Intrapleural Analgesia Using Ropivacaine for Postoperative Pain Relief after Minimally Invasive Thoracoscopic Surgery

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Purpose: to evaluate the efficacy and safety of intrapleural analgesia (IPA) using ropivacaine after thoracoscopic surgery, compared with thoracic epidural analgesia (TEA) using ropivacaine.

Methods: forty patients undergoing thoracoscopic bullectomy for spontaneous pneumothorax were randomly assigned to one of two groups. IPA group (n = 20) received intermittent bolus injection of 0.375% ropivacaine into intrapleural space two times; at the end of operation and one more time as the pain increased. TEA group (n = 20) received continuous epidural analgesia with 0.375% ropivacaine. Transrectal diclofenac was administered as an additional analgesic. Pain was assessed on the basis of additional analgesics requirements and by using a visual analog scale (VAS).

Results: the time courses of VAS scores along the postoperative time course were not significantly different (p = 0.175). Consumption of transrectal diclofenac was significantly smaller in IPA group (p = 0.025). No major complications appeared in both groups, and incidence of adverse symptoms was not different.

Conclusions: in IPA group, pain was managed with less consumption of additional analgesics. IPA could be one of the good choices after thoracoscopic surgery for its efficacy, safety, and benefit of easy placement of the catheter.

Keywords: intrapleural, epidural, analgesia, ropivacaine, thoracoscope

Introduction

The development of video-assisted thoracoscopic surgery (VATS) decreased the severity of postoperative pain, due to small incisions without rib spreading, and altered the way of postoperative pain relief. Although thoracic epidural analgesia (TEA) has been used favorably for open thoracotomy, it is controversial whether TEA provides additional benefit after less invasive surgery like VATS.11 Epidural analgesia carries potential risks of complications such as dural perforation, bleeding, infection, hypotension, bradycardia, and neurological injury.2–4 Moreover, it is relatively difficult to place a catheter appropriately into the epidural space in TEA, resulting in

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Received: November 29, 2011; Accepted: January 10, 2012
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migration or inadequate placement. On the other hands, intrapleural analgesia (IPA) using a chest tube is performed without difficulty by thoracic surgeons, avoiding major risks related to catheter placement. Several investigators have reported the clinical uses of IPA, but its efficacy is still controversial for post-thoracotomy pain. However, in less invasive surgery like thoracoscopic procedure, IPA could become the alternative to TEA for its advantages of easy adaptation and safety.

In this study, we compared the efficacy and the safety of IPA with TEA on the postoperative pain therapy.

**Material and Methods**

This non-blinded, prospective randomized trial was approved by the Institutional Review Board at Yokohama Rosai Hospital on 17 March 2008, and individual consent was obtained for all participants. Candidates were patients 15 to 35 years of age with spontaneous pneumothorax on one side of the lung. Exclusion criteria were synchronous bilateral pneumothorax, history of former thoracic surgery, allergy to ropivacaine or fentanyl, hepatic and renal insufficiency, and inability to complete pain scales. 40 patients were enrolled and randomly assigned to one of two groups.

**Surgical procedures**

Patients were introduced to general anesthesia by intravenous bolus infusion of propofol and maintained by inhaled sevoflurane. Intraoperative systemic analgesia was limited to fentanyl, from 2.0 to 3.0 \( \mu g/kg \). A single surgical team performed thoracoscopic bullectomy in the same manner. In the lateral position, a thoracoscope of 5mm in diameter was introduced via a port placed in the seventh intercostal space on the posterior axillary line. Another incision of approximately 3 cm in width was made in the fourth intercostal space on the anterior axillary line for insertion of manipulation devices and surgical staplers. Apical pleurectomy or pleural abrasion was not done. At the end of the operation, surgeons inserted an 18 Fr. double lumen Trocar catheter\(^\circledR\) (Nippon Sherwood Medical Industries Ltd. Tokyo, Japan) percutaneously in the seventh intercostal space. The tip of the catheter was visually directed toward the top of the intrapleural space on the paravertebral line. The main lumen of the catheter was suctioned to -15 cm H\(_2\)O pressure continuously, and the smaller lumen was used for ropivacaine injection in IPA group. The catheter was removed approximately 24 hours after the operation after ascertaining patients had neither air leak nor intrathoracic bleeding.

