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Epidural Morphine on Ventilatory Function in Chest Trauma and Thoracotomy Patients

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Epidural morphine injection was done in nineteen patients who had been admitted from March to August 1990 to the Intensive Care Unit, Severance Hospital, Yonsei Medical Center for respiratory care including ventilator care. Morphine suplphate, 2.67±0.27 mg was injected one to three times to four patients after chest trauma, and to fiffteen patients after thoracotomy. Tidal volume and vital capacity were increased from 4.45±0.48 and 8.31±0.50 to 6.91±0.41 and 12.81±0.73 ml/kg. However, respiratory rates decreased from 26.07±1.41 to 20.07±1.16/min. Inspiratory force increased from −13.40±1.31 to −26.53±1.82 cmH_2O. Pain score decreased from 9.22±0.57 to 3.56±0.83 during this period. P_aCO_2 did not differ significantly (39.33±1.13 and 39.48±1.42 mmHg). Side effects such as pruritis and urinary retention were treated with naloxone 7~10 ng/kg/min. Mean arterial pressure and pulse rates stayed stable during the study periods. Ventilator hours and ICU stays differed from the control group. However, the duration was not statisticially significant. The control group consisted of patients who were admitted during the six months from September 1989 to Feburuary 1990 to the ICU for respiratory care, without epidural morphine injection.

Key Words: Epidural morphine, ventilatory function, thoracotomy and chest trauma

Pulmonary complications continue to be a major source of the morbidity associated with blunt chest injuries or thoracotomy. The severe pain associated with multiple rib fractures and flail chest frequently leads to splinting, hypoventilation and atelectasis. Reduced ventilation may further lead to the development of hypoxia, pneumonia and the need for mechanical ventilation. Sufficient pain control, to allow deep breathing and coughing, were of primary concern. This was to prevent pulmonary complications in patients with thoracic trauma or elective thoracotomy (Cicala *et al.* 1990). The use of lumbar epidural morphine to control the pain associated with thoracotomy and rib fractures has been common, but its efficacy in improving pulmonary function is less well documented. We attempted to assess the use of lumbar epidural morphine in the efficacy of improving ventilatory function and pain relief and its effect on length of mechanical ventilator use and ICU stay.

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PATIENTS AND METHODS

Of nineteen patients who received continuous epidural morphine analgesia, four had chest trauma with flail chest and fifteen were post-thoracotomy cases. All patients had been admitted, for respiratory care including ventilator care and oxygen therapy, to the Intensive Care Unit, Yonsei University Medical Center from March to September 1990. As a control group, we included eighteen patients that did not receive epidural morphine who were admitted to the Intersive Care Unit from September 1989 to February 1990. These patients also had chest trauma with rib fractures or were postthoracotomy state. Six patients that did not require ventilator support were excluded. Epidural catheters were placed via the midlidne approach by the anesthesia staff.

Coagulation indices (PT, PTT, platelet count and bleeding time) were evaluated before epidural catheter placement and any signficant abnormalities were corrected. Ventilatory function tests, including tidal volume, respiratory force and pain score were obtained before initial epidural morphine adminstration and one hour after the morphine injection. Pain scores were defined such as 10, if there was severe pain and 0, if there was no pain. Vital signs such as mean arterial pressure, pulse rate and blood gas analysis were measured during the same period. All patients enrolled in this study were supported with a mechanical ventilator. As soon as patients complained of pain, a bolus dose of epidural morphine 2~3 mg mixed with 5 ml distilled water was given. Systemic narcotic medications were not allowed two hours prior to the study, and we did not give any narcotic or sedatives to the epidural group. The criteria for discontinuing epidural morphine were in the absense of deterioration of ventilatory function and lack of recurrent pain.

After pain had subsided with morphine, the ventilator was disconnected in most patients through IMV (intermittent mandatory ventilation) or T-piece. Paired t-tests were used to compare the changes in ventilatory function, vital signs and pain score before and after epidural morphine injection. The unpaired t-test and Mann Whitney test were used to compare data between the epidural (Group 1) and non-epidural (Group 2) group. A p value less than 0.05 was consdiered as significant.

