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Thoracic Epidural Anesthesia for Cardiac Surgery via Left Anterior Thoracotomy in the Conscious Patient

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ABSTRACT

Background: Cardiac surgery is perceived to be maximally invasive and fraught with complications. In response to this perception, cardiothoracic surgeons have been refining traditional techniques to minimize their invasive nature. Epidural anesthesia has been used safely and effectively for numerous surgical procedures to reduce morbidity associated with general anesthesia. In hopes of achieving a similar result, we set out to determine the feasibility of using thoracic epidural anesthesia for limited cardiac surgery through a left anterior thoracotomy for patients who were awake and spontaneously breathing.

Methods: A high thoracic epidural technique was used in all cases. In each instance, the chest was entered through a small left anterior thoracotomy. The procedures included minimally invasive direct coronary artery bypass (MIDCAB) and transmyocardial revascularization (TMR). These procedures were performed in routine fashion using standard techniques. Pulmonary function tests were performed preoperatively, and the adequacy of respiratory function was serially monitored throughout each operation. The epidural catheters were left in place for 24 hours after operation for pain control.

Results: A total of 10 operations were performed. These included 7 MIDCAB, 2 TMR and 1 MIDCAB/TMR hybrid. The mean preoperative forced expiratory volume for one second (FEV1) was 1.9 liters. Significant intra-operative hypoxia or hypercarbia was not seen. One patient required intubation during the procedure for restlessness not associated with hypoxia. Two others required brief periods of assisted ventilation. All procedures were completed without incident. The mean operating time and length of stay were 70 minutes and 4.7 days. Postoperative pain control and patient satisfaction were excellent.

Conclusions: Thoracic epidural anesthesia for limited cardiac surgical procedures by means of a left anterior thoracotomy is feasible, even in patients with diminished pulmonary function. Furthermore, this method offered no significant technical hurdles. Nevertheless, the applicability of this technique to other procedures remains unclear. We believe that these results warrant controlled comparison of regional versus general anesthesia for limited cardiac surgery.

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INTRODUCTION

Cardiac surgery is viewed by many as a maximally invasive undertaking. Because of this perception, and due to the availability of less invasive catheter-based interventions, surgeons have been refining traditional techniques to minimize their invasive nature and make them more appealing to patients. In this pursuit, extra-pleural coronary artery bypass was recently reported using a thoracic epidural block as the sole anesthetic technique [Karagoz 2000]. With this as a background, we set out to determine the feasibility of performing a left anterior thoracotomy for a limited cardiac surgical procedure using the same anesthetic approach.

MATERIALS AND METHODS

Patients who required only limited cardiac surgical intervention were enrolled after granting informed surgical consent. Anticoagulants were discontinued one week before the operation, and routine preoperative pulmonary function tests were obtained in each case. All patients underwent epidural placement the evening before surgery. A high thoracic epidural anesthesia technique was used. A flexible catheter (Arrow International Inc., Reading, PA) was introduced at the fourth thoracic (T4) interspace. A dose of 2% lidocaine (with epinephrine 1:200,000) was given to test the efficacy of the block and to rule out intrathecal or intravascular catheter placement. Immediately before surgery, 0.75% bupivacaine was infused and titrated to achieve a motor and sensory block to the first thoracic (T1) level. Additional doses were given throughout the procedure to maintain the block. Intravenous sedation with dexmedetomidine was also administered to provide satisfactory patient comfort while preserving spontaneous respiration. Supplemental oxygen was given using a 100% non-re-breather mask. The patients were monitored in standard fashion, including continuous end-tidal CO_2. Serial blood gas analysis was performed during the procedures. Systemic hypotension secondary to vasodilation from the

Table 1. Patient Characteristics.

Patient	Age	EF	Procedure	Op Time	Outcome	LOS
1	55	40	MIDCAB	90	Fine	4
2	61	35	MIDCAB	80	Fine	4
3	68	45	MIDCAB	105	Assisted	5
4	75	30	TMR	45	Intubated	12
5	66	50	MIDCAB / TMR	65	Fine	4
6	71	55	MIDCAB / PTCA	55	Fine	5
7	59	45	TMR	50	Fine	3
8	51	55	MIDCAB	60	Assisted	3
9	63	45	MIDCAB / PTCA	75	Fine	4
10	60	25	MIDCAB	70	Fine	3
Mean ± Std Dev	63 ± 7.3	42.5 ±10.1		70 ± 18.6		4.7 ± 2.7

EF = Ejection fraction (%)
Op Time = Operative time (min)
LOS = Length of stay (days)

sympathectomy was treated with intravenous volume expansion or low-dose pressor infusion.

