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MISCELLANEOUS

Comparison between Continuous Thoracic Epidural and Paravertebral Blocks for Postoperative Analgesia in Patients Undergoing Thoracotomy: Systematic Review

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KEYWORDS
Analgesia, Epidural;
Anesthesia, Epidural;
Nerve Block;
Pain, Postoperative;
Postoperative Complications;
Thoracotomy

Abstract

Background and objective: Thoracotomy is a procedure associated with postoperative severe pain. Epidural block (EB) is considered the gold standard for its control. Paravertebral block (PVB) is an option for the management of postoperative pain. The aim of this study was to evaluate by meta-analyses the effectiveness of continuous thoracic epidural and paravertebral blocks for pain management after thoracotomy and the incidence of adverse effects.

Method: The study was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) protocol. We analyzed primary (postoperative pain at rest) and secondary outcomes (urinary retention, nausea, vomiting, hypotension). We estimated the weighted mean difference for continuous variables and odds ratios for categorical variables.

Results: We included eight prospective, randomized, controlled studies. Meta-analysis showed no statistically significant differences between the two techniques regarding the outcomes of postoperative pain at rest at four, eight, 12, 16, 20, 24, 36, and 48 hours. Incidence of urinary retention was higher in EP group (OR = 7.19, CI95 = 1.87 to 27.7). The occurrence of hypotension was higher in PVB group (OR = 10.28, 95 = 2.95 to 35.77). There was no statistically significant difference between both groups regarding the outcome nausea/vomiting (OR = 3.00, CI95 = 0.49 to 18.45).

Conclusion: There were no statistically significant differences in pain relief after thoracotomy between EB and PVB. PVB showed a lower incidence of side effects with reduced frequency of urinary retention and hypotension.

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Introduction

Open thoracotomy is a procedure usually associated with severe postoperative pain.[1] The subsequent thoracotomy pain is due to trauma to the chest wall, rib fractures, intercostal nerve injury, and central nervous system sensitization. Thoracotomy impairs the respiratory function and its effects are exacerbated by pain,[2] requiring the use of regional anesthesia techniques to obtain adequate postoperative analgesia.[3]

In many centers, epidural anesthesia is considered the gold standard for pain management. However, this method is not suitable for all patients and may be associated with dura mater perforation, bleeding, infection, hypotension, bradycardia, and urinary retention.[4]

Paravertebral block is one option for epidural block, as it has shown good analgesic efficacy and is associated with few side effects.[5-8]

With the increasing interest in regional block techniques, studies have been conducted to determine the best procedure for post-thoracotomy pain management. However, the small number of articles on the topic and limited number of patients involved in each study fail to reach evidence level 1 (studies including a systematic review with homogeneity of controlled clinical trials and random allocation, or controlled clinical trials and randomization with narrow confidence intervals) regarding comparisons between the two techniques. In recent meta-analysis[9] comparing epidural anesthesia with other techniques of regional analgesia, the authors concluded that it was impossible to determine the superiority of one technique over another. The authors included studies involving a wider range of procedures (thoracotomy, lobotomies, sternotomy) and various analgesic techniques, such as intercostal blockades alone, intravenous analgesia, and paravertebral blocks alone, which may have been responsible for the difficulty in demonstrating the effects studied.

The aim of this study was to evaluate by meta-analyses the effectiveness of continuous thoracic epidural and paravertebral blocks for pain management after thoracotomy and the incidence of adverse effects.

Method

We performed a systematic review according to the procedures prescribed by the PRISMA protocol[10] consisting of the following steps: systematic literature search, critical analysis for inclusion and exclusion of studies, selection of outcome variables (data extraction), and meta-analytic calculations as described below.

Search strategy

We performed a systematic search in Medline and Cochrane databases for studies published up to September 2011 comparing thoracic epidural block with paravertebral block for postoperative analgesia after thoracotomy. We searched the following terms in various combinations: "pulmonary surgical procedures", "thoracotomy", "epidural", "peridural", "extradural", "paravertebral", "intercostal", "nerve block", and "postoperative pain". The search was limited to randomized clinical trials that included adult patients (aged over 18 years), with no language restriction. We reviewed references from studies initially found for further clinical trials.

