

## Thoracic Epidural Anesthesia and Analgesia (TEA) in Patients with Rib Fractures

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**Background:** We analyzed the results of surgical reduction and fixation of ribs under thoracic epidural anesthesia and analgesia (TEA) in patients who had no more than 3 consecutive rib fractures with severe displacement to examine the clinical usefulness of this method. **Materials and Methods:** From May 2008 to March 2010, 35 patients underwent surgical reduction and fixation of ribs under TEA. We reviewed the indications for this technique, number of fixed ribs, combined surgical procedures for thoracic trauma, intraoperative cardiopulmonary events, postoperative complications, reestablishment of enteral nutrition, and ambulation. **Results:** The indications of TEA were malunion or nonunion of fractured ribs in 29 (82.9%; first operation) and incompletely ribs under previous general anesthesia in 6 (17.1%; second operation). The average number of fixed ribs per patient was 1.7 (range: 1~3). As a combined operation for thoracic trauma, 17 patients (48.6%) underwent removal of intrathoracic hematomas, and we performed repair of lung parenchyma (2), wedge resection of lung (1) for accompanying lung injury and pericardiostomy (1) for delayed hemopericardium. No patient had any intraoperative cardiopulmonary event nor did any need to switch to general anesthesia. We experienced 3 postoperative complications (8.6%): 2 extrapleural hematomas that spontaneously resolved without treatment and 1 wound infection treated with secondary closure of the wound. All patients reestablished oral feeding immediately after awakening and resumed walking ambulation the day after operation. **Conclusion:** Thoracic epidural anesthesia and analgesia (TEA) may positively affect cardiopulmonary function in the perioperative period. Moreover, this technique leads to an earlier return of gastrointestinal function and early ambulation without severe postoperative complications, resulting in a shortened hospital stay and lowered costs.

Key words: 1. Trauma, blunt  
2. Ribs  
3. Anesthesia

### INTRODUCTION

Over the last ten years, the morbidity and mortality rates of thoracic surgeries have decreased continuously as postoperative care techniques have improved. These results were specifically identified to result from effective pain control

[1,2]. In the case of simple or multiple rib fractures without severe dislocation of the ribs, conservative treatments such as pain control and respiratory physiotherapy are performed rather than surgical treatments, in order to prevent complications like atelectasis and pneumonia. However, in patients who had rib fractures with severe dislocation of the ribs, splinters can

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press the nerves between the ribs, resulting in chronic intercostal neuralgia. Chest wall deformity can result from malunion or nonunion as the dislocation of splinters progresses.

An aggressive operation for fixation in the early stage of rib fractures is needed to prevent chronic complications of rib fractures. Thoracic epidural anesthesia and analgesia (TEA) is a method of muscle relaxation for surgery of the chest or upper abdomens performed by injecting local anesthetics through a catheter which is inserted in the thoracic epidural spaces. This method has the advantages that the decrease of cardiopulmonary function is less severe than that caused by general anesthetics and recovery from surgery, enteral nutrition, and early ambulation are can be resumed more quickly than with general anesthesia, which involves loss of consciousness, intubation, and mechanical ventilation by general anesthetics and muscle relaxants. In fact, the morbidity and mortality rates can be decreased by controlling pain after surgery in high-risk patients. Thoracic or abdominal surgeries can be performed by epidural anesthesia with the appropriate amount of local anesthetics in aging people or high-risk patients who have problems with cardiopulmonary function. The operation is performed with the patient fully conscious but experiencing no pain. In addition, painless recovery is possible by epidural analgesia. So far, although debates over the need for and indication of TEA remain, this technique has been shown to decrease the complications of general anesthesia. It decreases pulmonary complications and speeds overall recovery, so it leads to shorter hospital stays and lower costs of treatment in patients with a small number of rib fractures with severe dislocation.

This study investigated the effects of thoracic epidural anesthesia and analgesia (TEA) on the surgical reduction and fixation of ribs in patients who had 3 or fewer consecutive rib fractures with severe dislocation of the ribs.

## MATERIALS AND METHODS

The subjects were 35 patients who gave informed consent, underwent surgical reduction and fixation of ribs under TEA, and had analgesia through TEA catheters to control pain during the postoperative period in the thoracic surgery department of Konyang University Hospital from May 2008 to

March 2010. Medical records were analyzed retrospectively to review the indications for this technique, number of fixed ribs, combined surgical procedures for thoracic trauma, intraoperative cardiopulmonary events, postoperative complications, reestablishment of enteral nutrition, and ambulation.

In this study, among the patients who needed TEA due to rib fractures, the first operation group was defined as patients with 3 or fewer consecutive rib fractures with severe dislocation of the ribs. The second operation group was defined as patients with incompletely fixed ribs or those whose progress was worsening after surgery with general anesthesia. The patients who had a history of previous spinal surgery or coagulopathy, or who had been converted to general anesthesia due to the failure of TEA catheterization were excluded in this study.

A 22 G catheter was inserted into the thoracic epidural spaces depending on the location of the rib fractures. Fentanyl, which is an opioid medication, and lidocaine, which is a local anesthetic, were injected depending on each patient's height and weight, and the surgical region. Propofol was injected to reduce the anxiety of patients.