All MIDCABs were performed by means of a small left anterior thoracotomy. The chest was entered in the fourth intercostal space. With the pleura open, the left internal mammary artery (LIMA) was harvested to the first intercostal space under direct vision. Subsequently, heparin was administered to achieve an activated clotting time of 300 seconds. After pericardiotomy, the left anterior descending artery (LAD) was isolated, and using a surgical stabilizer (Genzyme Surgical, Fall River, MA), the anastomosis was performed. Shunts were used selectively. Upon completion, patency was assessed using a transit time flow meter (Medi-Stim A/S, Oslo, Norway). Protamine was administered in each case and the chest was closed in routine fashion.

Transmyocardial revascularization (TMR) was performed with the holmium laser (CardioGenesis Corp., Sunnyvale, CA), using a standard technique. The chest was entered in the fifth intercostal space when TMR was done as the primary procedure. Transesophageal echocardiography was not performed. Audible signals were utilized to guide transmural penetration. All patients received intra-operative lidocaine and postoperative magnesium infusions. When performed in combination with a MIDCAB, the TMR was done secondarily after protamine administration. In all instances, the epidural catheters were left in place for 24 hours for pain control. A normal coagulation profile was obtained prior to discontinuation. When percutaneous transluminal coronary angioplasty (PTCA) was to be performed as an adjunct, this was done after catheter removal due to the need for extended anticoagulation following the intervention.

RESULTS

A total of 10 procedures were performed, all on male patients. The operations included 7 MIDCABs, 2 TMRs, and 1 MIDCAB/TMR hybrid. Two MIDCAB procedures were combined with subsequent PTCA. Three patients demonstrated moderate to severe abnormalities on preoperative pulmonary function testing. One patient (TMR) required intubation during the procedure for restlessness not associated with hypoxia, and two others required brief periods of assisted ventilation. Mean intraoperative arterial carbon dioxide and oxygen levels did not exceed 50 or fall below 100 mmHg. The mean operative time was 70 ± 19 minutes. The mean length of hospital stay was 4.7 ± 2.7 days, although one patient required an extended stay (12 days) for prolonged chest tube drainage. All procedures were performed without incident and there were no surgical or anesthetic-related complications. Patient and operative characteristics are shown in Tables 1 (🔍) and 2 (🔍).

DISCUSSION

Epidural anesthesia is used for a myriad of surgical procedures and is commonly employed for postoperative pain management following cardiothoracic surgery [Liem 1998]. Although endotracheal anesthesia is recognized to be safe and provides a stable operative environment, it is not free of complications. There are even some potential benefits to avoiding it, including reduction of stress responses, preservation of the coagulation profile, and the stimulation of coronary vasodilation [Blomberg 1990, Paulissian 1991, Rosenfeld 1993]. These benefits may be especially important in the context of cardiac surgical procedures. In addition, patient concerns regarding endotracheal intubation must be considered. Despite the potential benefits of avoiding endotracheal anesthesia, we were concerned whether a thoracotomy with epidural anesthesia would be tolerated from the physiologic and anesthetic points of view. To date, the only reported experience with this technique used a limited extra-pleural approach without intrathoracic dissection. Although these concerns proved to be unfounded, several interesting observations were made.

First, upon entering the chest, we observed that the lung promptly collapsed and conveniently remained out of the surgical field throughout the procedure. Dissection of the LIMA

Table 2. Operative Characteristics.

Patient	FEV_1	VC	DLCO	Max $PaCO_2$	Min PaO_2
1	1.78 (59)	3.27 (81)	18 (65)	48	115
2	1.36 (37)	1.49 (32)	13 (55)	53	105
3	2.15 (68)	3.97 (85)	24 (77)	47	125
4	1.55 (49)	3.01 (72)	21 (75)	50	112
5	1.15 (30)	1.85 (45)	15 (57)	55	99
6	2.35 (72)	4.05 (85)	25 (80)	48	120
7	2.55 (80)	4.80 (80)	27 (85)	45	110
8	2.2 (60)	3.5 (70)	22 (65)	45	100
9	1.5 (60)	3.68 (73)	23 (70)	49	105
10	2.65 (73)	4.50 (85)	25 (75)	45	130
Mean ± Std Dev	1.9 ± 0.5	3.41 ± 1.1	21.3 ± 4.6	48.5 ± 3.4	112.1 ± 10.4