**Postoperative pain evaluation**

After the operation, all patients were extubated, and Foley catheter was removed at the operation room, and then carried to their ward via a recovery room. Patients became almost alert after this transfer, and then pain evaluation started by ward nurses using a visual analog scale (VAS) six times regularly and at the time pain got worse in a non-blinded manner. Regular six times occurred at times 0, 4, 8, 12, 16, 20 hours after returning to the ward. VAS is a grading from 0 (no pain) to 100 (worst pain imaginable), measured by pointing a scale in increment of 5. A VAS score of 60 or above was deemed unacceptable and then additional analgesics or ropivacaine were administered.

**Pain management**

In IPA group, the patients received intermittent bolus injection of 40 mL of 0.375% ropivacaine (150 mg) through the smaller lumen of the catheter two times: at the end of the operation and at the time when pain worsened with an interval of more than two hours. Transrectal diclofenac sodium 25 mg as an additional analgesic was administered except for the second injection of ropivacaine. To avoid suctioning of ropivacaine by negative pressure, Trocar catheter was clamped for 30 minutes after the injection. If the patients had an air leak, its drainage tube was not clamped but lifted above the thorax.

In TEA group, the operation was performed under general anesthesia with TEA. The epidural catheter was placed in Th4/5, Th5/6, or Th6/7 prior to induction of general anesthesia in the operation room. This group received continuous TEA of 0.375% ropivacaine at a rate of 3 mL/hour starting at the beginning of operation until removal of Trocar catheter. No opioids were administered into the epidural space. Transrectal diclofenac sodium 25mg as an additional analgesic was administered when a patient was assessed as being in worsened pain (VAS \(\geq 60\)). Additional epidural administration of ropivacaine was prohibited.

**Statistical analysis**

Statistical analysis was performed with SPSS 11.0.1 software (SPSS, Inc, Chicago, Ill, USA). Probability (\(p\)) less than 0.05 was considered significant. Group comparisons of patient characteristics and additional analgesics doses were conducted with the T test, except for sex and...
adverse effects with the Fisher exact test. VAS scores along the whole time courses were compared by ANOVA with repeated measures. Comparison for mean VAS scores at each measurement was done by the T test.

**Results**

The characteristics of the patients are shown in Table 1. Age, sex, height, body weight, duration of operation, and duration of postoperative hospital stay were not significantly different between the two groups. The duration of operation room stay in IPA group was significantly shorter ($p = 0.001$). The total doses of ropivacaine and intraoperative fentanyl were not statistically different. Doses of diclofenac sodium were significantly smaller in the IPA group ($p = 0.001$).

The time courses of VAS scores were shown in Fig. 1. The similarity between the trends of VAS over the whole 20 hours was identified ($p = 0.175$). Mean VAS score at all six points were not statistically different including 0 and 8 hour ($p = 0.179, 0.165$, respectively). The interval of first and second injection of ropivacaine in IPA group was ranging from 120 to 450 (median 180) minutes. The incidence of postoperative adverse symptoms was not significantly different. Outpatient follow-up for about a month after the discharge detected no late complications such as empyema, pleural effusion, and pneumonia (Table 3).

![Fig. 1](image_url) Visual analog scale (VAS) scores of the two groups along the postoperative course. The trends of VAS were not significantly different ($p = 0.175$). Mean VAS score at all six points were not significantly different. Mean and standard deviations of VAS scores were figured as large points (round and square) and two-sided bars.

**Discussion**

Several reports have described effectiveness of IPA as postoperative pain relief for thoracic surgery, but some reports have been only mildly positive or frankly negative. These conflicting results may be due to a variety of the applications and the study settings. The
The most important reasons for lack of efficacy have been thought to be localized distribution inside the intrapleural space, and dilution of local anesthetic by pleural effusion, blood, or infected fluid, suctioning of local anesthetic from the intrapleural space. Consequently, patients with spontaneous pneumothorax undergoing bullectomy were considered to be appropriate for IPA; their intrapleural space is usually small without loculation or adhesion, and produced a small amount of pleural effusion. In addition, the prevention of suctioning of ropivacaine by clamping or lifting of the chest tube is also indispensable.

