Thoracic Epidural Anesthesia in Cardiac Surgical Patients: A Prospective Audit of 2,113 Cases

Murali Chakravarthy, MD, DA, DNB, Patil Thimmangowda, DA, Jayaprakash Krishnamurthy, MD, Shivananda Nadiminti, DA, DNB, and Vivek Jawali, MS, MCh

Objective: **The purpose of this study was to present an audit report of thoracic epidural anesthesia without permanent neurologic deficits in more than 2,000 patients undergoing cardiac surgery.**

Design: **A prospective audit of cases conducted over a 13-year period.**

Setting: **Tertiary referral heart hospital.**

Participants: **Two thousand one hundred thirteen patients over a period of 13 years.**

Interventions: **Epidural catheters were inserted at the C7 to T3 intervertebral space on the day before the operation in all patients; cardiac surgery was performed with or without cardiopulmonary bypass.**

Measurements and Results: **The authors did not encounter any permanent neurologic deficits in their series. The authors encountered 18 (0.85%) primary dural punctures and 4 cases (0.18%) of temporary neurologic deficits.**

Conclusion: **This series adds to the worldwide experience of the use of epidural analgesia concomitantly with anticoagulation in cardiac surgery without serious complications.**

KEY WORDS: thoracic epidural anesthesia, cardiac surgery, neurologic complications, epidural hematoma, temporary neurologic deficits

THORACIC EPIDURAL ANESTHESIA (TEA) can be beneficial in patients undergoing surgical procedures.[1] In cardiac surgery, potential benefits of TEA include early recovery of consciousness and spontaneous ventilation,[2] hemodynamic stability,[3] superior analgesia,[2] reduced oxygen demand, optimal redistribution of coronary blood flow,[4] reduced risk of depression and posttraumatic stress,[5] improved pulmonary function,[6], and early extubation.[7]

Despite these advantages, the apprehension of permanent neurologic complication caused by extradural hematoma persists in the minds of anesthesiologists. The occurrence of epidural hematoma remains a fear, which has not (yet) been documented in the literature,[8,9] based on the assertion that in almost 4,600 reported cases up to 1999, there has not been a single reported case of clinically significant spinal hematoma. Ho et al[8] mathematically estimated the risk of spinal injury from an epidural-blockade-induced hematoma during conventional cardiac surgery to range from 1:150,000 to 1:1,500 (95% confidence interval). However, it is unlikely that clinicians will widely adopt the technique of epidural anesthesia in cardiac surgery until they are convinced that the risk of paraplegia from an epidural hematoma is infinitesimal and the clinical benefits well validated.[9]

The authors describe their experience with TEA in cardiac surgery to increase the worldwide-published cases without serious complications.[8,9-12] The data were collected prospectively, and this study did not include outcome parameters.

METHODS

Between May 1991 to November 2003, 2,113 patients who underwent cardiac surgery with concomitant TEA were included in this prospective audit. Surgeries included coronary artery bypass, valve replacement, and congenital heart surgery in adults. All the patients gave written informed consent for epidural use. The risks and benefits of epidural anesthesia were explained to them. The risks of potential neurologic injuries, headache, and backache were mentioned, and the potential benefits of good analgesia, reduced stress, better compliance to physiotherapy, and reduced analgesic requirement were explained to them. They were also informed that permanent neurologic deficits after TEA were rare.

TEA was administered if the coagulation profile was normal (activated partial thromboplastin time <45 seconds, international normalization ration of <1.5, platelet count of $>100{,}000$) and in whom antiplatelet medications were withdrawn at least a week earlier. Heparin infusions if present were discontinued 6 hours before performing epidural catheterization. Low–molecular-weight heparin was stopped 12 hours before epidural catheterization. Heparin sodium infusion at the rate of 1,000 U/h was commenced and discontinued 6 hours before epidural catheterization. The infusion was recommenced 1 hour after epidural catheterization. The epidural catheter was inserted on the evening before surgery in all patients.