RESULTS

The total number of patients were nineteen in group 1 and twelve in group 2. The man age was 45.36 and 40.80 years of age, respectively. The ratio of male to female was fifteen to four and ten to two in groups 1 and 2. According to each group respectively, disease distributions was four and five patients with chest trauma, fifteen and seven with post-thoracotomy state (table 1). Twelve in group 1 and seven patients in group 2 were disconnected from the vetilator through the "T" piece, seven in group 1 and five patients in group 2 through intermittent mandatory ventilation mode and the "T" piece (table 2). Ventilator hours were 49.57±25.98 in group 1 and 114.56±46.39 hours in group 2. In group 1 and group 2 patients stayed in the ICU for 4.82±1.11 and 10.00±3.27 days respectively (table 3). There was no significant difference in ventilator hours and ICU days and age between the two groups ($P>0.05$). One patient with chest trauma received epidural catheter insertion twice because of premature removal. In the epidural group, dosage, frequency of morphine injection and duration of epidural catheter were 2.63 mg/day, 1.71

Table 1. Sex and disease distribtion
mean±se (minimum-maximum)

	Group 1	Group 2
No. of patient	19	12
Age(year)	45.36±3.6 (19~80)	40.8±4.5 (30~60)
Male	15	10
Female	4	2
Disease distribution		
Chest trauma	4	5
Thoractomy	15	7

se: standard error

Table 2. Weaning method

Method	Group 1	Group 2
CMV-T piece	12	7
CMV-IMV-T piece	7	5

CMV: control mode ventilation
IMV: intermittent mandatory ventilation

Table 3. Ventilator Hours and ICU days
mean±se (minimu-maximum)

	Group 1	Group 2
Ventilator hours	49.57±25.98 (2~432)	114.56±46.39 (2~984)
ICU days	4.82± 1.11 (2~ 18)	10.00± 3.27 (2~ 41)

se: standard error

Table 4. Dosage, frequency of morphine injection and duration of catheter insertion
mean±se (minimum-maxium)

Morphine dosage (mg/day)	2.63±0.27(2~ 6)
Frequency of morphine injection	1.71±0.17(1~ 3)
Duration of catheter insertion (day)	3.12±0.60(1~ 8)
Weight (kg)	57.27±2.28(40~48)

se: standard error

Table 5. Cardiovascular, ventilatory function and pain score (mean±se)

	Preblock	Postblock	
MAP(mmHg)	103.88±3.10	98.55±3.58	
PR(/min)	104.80±3.98	92.67±3.00	
Vt(ml/kg)	4.45±0.48	6.91±0.41	
RR(/min)	26.07±1.41	20.07±1.16	
VC(ml/kg)	8.31±0.50	12.81±0.73	
IF(-cmH_2O)	13.40±1.31	26.53±1.81	
$PaCO_2$(mmHg)	39.33±1.13	39.48±1.42	(P=1.155)
Pain Socre	9.22±0.57	3.56±0.83	

MAP: mean arterial pressure PR: pulse rate Vt: tidal volume RR: respiratory rate VC: vital capcity IF: inspiratory force se: standard error

and 3.12 days (table 4). In group 2, patients received narcotics, sedatives and muscle relaxants. The drugs which they received during their stay in the ICU were diazepam 11.1 mg, morphine 8.5 mg, meperidine 40.1 mg, lorazepam 4 mg and pancronium bromide 4.6 mg.

Mean arterial pressure and pulse rate decreased significantly. Tidal volume, vital capacity increased from 4.45±0.48 and 8.31±0.50 to 6.91±0.41 and 12.81±0.73 ml/kg ($P<0.05$).

Inspiratory force increased from −13.40±1.31 to −26.53±1.81 cmH_2O. As shown below $PaCO_2$ level did not differ significantly between the two groups ($P>0.05$).

Patietns had excellent pain relief with an average decrease in pain score from 9.22±0.57 to 3.56±0.83 (table 5). With the exception of the $PaCO_2$ levels, all data between the groups differed signficantly ($P<0.05$).

Side effects occurred in four patients. Two had pruritis and two had urinary retention. Pruritis and urinary retention were treated with naloxone 7~10 ng/kg/min. We reinserted the epidural catheter in one patient whose epidural catheter had been removed prematurely.

DUSCUSSION

A prospective study was conducted to assess the effect of epidural morphine in improvement of pulmonary function, analgesic action and duration of ventilator and ICU days. Nineteen patients were admitted to an intensive care unit, after thoracotmy, for lung lesions or chest trauma with rib fractrures for ventilatory care during a six month period. We included twelve patients without epidural catheter as a control group. These patients were admitted to the intensive care unit from September 1989 to February 1990, after thoracotomy or chest trauma, for respiratory care.