To evaluate the efficacy of the pain management, VAS scores and consumption of additional analgesics were compared. The trend of VAS scores along the time course and mean VAS scores at all six points presented no significant differences between the two groups, while consumption of additional diclofenac was significantly smaller in the IPA group. We think this superiority of IPA is due to its mechanism of blockage and origin of postoperative pain after thoracoscopic surgery. IPA, analgesia is thought to occur as a result of diffusion of local anesthetic through the parietal pleura and the innermost intercostal muscle to reach the intercostal nerves where blockage occurs, as well as a result of blockage of the intrathoracic sympathetic chain, and direct action of local anesthetic on nerve endings within the pleura. For those reasons, IPA can be applied to diffuse pain in thoracic and upper abdominal area caused by various disorders including neoplasm, herpes zoster, and traumatic rib fractures as well as postoperative pain. After thoracoscopic procedure, patients are sensitive to mild but diffuse compressive pain produced by placement of a chest drain, because somatic pain in upper thorax is less due to small incision and preservation of rib and intercostal nerves. IPA has possible efficacy for this kind of diffuse pain, but epidural analgesia by local anesthetics is more selective analgesia effective for localized dermatomes and intercostal nerves without thoracic sympathetic chain. This consideration can explain that IPA is more effective for such kind of diffuse thoracic pain as well as pain from the small skin incision and minimal muscle division.

Our results presented scarce adverse effects in both groups. Occurrence of complications of epidural analgesia has been described well, while that of IPA has not been reported much because its settings and procedures have been varied. A review article described that the most frequent complication of IPA was pneumothorax (2.0%), followed by systemic toxicity of local anesthetics (1.3%) and pleural effusion (0.42%). Pneumothorax may occur because of air entrainment or as a result of damage to the lung parenchyma caused by the percutaneous technique of catheter placement. Placement under direct vision such as our technique clearly reduces the incidence of pneumothorax.

Systemic toxicity from local anesthetic agents is another major concern for clinicians. Its prevalence in IPA as being 1.3% was not considered to be satisfactory, though bupivacaine has been used in most of the previous reports. To decrease the prevalence of systemic toxicity, we selected ropivacaine for its lower potential of cardiovascular and central nervous system toxicity and limited maximal doses to 300 mg per body in both of the groups. Consequently, no adverse symptoms related to systemic toxicity occurred in our series of patients.

The interval between the two injections in IPA group is thought to be associated with the effecting time of ropivacaine. Its median time as 180 minutes was not long enough for postoperative 20 hours. Possible solutions to this matter are addition of adrenaline to ropivacaine solution, and continuous infusion of ropivacaine. Addition of adrenaline 5 µg/mL to local anesthetics was expected to decrease its plasma concentration and increase its effecting time. However, because intrapleural ropivacaine with adrenaline was not reported ever, careful application with pharmacokinetic examination will be explored. Continuous administration of local anesthetics was expected to decrease its plasma concentration and increase its effecting time. However, because intrapleural ropivacaine with adrenaline was not reported ever, careful application with pharmacokinetic examination will be explored. 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One of limitations of this trial is that because this was a non-blinded study, the results might include bias.
However, technical differences between IPA and TEA make it difficult to establish a blinded study. To evaluate the efficacy of IPA more clearly, we should have designed a placebo-controlled trial on IPA without TEA. Another limitation is that this was based on a small number of patients that did not have an enough power to detect a small difference. However, patients in the two groups were well standardized, meaningful results could be obtained in this trial.

In conclusion, our results showed that IPA with 0.375% ropivacaine was safe and effective in patients undergoing VATS bullectomy. IPA demonstrated almost similar efficacy in pain management with smaller consumption of additional diclofenac, compared with TEA. In addition, IPA has the advantage of easiness and safety in catheter placement.

Disclosure Statement

The authors have no conflict of interest to declare.

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