The contraindications to epidural catheterization were as follows: patient refusal; continued use of clopidogrel, ticlopidine, dipyridamole, aspirin, heparin, or low–molecular-weight heparin; bleeding disorders; past surgery of the cervical and upper thoracic spine; and infection at the local site of injection. After 1996, aspirin was not considered as a contraindication. Congestive heart failure was considered a contraindication because the potential vasodilation caused by high TEA may decompensate the compromised cardiac function. Critical left main coronary artery disease and critical aortic stenosis were considered as relative contraindications to TEA. In the mid-1990s, patients with bradycardia, 40 to 50 beats/min, because of β-blockade, were excluded; but since 2000, glycopyrrolate, 0.2 mg, is administered intravenously before epidural catheterization.

Epidural catheterization was performed in a high-dependency area on the evening before surgery by an experienced anesthesiologist who had performed a considerable number of epidural punctures at other sites and had performed at least 20 thoracic epidural punctures under supervision. Trainees and resident doctors were not allowed to perform this procedure. Routine monitoring included electrocardiogram, noninvasive blood pressure, and pulse oximetry. A 16-G epidural catheter (Epidural minipack; Portex Ltd, Kent, UK, or Perifix, B Braun, Melsungen AG, Germany) was inserted at the most prominent intervertebral space between C7 to T3 space. The patient was positioned sitting upright, and a midline approach was used. If a hemorrhagic tap was encountered, the catheter was removed and reinserted at a level above or below. The epidural space was identified by loss of resistance to air. Two to 4 cm of the epidural catheter were left indwelling in the epidural space. If a dural tap was encountered, the epidural catheter was reinserted at a different level and the patient was advised to maintain a

From the Wockhardt Heart Institute, Bangalore, Karnataka, India.

Address reprint requests to Murali Chakravarthy, MD, DA, DNB, Wockhardt Heart Institute, 14 Cunningham Road, Bangalore 560052, Karnataka, India. E-mail: chakravarthy@vsnl.com

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supine position until surgery. If the patients developed bradycardia at the time of insertion of the epidural catheter, 0.2 mg of glycopyrrolate was administered intravenously. The patients were transferred to the presurgical ward for observation until surgery. One of the resident trainees or anesthesiologist visited these patients at 8-hour intervals and more frequently if positive findings were elicited. All the patients were asked whether they felt any pain in the back, numbness in the arms or chest, and difficulty in moving any of the limbs. If the answer to any one of the questions was yes, a consultant anesthesiologist or neurologist was involved.

Fentanyl, 3 μg/kg body weight, midazolam, 50 μg/kg, were administered intramuscularly half an hour before surgery. In the operating room, invasive monitoring catheters were inserted under local anesthesia. An epidural test dose of 3 mL of 2% lidocaine (Wockhardt Ltd, Ahmedabad, India) with 1:200,000 epinephrine was administered before administering the full loading dose of 0.1 mL/cm of patient's height, a mixture of 0.5% bupivacaine and 2% lidocaine with 1:200,000 epinephrine. The ratio of bupivacaine and lidocaine was in the ratio of 2:1. The level of the block was tested by loss of pinprick and temperature discrimination to ice, aiming for a block from C7 to T9.

The authors made the following changes in their epidural technique:

