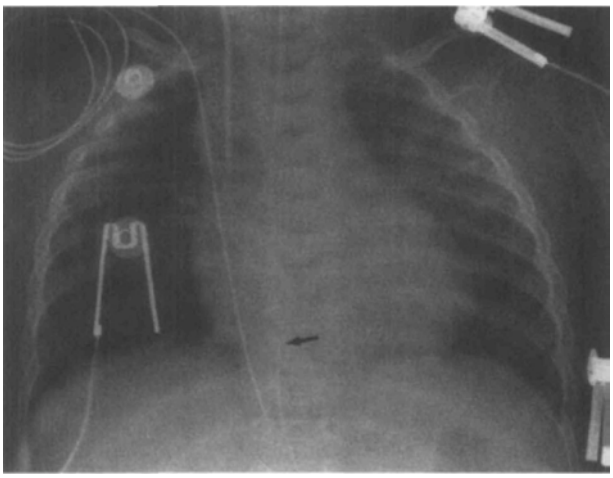

FIGURE 2 Anteroposterior chest x-ray. Arrow shows the tip of catheter at $T_9$ level.

epidural catheter. The patient remained hemodynamically stable throughout the operation without requiring intravenous opioids. The operation was uneventful and lasted two hours. Thereafter, the patient was transported to the pediatric intensive care unit for recovery. The admission chest x-ray (Figure 2) showed the epidural catheter tip was at the $T_9$ level. The patient awakened without distress and the trachea was extubated the same evening and he was discharged to the ward next morning with a continuous epidural infusion of bupivacane 0.1% with 1 $\mu g \cdot ml^{-1}$ fentanyl at 1.6 $ml \cdot hr^{-1}$ for pain control.

Prior to discharge to the ward, the child appeared to be comfortable and was able to move all four limbs. One hour later, following arrival on the ward, the infant was crying and thought to be in pain. The epidural catheter location was reassessed by electrical stimulation which demonstrated intercostal muscles movement ($T_{9-10}$ level) at 7mA. This indicated proper epidural catheter placement. Following this, the child settled with holding and remained comfortable for the next three days. On postoperative day four, the epidural catheter was removed and the child was given 60 mg acetaminophen *pr* when needed. He was also slowly introduced to feed via the G-tube which was well tolerated, and was discharged on postoperative day five without complication.

## Discussion

We have described successful perioperative analgesia using a thoracic epidural catheter in a small infant with CATCH 22. While thoracic epidural catheters inserted via the caudal route are used for pediatric patients, there are no reports of such an approach being guided by nerve stimulation instead of by radiological imaging.

Epidural anesthesia and analgesia may have beneficial effects in pediatric patients including encouraging a more rapid return of appetite and earlier ambulation.[3] Adequate postoperative analgesia promotes more rapid weaning from the ventilator and reduces time spent in the catabolic state with lower circulating stress hormones.[3] By precise placement of an epidural catheter, the dermatomes involved in the surgical procedure may be selectively blocked, minimizing the dose of local anesthetic agent required to provide analgesia. For ease of administration and practical reasons, epidural catheter placements are commonly performed under sedation or general anesthesia in pediatric patients. However, paresthesia, an early warning sign of permanent neurological injury, cannot be elicited in an anesthetized patient.[6-7] Lumbar and thoracic epidural catheter insertion carries the risk of traumatic damage to the spinal cord because of the narrow epidural space in the small infant.

A major advantage of achieving thoracic analgesia via threading a catheter up to the desired level from the caudal space is that access via the caudal epidural space is technically easier and less hazardous than the lumbar or thoracic epidural routes.[2-5] However, neither ease of

threading of the epidural catheter nor age predicts successful placement.[5] Previous studies suggested that it would be essential to verify placement of the tip radiologically if this approach is attempted due to the possibility of the catheter kinking or coiling without advancing in any direction.[2,5] Perhaps, it is for this reason that the caudal approach to thoracic epidural anesthesia has not gained popularity in children. The findings from this case are consistent with such an observation. On the first attempt, the catheter appeared to be curling up in the low lumbar region as indicated by bilateral lower limb movement (hip flexion). On the second attempt, a positive motor response involving intercostal muscles ($T_{9-10}$ level) was exhibited at 4.2 mA. The tip of the catheter was later confirmed to be at the $T_{9-10}$ interspace by radiographical imaging (Figure 1). As shown in a previous study,[9] the threshold current required to produce a positive test increases after the administration of a local anesthetic in a properly placed epidural catheter. This is consistent with our observation in this case that the threshold current for motor movement increased to 7mA during infusion of local anesthetic during the postoperative period.

As this insertion technique involves advancement as well as potential withdrawal of the epidural catheter, an intravenous catheter was used to introduce the epidural catheter in order to avoid shearing the epidural catheter by manipulation through a needle. The test must be performed under no significant clinical effect from the neuromuscular blockers, otherwise no twitch will be seen. Meticulous removal of air bubbles must be carried out before performing the test since these prevent transmission of current through the catheter.

Assessment of block level in the awake preverbal child is difficult. Crying is a poor indication of inadequate analgesia. A number of factors, besides inadequate analgesia directly affect children's behaviour. Apprehension in the hospital setting and anxiety due to separation from their parents are common causes of crying in small children. In the past, it has been very difficult to demonstrate and provide objective evidence about exact epidural catheter location. Thus, unnecessary removal of a properly placed epidural catheter may be more common in the pediatric population. The electrical stimulation test relies the observation of movement. Its use in pediatric patients may avoid the unnecessary removal of a properly placed epidural catheter. After the demonstration of the motor responses and with explanation and reassurance to our nursing colleagues, no further complaints of inadequate analgesia were reported to the acute pain service. The nurse and anesthesiologist from the acute pain service assessed the clinical effect of epidural analgesia as good. Thus, this test appears to have the potential to confirm proper epidural catheter placement and it may circumvent unnecessary removal of a properly placed epidural catheter. Additionally it will hopefully reduce the risk of neurological complications of thoracic epidural placement by making positioning the epidural catheter quicker and easier. However, a single case of successful placement of a thoracic epidural catheter placement using nerve stimulation requires caution prior to making generalizations about the merits of this test. Further prospective research is warranted.

Even though there were no signs of bupivacaine toxicity in our patient, the dosage of 0.375 $mg \cdot kg^{-1} \cdot hr^{-1}$is near the maximum dosage recommended by Berde[12] for older infants and children. It is known that neonates of less than four months age receiving continuous epidural bupivacaine infusions have higher plasma bupivacaine levels and can also accumulate bupivacaine.[13,14] Until further data are available, it is prudent to limit epidural bupivacaine infusion rates to 0.2 $mg \cdot kg^{-1} \cdot hr^{-1}$ in infants less than six months of age. In retrospect, our patient probably could have achieved adequate analgesia with a lower infusion rate of local anesthetic as epidural catheter tip was proximal to the dermatomes involved in the surgical procedure.

In conclusion, the electrical stimulation test may help to position epidural catheter at the appropriate dermatome to provide effective anesthesia and analgesia.

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