The efficacy of paravertebral block using a catheter technique for postoperative analgesia in thoracoscopic surgery: a randomized trial

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Abstract

Objective: The analgesic scheme combining paravertebral block (PVB) and intravenous non-steroidal anti-inflammatory drug (NSAID) has proven to be effective for postoperative pain control after thoracotomy. The hypothesis tested in this study was that this policy was also suitable to improve pain control after video-assisted thoracic surgery (VATS). Methods: This was a prospective randomized study on 40 patients submitted to three-ports’ VATS for pneumothorax or solitary pulmonary nodule. The sample size was calculated to detect one point of minimum pain score difference with 80% statistical power. Patients were randomly assigned to two groups: (1) paravertebral block group (PVB) (n = 20) – At the end of surgery, a catheter was placed in patients in the thoracic paravertebral space under camera control; they received a bolus of 15 ml of local anesthetic (ropivacaine 0.2%) every 6 h, combined with endovenous metamizol (1 g); and (2) alternate NSAIDs group (AN) (n = 20) – They were treated with paracetamol (1 g) combined with metamizol (1 g) every 6 h. Subcutaneous meperidine (synthetic opioid) was employed as rescue drug. Both groups were comparable in terms of age, sex, pathology, and co-morbidity. Pain level was measured with the visual analog scale (VAS) at 1, 6, 24, and 48 h. Results: No side effects related to any of the two analgesic techniques were noted. Two patients needed rescue meperidine in the AN group, and none in the PVB group. VAS scores were the following: PVB group, VAS 1 h: 1.4 ± 0.8, VAS 6 h: 3.4 ± 1.2, VAS 24 h: 2.6 ± 1.0, VAS 48 h: 2.2 ± 0.9, and mean VAS: 2.4 ± 1.3; AN group, VAS 1 h: 2.8 ± 1.0, VAS 6 h: 4.9 ± 1.3, VAS 24 h: 3.9 ± 1.4, and mean VAS: 3.8 ± 1.4. VAS scores were significantly lower at any time in the PVB patients (p < 0.01). Conclusions: The analgesic regimen combining PVB and NSAID provided an excellent level of pain control. Thoracoscopy assisted positioning of the paravertebral catheter is simple and effective, and allows direct visualization of correct delivery of local anesthetic. It represents a valuable addition to any VATS procedure.

Keywords: Thoroscopic surgery; Thoracic paravertebral block; Paravertebral anesthetic techniques

1. Introduction

Most video-assisted thoracoscopic surgery (VATS) procedures are considered low-risk interventions requiring short hospital stays or even outpatient settings. Because of these factors, VATS did not raise as much interest as thoracotomy in hospital stays or even outpatient settings. Because of these procedures are considered low-risk interventions requiring short therapy or combined.

However, as with thoracotomy, there is no generally accepted policy for its management.

The use of PVB for thoracic procedures is well accepted, they are comparable to epidural block with respect to pain relief, and, as part of a balanced analgesia, they have demonstrated to be even superior [4–7]. They are characterized by unilateral effective blockade of pain stimuli over several dermatomes. This unique characteristic is attributed to an ipsilateral blockade of the spinal nerves and sympathetic chain [8].

There are two approaches for thoracic PVBs; the paravertebral space can be approached percutaneously, or alternatively, a paravertebral catheter (PVC) can be placed under direct vision at thoracotomy. Direct placement of a PVC in the paravertebral space in VATS surgery has been with local anesthetics (PVB), patient controlled analgesia, cryoanalgesia, surgical wound infiltration, transcutaneous electrical nerve stimulations, etc. [3]. They are used as single therapy or combined.
considered technically too difficult, and has not been routinely performed [9,10].

Since 2002, in our Department we have been employing a multimodal treatment of post-thoracotomy pain consisting of a PVB through a PVC inserted during surgery with a bolus of a local anesthetic (ropivacaine 0.2%) combined with an NSAID (metamizol) with excellent results [11,12].

Given our experience in the placement of the PVC under direct vision, we decided to go further and place them in VATS surgery guided by the images of the camera, and therefore employ the same policy of pain management used for thoracotomy in VATS patients: PVB through PVC combined with NSAID.

This randomized and prospective study was designed to evaluate this policy comparing it with our usual VATS pain management (wound infiltration after surgery plus combination of two alternate NSAIDs postoperatively).

2. Materials and methods

Prospective randomized study of 40 patients submitted to three-ports’ VATS. The sample size was calculated to detect one point of minimum pain score difference with 80% statistical power.