Patient controlled analgesia (PCA) was administered with 0.5  $\mu$ g/mL sufentanyl and 0.2% ropivacaine through an epidural catheter for 3~5 days to control pain after surgery.

5 L/min oxygen was supplied by a facial mask, and the respiratory rate and oxygen saturation were monitored during the intraoperative period. 1/3 tubular plates (Sanat Metal, Hungary) and 3.5 cortical screws (Solco Medical, Korea) made of titanium were used for surgical reduction and fixation of the ribs. These surgical materials were provided by the KFDA (Korean Food and Drug Administration) for surgical materials, and approved by the IRB of our hospital.

In a combined operation for thoracic trauma, the removal of the intrathoracic hematoma, the repair of the lung parenchyma, and wedge resection of the lung were performed together.

## RESULTS

The number of male patients with TEA was 23, which was twice as high as the number of females. The mean age of the patients was 54.1 (29~77). The number of patients under-

**Table 1.** Patient characteristics (n=35)

Characteristics	N (%)
Gender	
Male	23 (65.7%)
Female	12 (34.3%)
Mean age at operation (range)	54.1±12.8 (29~77) years
Surgical indication	
First operation	29 (82.9%)
Second operation	6 (17.1%)
Number of ribs repaired (range)	1.7±0.7 (1~3)
Operation time (range)	58.9±23.3 (25~120) minutes
Side of operation	
Right	15 (42.9%)
Left	20 (57.1%)
Combined operation	
Removal of hematoma	17 (48.6%)
Repair of lung parenchyme	2 (5.7%)
Wedge resection of lung	1 (2.9%)
Pericardiotomy	1 (2.9%)
Conversion to general anesthesia	0 (0.0%)
Postoperative complications	
Hematoma of the chest wall	2 (5.7%)
Wound infection	1 (2.9%)
Perioperative morbidity	0 (0.0%)
Late mortality	0 (0.0%)

going the first operation due to malunion or nonunion of fractured ribs was 29 (82.9%) and the number of patients undergoing the second operation due to an incompletely fixed rib under previous general anesthesia was 6 (17.1%). Among the 36 patients experiencing TEA, general anesthesia was administered to one patient (2.8%) because the insertion of the catheter for TEA failed. The average number of fixed ribs per patient was 1.7 (range: 1~3) and the average operation time was 58.9 minutes. In the combined operation for thoracic trauma in 20 patients (57.1%), 17 patients (48.6%) underwent the removal of intrathoracic hematoma. The repair of the lung parenchyma due to pulmonary laceration, the wedge resection of the lung due to lung injury, and pericardiotomy from delayed hemopericardium were performed in 2 patients, 1 patient, and 1 patient, respectively.

No patients had any abnormal findings such as hypotension, arrhythmia, or respiratory failure by cardiopulmonary dysfunction during the monitoring of vital signs, electrocardiogram, and oxygen saturation. It was not necessary to switch to general anesthesia due to failure of TEA during

**Table 2.** Details of secondary operation group (n=6)

Patients	Sex/Age	Side of operation	Interval (days)	Combined operation
1	F/69	Ipsilateral	26	None
2	M/57	Ipsilateral	17	None
3	F/65	Ipsilateral	13	None
4	M/44	Contralateral	9	None
5	F/52	Ipsilateral	28	Pericardiotomy
6	M/72	Ipsilateral	113	None

operation. We experienced postoperative complications in 3 cases (8.6%). 2 cases of extrapleural hematoma were spontaneously resolved without treatment. A wound infection was treated with secondary closure of the wound in the other one case (Table 1).

The second operation was performed for the remaining rib fractures with dislocation on the same or opposite side after primary surgery under general anesthesia. The time gap between the first and the second operation was 34.1 days (9~113 days), and pericardiotomy was performed as an accompanying surgery in 1 case (16.7%) of the second operation group (Table 2). All patients reestablished oral feeding immediately after awakening and resumed walking ambulation on the day after operation.

## DISCUSSION

Many studies have shown that epidural anesthesia is more effective than opioid anesthesia. For example, recently, this was demonstrated clearly by Block et al's meta-analysis of more than 100 studies [3]. Dolin et al. analyzed 165 studies concerning the effect of acute pain control on 2,000 patients. The percentages of patients who reported moderate to severe pain were 20.9% in the epidural analgesia group, 35.8% in the intravenous patient-controlled analgesia (IV PCA) group, and 67.2% in the intramuscular administration (IM) group. The percentages reporting severe pain were 7.8% in the epidural analgesia group, 10.4% in the IV PCA group, and 29.1% in the IM group. There were no differences in the averages of the visual analog scale (VAS), which is a pain indicator, between the IV PCA group and IM group. A painless condition was reported by 4% of the IM group, 54% of

the IV PCA group, and 71% of the epidural analgesia group after pain control was administered [4].