We performed epidural catheter insertion and measured the ventilatory functions and pain scores. Tidal volume was increased from 4.45 to 6.91 ml/kg and respiratory rate was decreased from 26.1 to 20.1/min. Minute volume was increased 19.55% from 116.0 ml/kg to 138.7 ml/kg. Vital capacity was increased also from 8.31 to 12.81 ml/kg and inspiratory force from −13.40 to −26.53 cmH_2O.

Pain secondary to thoracic trauma such as rib fracture, pneumothorax, hemotherax and contusion has been shown to cause a decrease in tidal volume (Worthley 1985). The decrease in tidal volume along with an inability to cough may lead to atelectasis and pulmonary infection. This can aggrevate the patients pulmonary status, prolong recovery, and may make mechanical ventilation necessary (Mackersie *et al.* 1987). Conventional treatment of multiple rib fractures has relied on either parenteral narcotic analgesia or intercostal nerve block to alleviate pain and improve ventilatory mechanics. The ideal analgesic would provide significant restoration of ventilatory function and should not cause central respiratory depression (Cicala *et al.* 1990). Use of epidural opioids has become a popular technique for the management of the postoperative pain. Recent studies would indicate that it is possible to achieve superior analgesia with lower doses of opioid medication when these drugs are administered in the extradural space versus the intramuscular or intravenous route of administration (Marlowe *et al.* 1989; Fromme *et al.* 1985). We used 2~6 (2.63±0.27) mg morphine through the epidural route one to three times in nineteen patients. In contrast, diazepam 11.1 mg, morphine sulphate 8.5 mg, meperidine 40.1 mg, lorazepam 4 mg and pancuronium bromide 4.6 mg was administered intravenously during the ICU stuy for the control group.

Maximal inspiratory pressure and vital capaicty are indices of ventilatory function and require a maximum voluntary effort in the use of respiratory muslces (Marckersie *et al.* 1987). In our study, vital capacity was increased from 8.31 to 12.81 ml/kg and inspiratory force increased also from −13.40 to −26.53 cmH_2O. Pulmonary function such as vital capacity, functional residual capacity, airway resistance and dynamic lung compliance increased

after epidural narcotics (Dittman and Wolff; 1978, Lomessys *et al.* 1984). Signficant improvement in postoperative pulmonary function has been demonstrated with epidural narcotics when compared with narcotics given intravenously (Bromage 1955). We achieved pulmoary function improvement in the epidural group but could not compare that to the control group because we had no data of pulmonary function for the control group. The pathophysiology of postoperative pulmonary function is complex and multifactorial (Craig. 1981, Simonneau *et al.* 1983). The marked decrease in forced vital capacity ratio postoperatively was a result of many factors, including reduced functional residual capacity secondary to pain and muscle splinting (Dyer *et al.* 1990). Several studies have demonstrated the value of objective measures of respiratory function as an adjunct to pain assessment (Wahba *et al.* 1975; Bromage. 1955). Our result showed a 55% increase in vital capacity after epidural block. This was achieved with a decrease of apin score from 9.22 ± 0.57 to 3.56 ± 0.83. This suggests that the measurement of vital capacity may be a useful objective pointer to improve pain relief particularly in intubated patient because communication with these patients is difficult.

Covino and Scott (1985) reported that the most common complications associated with epidural analgesia included pruritis, urinary retention, nausea and vomiting, ileus, paralysis and hypotension (Mattews and Govenden. 1989). We experienced two cases of pruritis and urinary retention which were treated successfully with low doses of naloxone $7 \sim 10$ ng/kg/min (Dailey *et al.* 1985). Although there was a decrease of vital sign values, vital signs remained stable during the study period.

Respiratory depression is a potential complication of narcotic administration by any route, including epidural injection (Marckersie *et al.* 1987). The $PaCO_2$ did not increase during spontaneous breathing after morphine epidural block, compared to the preblock peried, when most cases were supported with a ventilator.

Duration of ventilator use and ICU stays were different between the two groups, However the difference was not statistically. significant.

CONCLUSION

Our results suggest that continuous epidural morphine produces effective analgesia in chest trauma or thoracotomy patients without the need for additional narcotics. This method of analgesia significantly improved ventilatory function and decreases pain scores without repiratory depression. The duration of ventilator use and ICU stays decreased in the epidural group. However, this was not statistically significant.

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