( ) = % predicted
FEV1 = Forced expiratory volume, 1 second (L/sec)
VC = Vital capacity (L)
DLCO = Diffusion capacity (ml/min/mmHg)
Max $PaCO_2$ = Maximum intraoperative arterial CO_2 (mmHg)
Min PaO_2 = Minimum intraoperative arterial O_2 (mmHg)

was well tolerated until the upper thorax was reached, when some discomfort ensued. This was managed with local lidocaine instillation. Also, left shoulder pain was noted upon opening of the pericardium. This was felt to be secondary to irritation of the pericardial branches of the phrenic nerve, which were not blocked by the epidural. Early in our experience, the pleural space was bathed in lidocaine with marked relief. More recently, upon entering the chest we have blocked the intra-thoracic phrenic nerve with 1% lidocaine, which has eliminated this problem. The block is tolerated from the respiratory standpoint, as the lung on the blocked side is not contributing significantly to respiratory function. Additionally, since the block is of short duration, it does not interfere with postoperative respiratory mechanics.

Another concern was the amount of mediastinal motion that would be encountered. This proved to be insignificant and was easily controlled with pericardial sutures and the surgical stabilizer. Chest wall motion secondary to the presence of a motor block to the T1 level was also minimal. However, we noted that if the motor block was incomplete, the thoracic retractor splinted the chest wall on the operative side. As a result, we now feel that only a sensory block is necessary. This may also allow for improved respiratory function and gas exchange.

Despite preoperative pulmonary function tests that were moderately to severely reduced in three patients, no significant respiratory compromise was experienced. The decreasing oxygen saturations responded well to increasing the patients' mean arterial pressure, primarily through the use of intravenous volume expansion. This result may be secondary to the recruitment of the partially collapsed lung. Hypercarbia was avoided by maintaining respiratory drive and avoiding excessive sedation. The two patients who required brief periods of assisted ventilation did so as a result of over-sedation. The use of a short-acting agent is also important in this regard. Additionally, we retracted the lung on the operative side as little as possible to facilitate any contribution to respiratory function it might have.

Although our mean length of hospital stay of 4.7 days is not a substantial improvement, having the epidural catheter in place for postoperative pain management was clearly beneficial and facilitated recovery. Patients were transferred out-of-bed and ambulated with the catheter in place. They also exhibited an increased willingness to participate in pulmonary physiotherapy. The main concern was the initiation of anticoagulation therapy and the possibility of developing an epidural hematoma. It has been our habit to initiate anti-platelet therapy early after MIDCAB procedures. More recently, we have been starting this preoperatively. Although this is probably most important for multi-vessel beating heart operations, it represents a problem with this technique. The avoidance of general anesthesia and its associated hypercoagulable state may offset this potential risk, but the exact extent of this effect is unclear. Importantly, it has been reported that epidural anesthesia in anticoagulated patients is a safe technique [Vandermeulen 1994]. Although we placed the catheters the evening before surgery, a period of two to four hours is all that is required. Thus, it is possible to admit patients as same-day surgery cases and observe them prior to operation. In the event of difficulty placing the catheter, the operation could be performed in the conventional manner.

CONCLUSION

This technique has several limitations. The patients selected must be cooperative and have favorable anatomy. In addition, they must be able to tolerate single-lung spontaneous ventilation, which is mostly dependent on diaphragmatic mechanics. Unstable patients, patients on anticoagulants, and those requiring emergent procedures will not be candidates.

Procedures that require greater exposure, such as that provided by sternotomy, or that require extensive manipulation will also be problematic. On the other hand, for limited procedures such as MIDCAB or TMR, this technique may be eminently appropriate. The current literature suggests that the results with MIDCAB surgery are comparable to conventional techniques, and the reported outcomes with TMR have been satisfying [Lansing 2000, Mehran 2000]. In addition, many surgeons are beginning to favor less invasive, narrowly targeted, and hybrid approaches for more complicated cases.

The degree of patient satisfaction we encountered was gratifying. It is not uncommon for a patient's primary concern to be aversion to endotracheal intubation. Accordingly, in each of our cases the patients overwhelmingly preferred this anesthetic approach. Finally, the technique posed no significant technical hurdles and should provide results comparable to conventional methods. In continuing to pursue this approach, we hope to better define candidacy criteria and procedure applicability, and improve operative results and long-term outcomes. A randomized study comparing regional versus general anesthesia for limited cardiac surgical procedures seems warranted. The end result should be an increasing frequency of these types of cases.

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