In TEA, the same epidural catheter is used for different medications. High doses of local anesthesia and opioid medication are used for epidural anesthesia, and low doses of local anesthesia and analgesia are used for epidural analgesia to control postoperative pain and recover ambulation early. In surgical treatment under TEA, appropriate anesthesia can be induced and pain control is possible immediately after thoracic and abdominal surgeries. In addition, morbidity and mortality rates are decreased by controlling the sympathetic nervous system. More specifically, the myocardial infarction rate is reduced in aging people and in high risk cardiovascular patients [5,6]. The stress reaction is checked by stress hormones like epinephrine, norepinephrine, cortisol, and rennin, and by mediators of inflammation such as cytokines and lipid mediators in blood or other body fluids. The level of norepinephrine (noradrenalin) in the blood within 24 hours can increase up to 3 times [7]. In the past, it was understood that myocardial infarction could occur within 72 hours postoperatively. However, according to updated results mentioned earlier, it has been shown that over 50% of cases of myocardial infarction occur within 24 hours postoperatively [8,9]. Brodner et al. reported that the level of catecholamine in the urine was decreased by TEA in the intraoperative and postoperative periods for 5 days [10].

According to the meta-analysis of Rodgers et al., the mortality rate can be reduced by over 30%, and the morbidity rate can be decreased by TEA. They reported that deep venous thrombosis was reduced by 44%, pulmonary embolism by 55%, myocardial infarction by 33%, and stroke by 15% [6]. TEA presents advantages to the respiratory, cardiovascular, gastrointestinal, and immune systems, and clotting mechanisms in high risk patients [11]. Therefore, pain control and stability of respiratory and cardiac function can be maintained with TEA. In this study, there were no cases of cardiopulmonary dysfunction or conversion to general anesthesia as a result of problems with TEA. Moreover, oral feeding was started after the recovery of consciousness, and all patients started to ambulate without limitation on the day after surgery.

In this study, the number of rib fractures was limited to a

maximum of 3 because the area for anesthesia would be larger, and thus the doses of anesthetics increased, as the surgical area got wider with 4 or more rib fractures so that TEA complications including hypotension, bradycardia, and decrease in cardiopulmonary function could occur. Therefore, the number of rib fractures was limited to 3 per patient, which led to shorter operation times, and few complications. Moreover, additional surgeries for accompanying injuries could be performed. Even though there were accompanying injuries in patients with rib fractures, our results indicated that such surgical treatments could be performed by TEA when the injuries were mild. In addition, the surgical reduction and fixation of the ribs could be performed in high risk patients who could not undergo general anesthesia. Furthermore, an additional advantage is that it can be applied safely and easily for the second operation on incompletely healed ribs previously operated under general anesthesia.

## CONCLUSION

TEA promotes early recovery and short hospital stays, and it is beneficial for aging people and high risk patients who have poor organ function and a large surgical field. According to the results of this study, TEA has many advantages for surgeries on 3 or fewer consecutive rib fractures or on fractures that remain after primary surgery during the postoperative period. Therefore, it is suggested that TEA be applied under these clinical conditions. However, studies comparing TEA with general anesthesia in the same clinic and prospective randomized multicenter studies are needed to confirm each indicator, such as mortality rate, myocardial infarction rate, cost savings, and improvement in quality of life.

## REFERENCES

1. Cerfolio RJ, Allen MS, Trastek VF, et al. *Lung resection in patients with compromised pulmonary function*. Ann Thorac Surg 1996;62:348-51.
2. Karmy-Jones R, Hyland RH, Lewis JR, Kvale P. *Staging lung cancer*. Can Respir J 1997;4:297-305.
3. Block BM, Liu SS, Rowlingson AJ, et al. *Efficacy of post-operative epidural analgesia*. JAMA 2003;290:2455-63.
4. Dolin SJ, Cashman JN, Bland JM. *Effectiveness of acute*

- postoperative pain management: I. Evidence from published data.* Br J Anaesth 2002;89:409-23.
5. Beattie WS, Badner NH, Choi P. *Epidural analgesia reduces postoperative myocardial infarction: a meta-analysis.* Anesth Analg 2001;93:853-8.
  6. Rodgers A, Walker N, Schug S, et al. *Reduction of peri-operative mortality and morbidity with epidural or spinal anesthesia: results from an overview of randomized trials.* BMJ 2000;321:1-12.
  7. Breslow MJ, Jordan DA, Christopherson R, et al. *Epidural morphine decreases postoperative hypertension by attenuating sympathetic nervous system hyperreactivity.* JAMA 1989; 261:3577-81.
  8. Rao TL, Jacobs KH, El-Etr AA. *Reinfarction following anesthesia in patients with myocardial infarction.* Anesthesiology 1983;59:499-505.
  9. Badner NH, Knill RL, Brown JE, et al. *Myocardial infarction after noncardiac surgery.* Anesthesiology 1998;88: 572-8.
  10. Brodner G, Van Aken H, Hertle L, et al. *Multimodal peri-operative management-combining thoracic epidural analgesia, forced mobilization, and oral nutrition-reduces hormonal and metabolic stress and improves convalescence after major urological surgery.* Anesth Analg 2001;92:1594-600.
  11. Liu S, Carpenter R, Neal JM. *Epidural anesthesia and analgesia: their role in postoperative outcome.* Anesthesiology 1995;82:1474-506.