1. Before 1995: the standard technique of anesthesia was induction of TEA with a bolus dose of 10 to 15 mL of 0.5% bupivacaine with supplemental boluses of 3 to 5 mL of 0.25% bupivacaine with morphine, 1 to 2 mg, or buprenorphine, 1 to 1.5 μg/kg. Induction of general anesthesia was achieved with halothane and isoflurane, and intubation was facilitated with vecuronium bromide (0.1 mg/kg). In the postoperative period, analgesia was achieved by 1.5 μg/kg of epidural buprenorphine. Local anesthetic agents were not included in the postoperative epidural infusion.
2. From 1995 to 2000: aspirin consumption ceased to be a contraindication for performing epidural blocks from 1996 onward. TEA was induced with bolus doses of a mixture of bupivacaine (0.5%) and lidocaine with epinephrine (2% with 1:200,000 epinephrine) equal to 0.1 mL/cm of the patient's height. Analgesia was achieved by fentanyl, 25 μg, as a bolus, every hour. Postoperatively, analgesia was achieved by administration of 25 μg of fentanyl epidurally at 8-hour intervals.
3. After 2000: induction of TEA was achieved with 5 to 10 mL of local anesthetic mixture and intraoperative maintenance was achieved by an infusion of a mixture of bupivacaine (0.25%), lidocaine (2%), and fentanyl (5 μg/mL) at the rate of 5 mL/h. Either one of the following inhalation agents are used: halothane, isoflurane, or sevoflurane. Postoperative analgesic medications such as fentanyl, 25 μg, at 8 hourly intervals, buprenorphine, 1 to 1.5 μg/kg, twice daily, and tramadol, 100 mg, twice daily, were administered in the epidural space. After ascertaining the level of the block, general anesthesia was begun with either intravenous induction (with slow bolus of 2 mg/kg of intravenous sodium thiopental [until the year 2000] or 1 mg/kg of propofol) or inhalation induction with a mixture of oxygen, air, and halothane/isoflurane/sevoflurane depending on the availability. Endotracheal intubation was facilitated with a nondepolarizing muscle relaxant available at that time, and positive pressure ventilation was commenced using a mechanical ventilator. Whenever conscious off-pump coronary artery bypass surgery was planned, the patients were allowed to breathe spontaneously during surgery. The same surgeon operated on all the patients. Anticoagulation was achieved with 300 U/kg of heparin in patients operated on with cardiopulmonary bypass to maintain an activated coagulation time (ACT) of more than 400 seconds and 200 U/kg in off-pump coronary artery bypass surgery to maintain an ACT of more than 300 seconds. One third of the initial dose of heparin was administered every hour. After completion of the surgical procedure, protamine in the ratio of 1 mg/kg for every milligram of heparin was administered, aiming for the return of the ACT to baseline values. After the completion of the surgical procedure, patients were transferred to the intensive care unit.

The following criteria were considered as suitable for extubation: awake and responding to simple oral commands, adequate analgesia, mean arterial pressure >80 mmHg, urine output of >1 mL/kg/h, spontaneous breathing (respiratory rate in the range of 10-15 breaths/min), partial pressure of arterial oxygen >90 mmHg with fractional inspired oxygen concentration of 0.4, partial pressure of arterial carbon dioxide <35 to 40 mmHg, absence of arrhythmias, blood loss <1 mL/kg/h, and normothermia (core temperature >36°C). Intermittent boluses of 25 μg of fentanyl or 1.5 mg/kg of buprenorphine were administered in the epidural space at 8 hourly intervals. The epidural catheter was removed on the second or third postoperative day depending on the need for analgesics expressed by the patient.

If the patients were scheduled to receive postoperative anticoagulants, the epidural catheter was removed on the day of the operation and systemic opioid and nonopioid analgesics were administered for postoperative pain relief. The removal of the catheter was not related to extubation.

Audit Endpoints

The following audit endpoints were defined after completing the first 100 cases of epidural use in cardiac surgical patients.

1. Primary dural perforation was defined as cerebrospinal fluid returning through the epidural needle or the catheter.
2. Peripheral nerve lesions were defined as the presence of altered neurologic functions in the areas supplied by nerve roots.
3. Spinal root damage was defined as radiation of pain and reduced sensitivity corresponding to a dermatome, which persisted after 6 hours.
4. Failed epidural anesthesia was defined as the absence of an adequate level of analgesia or presence of patchy analgesia 15 to 30 minutes after the injection of local anesthetic in the epidural space.
5. Radicular pain was defined as tingling and numbness occurring at the time of identifying epidural space or with insertion of epidural catheter.
6. A sign of an expanding epidural hematoma was defined as presence of intense back pain associated with sensory or motor deficits.

RESULTS

Between May 1991 and November 2003, 2,113 patients (out of 8,621 patients operated on during that period) received epidural analgesia without any permanent neurologic deficits. Figure 1 shows the ratio of the total number of surgeries carried out and the number of epidurals performed during that period. A total of 2,224 patients consented to undergo epidural catheterization and the demographic details and patient profile are shown in Table 1. In 19 patients (0.9%), it was not possible to identify the epidural space or insert the epidural catheter because 18 patients had primary dural perforation, and in 10 of them the catheter was reinserted uneventfully at a space below the previously attempted site. Hemorrhagic tap occurred in 22 patients (0.09%), in 12 of whom the epidural catheter was reinserted later.

Four patients had temporary neurologic deficits (TND) in the form of transient monoplegia attributable to the epidural. Neurologic injury was suspected in all these patients because the