Study inclusion and exclusion criteria

Inclusion criteria included randomized, prospective, clinical studies with patients undergoing thoracotomy and comparing techniques of continuous epidural and paravertebral blocks, with infusion of local anesthetics alone or combined with opioids via catheter insertion in the thoracic region.

We excluded articles using single injection of local anesthetic, intrapleural analgesia, blockade outside the thoracic area, and opioids alone or procedures other than thoracotomy.

The authors performed critical readings of the studies selected in the initial search. We excluded articles that were clearly irrelevant by analyzing titles and abstracts. After selecting the articles, the second step began with the classification of studies according to the Jadad criteria.[11]

Critical analysis: quality and classification scores

All authors performed classification of the studies individually and independently through rating the article's quality according to the Jadad criteria.[11] Jadad scoring evaluates the study by the following parameters: random allocation of individuals in groups, blinding, description of losses and adequacy of random allocation of individuals and blinding, with a maximum score of five. According to this score, studies are classified as high (≥ 3) or low quality (< 3).

We defined the final score using Delphi technique,[12] and consensus criterion was the median for individual scores with an interquartile range lower than one. We made successive rounds until we reached consensus. Based on this score and given the small number of available studies, we did not exclude the prospective, randomized, clinical trials.

Outcome variables and method of data extraction

The primary outcome variable was postoperative pain at rest at four, eight, 12, 16, 20, 24, 36, and 48 hours. The secondary outcome variables were the frequencies reported for nausea and vomiting, urinary retention, and hypotension. The visual analog pain scores were extracted as mean and standard deviation. We converted the scores described as median to a mean.[13] We converted the scores into standard deviation units from the mean scores measured in the respective scales to standardize the scalar units of visual analog pain scores, measured on scales with varying ranking numbers in the different studies.

We digitally extracted scores described in graphical form using the Engauge Digitizer 4.1 program,[14] if data were not provided after contact by e-mail with their respective authors.

Meta-analyses

We used the Review Manager[15] program for meta-analyses. The effect sizes and respective 95% confidence intervals (CI) were estimated by weighted mean differences (interval variables) or odds ratio (dichotomous variables). We applied fixed and random effects in meta-analytic models. The heterogeneity of the studies was quantified by the Cochran Q test and coefficients of heterogeneity I^2.[16] Group of studies

with I^2 greater than 30% were considered heterogeneous and determined the choice of the respective random effects models. We assessed publication bias by funnel plot analysis.[17] We performed sensitivity analyzes using successive meta-analyses, eliminating one study at a time.

We based our post hoc tests of robustness and sample size estimates on the calculated effect sizes in meta-analyses.[18]

Results

Our search strategy resulted in the recovery of 22 studies, six of which were excluded due to their obvious irrelevance after reading the abstracts. We included the remaining 16 studies in the critical analysis phase and excluded eight for not meeting the inclusion criteria (Fig. 1). Table 1 shows the summary of the studies included in the meta-analyses.[3,5-8,19-21]

Primary outcome

Those eight studies reported the intensity of postoperative pain at different times. Therefore, meta-analyses of this outcome were different regarding the number of included studies. There were no statistically significant differences between treatments at four, eight, 12, 16, 20, 24, 36, and 48 hours in the postoperative period (Figs. 2-8).

Secondary outcomes

Four studies reported the incidence of nausea and vomiting.[3,5,7,20] Meta-analysis showed no significant difference between both anesthetic approaches (OR = 3.00, 95% CI = 0.49-18.45). Four studies reported incidence of urinary retention. Epidural anesthesia was associated with a higher incidence of urinary retention compared to paravertebral block (OR = 7.19, 95% CI = 1.87-27.7). Five studies reported the incidence of hypotension. Epidural anesthesia was associated with a higher incidence of hypotension compared to paravertebral block (OR = 10.28, 95% CI = 2.95-35.77) (Figs. 9-11).