Included in the study were patients scheduled for VATS for spontaneous primary pneumothorax or solitary pulmonary nodule (SPN) during 2008–2010. Written informed consent was obtained in all the cases, and the protocol was approved by our institutional Ethical Committee. The use of a visual analog scale (VAS) for pain measurement was explained previously to those involved in the study.

Patients were allocated randomly by computer-generated random numbers for a PVC to be placed under VATS guidance and receive a bolus of 15 ml of ropivacaine 0.2% every 6 h combined with endovenous metamizol (PVB group), or to be submitted to infiltration of the surgical wounds with bupivacaine 0.5% (5 ml for each wound) at the end of surgery and receive postoperatively endovenous paracetamol (1 g) combined with endovenous metamizol (1 g) every 6 h (alternate NSAIDs (AN) group).

General anesthesia was induced with 1.5–2 mg kg$^{-1}$ of propofol, 2 μg kg$^{-1}$ of fentanyl, and 0.6 mg kg$^{-1}$ of atracurium and maintained with sevoflurane, nitrous oxide, and oxygen. All patients were intubated with a double-lumen endobronchial tube for one-lung ventilation.

After positioning patients in the lateral position for the operation, the surgical procedure was performed. Three ports were employed in all the cases (12 mm, 10 mm, and 5 mm) through which were placed the camera and endo-instruments. Ports were placed in a maximum range of three intercostal spaces between the lower and the upper.

In SPN surgery, the lung nodule was identified and resected with endostaplers.

At the end of the resection, the upper edge of the spinal process of the thoracic vertebral body (equidistant to the upper and lower intercostal space where ports had been placed) was recognized. With an epidural needle (Tuohy 18 G; Braun, Melsungen, Germany), the injection point was punctured 3 cm lateral to the midline. The paravertebral space was entered by advancing the Tuohy needle over the superior border of the transverse process. Once in the right place, the PVC was placed through the needle, checking the tip remained placed when removing the needle. The advance of the needle and the entering of the catheter into the paravertebral space were verified all the time by the surgeon using the camera (Fig. 1).

In pneumothorax surgery, pleural and parenchymal inspection looking for bullae or dystrophic complexes was done. When they were identified, they were resected with an endostapler. In the case of diffuse disease and when there were no evident lung abnormalities, the lung apex was resected for histopathological characterization.

The PVC was inserted at this point. Pleurodysis by pleural abrasion was performed with a Marlex mesh held on a long curved sponge stick, by scarification of the thoracic wall parietal pleura, except for the paravertebral area and lower pleura. Therefore, the PVC area was preserved.

One drain was left in place connected to an underwater seal bottle with a negative pressure of 15 cmH₂O in all the cases.

Chest tube removal was performed at 24 h after surgery in SPN cases and 48 h in pneumothorax cases; patients were discharged after removal. In all the cases, the VAS measurement was done in the same conditions (with one chest tube on). In SPN cases, VAS was collected over a period of 24 h and in pneumothorax cases during 48 h.

In the AN group, surgical procedures were the same (except the PVC placement).

At the end of surgery, the PVB group patients received a bolus of 15 ml of ropivacaine 0.2% through the PVC, and the AN group patients had infiltration of the three-ports’ wounds with 15 ml of bupivacaine 0.5% (5 ml for every wound).

The total dose, volume, and concentration of ropivacaine for PVB were selected considering previous studies, all of which showed the efficacy of plain ropivacaine in concentrations of 0.2% in a bolus of 15 ml.

Therefore, PVB patients received, postoperatively, a bolus of 15 ml of ropivacaine 0.2% every 6 h, with 1 g of endovenous metamizol intercalated every 6 h. AN patients received 1 g of endovenous paracetamol with 1 g of endovenous metamizol, also intercalated every 6 h. Meper-
idine, a synthetic opioid, was employed as rescue drug in both groups (a bolus of 50 mg subcutaneous).

Patients’ pain was evaluated with a VAS graded from 0 (no pain) to 10 (the worst pain imaginable) recorded 1 h after the paravertebral analgesic bolus or the endovenous NSAID.

The study period lasted 48 h, and data collection was performed by a third person (the assigned ward nurse), who wrote the VAS score in the patient Kardex.

The following data were assessed: (1) 1, 6, 24, and 48 h pain scores, (2) any requirement for rescue analgesia (meperidine), and (3) adverse events related to the analgesia technique, including respiratory depression (respiratory rate < 8 breaths/min), cardiotoxicity, confusion, sedation, urinary retention, nausea, vomiting, and pruritus.

Statistical Package for Social Sciences (SPSS) version 13 package (Chicago, IL, USA) was used for statistical data analysis. Sigma Plot 11.0 was used for graphics. Adjustment of data sets to a normal distribution was always verified for the applicability of parametric statistics (Kolmogorov–Smirnov test). Subsequently, the comparison of serial measurement (variables) was performed by one-way analysis of variance (ANOVA) test.

3. Results

A total of 44 patients were enrolled initially. Four cases were excluded, three because data collection (VAS values) were incomplete and one because of accidental PVC removal.

No pruritus or periods of excessive somnolence were detected in either of the groups. There were no intra-operative or postoperative complications in any of the patients with regard to PVC placement, local anesthetic infusion, wound infiltration, or paracetamol and metamizol dosages.

Patient characteristics and operative data were comparable between the groups (Table 1). Mean VAS values and statistical differences between the PVB and the AN groups can be seen in Table 2.

Acceptable postoperative analgesia was provided in both groups, as shown by the pain scores. There were statistical significant differences in mean VAS values between both groups, with a significant lower mean VAS of 2.4 for PVB versus 3.8 for AN; p < 0.01.

Analyzing VAS values per h, the PVB group also showed lower scores that were statistically significant (p < 0.01). Initial VAS scores were low in both groups (1.4/2.8) with a peak of pain at 6 h control (PVB: 3.4 vs AN: 4.9). VAS pain scores decreased progressively, being lower after this point.

Two patients (5%) needed meperidine as rescue drug at some moment (both in the AN group); this was statistically significant (p < 0.05).

No complications attributable to postoperative pain (retention of secretions, atelectasis, or pneumonia) or PVB or NSAIDs were recorded.

4. Discussion

This study tested the hypothesis that PVB through a PVC, combined with one NSAID, provides better analgesia after VATS than alternate NSAIDs.

Several authors have demonstrated that a thoracic PVB before VATS provides excellent pain relief with few side effects during the first postoperative hours. These procedures have been mainly performed percutaneously by experienced anesthesiologists [13–15].

Analyzing the results obtained by these groups, it is apparent that the percutaneous approach to PVB is effective; however, in comparison to the direct approach, it has several drawbacks. It is performed ‘blindly’ (there is no direct vision of the needle entering the paravertebral space). This carries the risk of inadvertent arterial injections, local anesthetic extension into the epidural space, and pneumothorax [16].

These complications are rare but make it advisable to perform the PVB in awake and cooperative patients [17]. Further, given that, with this approach, it is not possible to be absolutely sure of the optimal place of infusion, the failure rate is considerable, estimated at 12% [18]. Finally, it is a single block that has proven to be very effective, but only during the first 6 h, making it useless after that time [15].

Thoracic PVB in VATS using a PVC technique had been previously demonstrated. Soni and colleagues described, in 1994, the technique of VATS placement of PVC in a patient submitted to surgery for bilateral spontaneous pneumothorax [19].

Canto and colleagues, in 2003, studied continuous bilateral PVB for conventional cardiac surgery. They found low pain scores during the intensive care unit stay, with good hemodynamic stability and a low complication rate [20].

In our group, we have a large experience in the use of PVC for post-thoracotomy analgesia [11,12]. We have demonstrated that its placement is technically simple and safe. It has the benefit of a continuous visual control of the procedure, it being possible to check the entry of the PVC

<table>
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<th>Table 1. Patients characteristics and operative data.</th>
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<tr>
<td>Group PVB (n = 20)</td>
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<td>Age (year)</td>
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<td>Intra-operative iv fentanyl (mg)</td>
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PVB: paravertebral block; AN: alternate NSAIDs. Means are presented ± standard deviation.
tip into the correct paravertebral space, verifying that it remains fixed correctly before closing the thoracotomy. This ensures the local anesthetic is delivered into the right place. Besides, the PVC can be maintained for several days, permitting a PVB every 6 h.

In thoracic surgical analgesia, it has been demonstrated that a complete pain control cannot be achieved with a single agent or technique, and that a balanced analgesic regime seems more appropriate. Combining PVB through PVC with NSAID has given excellent results in post-thoracotomy pain control [21].

In daily practice, our policy for VATS analgesia consists of wound infiltration at the end of surgery and postoperative alternate NSAIDs with systemic opioids as rescue drugs. After seeing our good results in post-thoracotomy pain control with PVB through PVC combined with a NSAID (metamizol), we decided to test the same policy in VATS procedures.