Assessment of effect sizes and robustness of the meta-analyses

The total number of patients included in the meta-analyses ranged from 172 (pain at 20 hours postoperatively) and 307 (pain at 24 hours postoperatively). Considering the mean absolute difference between the standardized visual analog scores found in meta-analyses of postoperative pain outcomes at four, eight, 12, 16, 20, 24, 36, and 48 hours between anesthetic approaches was equal to a standard deviation of 0.18 and the average and standard deviation of standardized scale are 0 and 1, respectively, it is estimated that the effect size observed was small (less than 0.3, according to Cohen criterion.[22] The sample size calculation associated with 80% power and probability of Type I error equal to 5% in groups of equal size yielded the estimate that 486 patients should be included in each arm of the study, which resulted in a sample of 972 patients. For the same level of Type I error, samples of 1,300; 1,608 and 2,272 patients would be required to achieve 90%, 95%, and 99% power, respectively. Considering that the maximum number of patients was 307 (n = 149 and 158), the estimated maximum robustness for comparisons between groups in our meta-analyses was 0.35, implying that Type II errors may have been responsible for the lack of statistical significance observed in primary outcome meta-analyses.

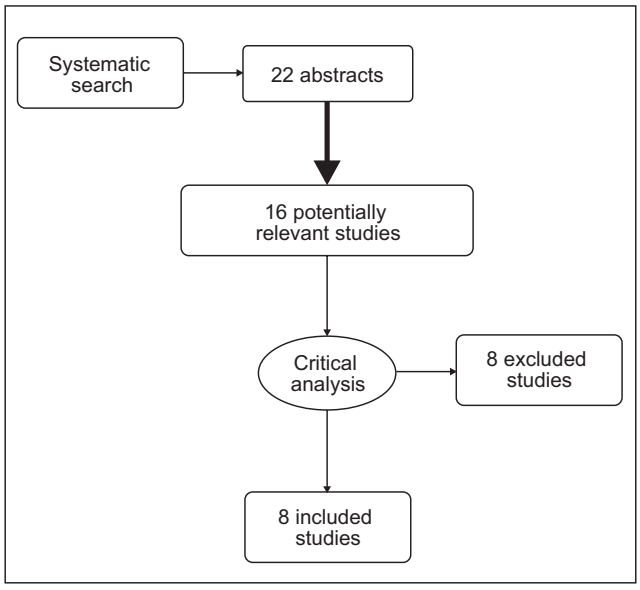


Figure 1 Flow chart of studies included and excluded according to PRISMA protocol.

Table 1 Summary of Studies included in Analysis.

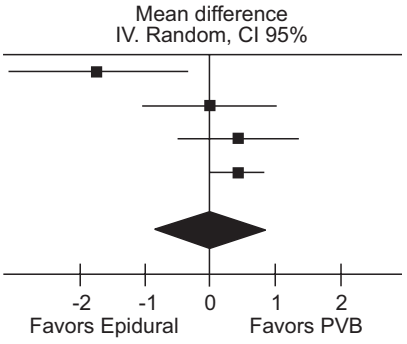
Authors	Publication (year)	Jadad score (median)	Paravertebral/Epidural (n)	Drugs
Matthews et al.[8]	1989	1	10/9	Bupivacaine 0.25%, CI
Perttunen et al.[21]	1995	1	15/15	Bupivacaine 0.25%, CI
Kaiser et al.[19]	1998	1	15/15	Bupivacaine 0.5%, CI
Richardson et al.[3]	1999	3	46/49	Bupivacaine 0.25%, CI
Bimston et al.[5]	1999	3	30/20	Bupivacaine 0.1% + Fentanyl 10μg.ml$_{-1}$, CI
Debreceni et al.[6]	2003	5	25/25	Bupivacaine 0.25%, CI
Casati et al.[22]	2006	5	21/21	Ropivacaine 0.2%, CI
Gulbahar et al.[7]	2010	1	25/19	Bupivacaine 0.25%, CI

CI, continuous infusion.

Figure 2 Assessment of pain at rest after 4 hours.