In 2005, Fernandez and colleagues [22] demonstrated that epidural analgesia in patients undergoing VATS for primary spontaneous pneumothorax did not confer any additional benefits to other less invasive methods of analgesia.

In our patients, PVB provided an excellent pain control. The difference in mean VAS values between PVB and AN (Table 2), with a strong statistical significance ($p < 0.01$) in the mean and all the postoperative hours, was remarkable.

We believe that the real advantage of PVB through PVC (besides the safety and low failure rate) is the possibility of periodical blocks. Several studies have shown the effectiveness of percutaneous PVB with a single dose of local anesthetic performed before surgery in the first 6 h after VATS; however, the same authors admit that a single block alone may not provide adequate postoperative analgesia, and that systemic supplementation may be necessary for the subsequent hours [13–15]. With the possibility of repeated PVB, this 6-h period lengthens and the addition of an NSAID improves the results on the basis of balanced analgesia.

The factors affecting the spread of local anesthetic in the thoracic paravertebral space have been studied by Cheema and colleagues [18]. They found a mean sensory level of 2.2 segments above and 1.4 segments below the level of injection. In our study, the PVC was left in the dermatome equidistant to the upper and lower trocar dermatome (never more than three dermatomes of distance between the upper and the lower). As Vogt and colleagues demonstrated, this spread is sufficient to block pain sensation after thoracoscopic surgery [14].

According to our data, we agree with this statement.

In conclusion, PVB through a PVC inserted under direct vision during VATS surgery is a safe and effective procedure to improve pain treatment after thoracoscopic surgery. Given its safety and benefits, this approach should be taken into account when performing VATS procedures.

References

allows you to directly place it up along the paravertebral space. I tried using a Touhy needle and putting the catheter in, but I could never get the catheter to advance very much to cover multiple interspaces. So I would ask you about how you cover multiple intercostal nerves, but I suspect that you have the catheter placed relatively locally and you rely on fluid to distribute along more spaces.

Before I came up with the tunnelling instrument, I just used a long clamp and grabbed the tip of the catheter with the clamp gently dissected up in the paravertebral space. I found this technique much easier to place, much more reliable, and to cover a larger distance than trying to advance the catheter with a Touhy needle.

Dr Fibla: We have been using this technique of placing the tip 3 cm to the midline in thoracotomy with no problems in its introduction, and when doing it in VATS, we have found it even easier controlling the entrance of the tip of the catheter with the camera. Cases where the pleura was not able to be dissected with a simple needle were not the best for this procedure, but in the cases in this study, we found no technical problems. Dr T. Demny (Buffalo, NY): You started your presentation with the fact that there is a concern about prolonged thoracic pain, and your time point ended at 48 hours. In the prevention of chronic pain, it is important to control initial pain, but prolonged pain can occur from a broader area of late inflammation and wound healing, so, theoretically, placing a paravertebral block or a catheter under the pleura could actually contribute to that.

So my question is, have you looked at the two groups in terms of whether or not there is a difference in chronic pain two, three, four months later rather than just your data that you collected in the hospital?

Dr Fibla: No, we just collected the data 48 hours after surgery, but it is an interesting point.

Dr E. Internullo (Genoa, Italy): Were the patients instructed on how to fill the VAS form in advance? Because that was your outcome measure.

Dr Fibla: We explained it before the surgery.

Dr Internullo: And did you compare the sedation score at one hour after surgery between the two groups? I didn’t see this comparison.

Dr Fibla: Yes, they were able to say what was the best rate.

Dr Internullo: Okay, I didn’t see that. Another point. When you took your pain score, at 1, 6, 12, 24 hours, was this just after the ropivacaine bolus or before?

Dr Fibla: After, yes.

Dr Internullo: And the control group had paracetamol and metamizol intravenously at the same time?

Dr Fibla: Yes. Alternated every 6 hours.

Dr Internullo: Was the score taken immediately after? Because the effects of ropivacaine administered paravertebrally must be much quicker than intravenous paracetamol.

Dr Fibla: It was one hour after the drug.

Dr A. Martin-Ucar (Nottingham, UK): Are patients who are on aspirin for cardiological conditions or strokes allowed to be included in this study because of the use of non-steroidals, or did you exclude them, or do you normally stop the aspirin preoperatively?

Dr Fibla: We normally stop the aspirin before surgery, yes.