Study	Epidural Mean	SD	Total	PVB Mean	SD	Total	Weight	Mean difference IV, Random, 95% CI
Debreceni et al.	5.48	2.8	25	7.22	2	22	17.1%	-1.74 [-3.12; -0.36]
Matthews et al.	1.3	1.2	9	1.3	1.1	10	22.6%	0.00 [-1.04; 1.04]
Perttunen et al.	3.8	1.4	15	3.36	1.14	15	25.0%	0.44 [-0.47; 1.35]
Richardson et al.	1.81		49	1.38	0.95	46	35.35%	0.43 [0.02; 0.84]
Total (95% CI)			98			93	100%	0.04 [-0.79; 0.72]

Heterogeneity: $Tau^2 = 0.38$ $Chi^2 = 9.12$, df = 3 (p = 0.03) $I^2 = 67\%$.
Test for overall effect: Z = 0.09 (p = 0.93).

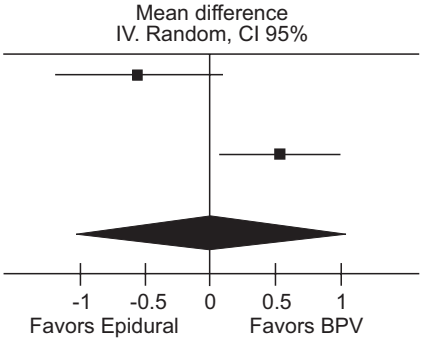


This table presents the summary of the comparative meta-analysis results for pain at rest treatments, four hours after surgery. We used data from four studies. Forest plot shows the weighted mean difference between group scores and respective 95% confidence intervals for each study. Note that, except for the fourth study, all other 95% confidence intervals crossed the vertical line of zero-effect. Diamond graph summarizing the meta-analysis results also crossed the line of zero-effect. This is numerically indicated by the value of Z, whose corresponding p was greater than 0.05. We conclude, therefore, that there was no statistically significant difference between both treatments regarding the parameter studied. Heterogeneity test results are shown in the figure. Note that there was statistically significant heterogeneity (p = 0.03), which reflected in the high level of heterogeneity I^2. IV, interval variable; random, random effect; CI, confidence interval.

Figure 3 Assessment of pain at rest after 8 hours.

Study	Epidural Mean	SD	Total	PVB Mean	SD	Total	Weight	Mean difference IV, Random; 95% CI
Debreceni et al.	3.74	1.95	25	4.73	2.55	22	47.8%	-0.43 [-1.01; 0.15]
Bimston et al.	1.22	0	21	2.58	0	29		Non-assessable
Richardson et al.	1.08	0.81	49	0.7	0.45	46	52.2%	0.57 [0.16; 0.98]
Total (95% CI)			95			97	100%	0.09 [-0.89; 1.07]

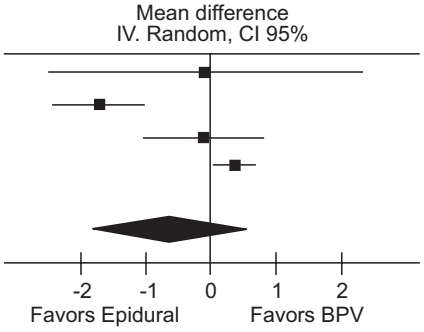
Heterogeneity: $Tau^2 = 0.44$; $Chi^2 = 7.65$, df = 1 (p = 0.006); $I^2 = 87\%$.
Test for overall effect: Z = 0.18 (p = 0.86).



This table presents the summary of the comparative meta-analysis results for pain at rest treatments, eight hours after surgery. We used data from three studies. Forest plot shows the weighted mean difference between group scores and respective 95% confidence intervals for each study. Note that the 95% confidence interval obtained in the third study did not cross the vertical line of zero-effect, unlike the first study. In the second study, we did not evaluate the sample standard deviation, making it impossible to calculate the study confidence interval. Diamond graph summarizing the meta-analysis results crossed the line of zero-effect. This is numerically indicated by the value of Z, whose corresponding p was greater than 0.05. We conclude, therefore, that there was no statistically significant difference between both treatments regarding the parameter studied. Heterogeneity test results are shown in the figure. Note that there was statistically significant heterogeneity (p = 0.006), which was reflected in the high level of heterogeneity I^2. IV, interval variable; random, random effect; CI, confidence interval.

Figure 4 Assessment of pain at rest after 12 hours.

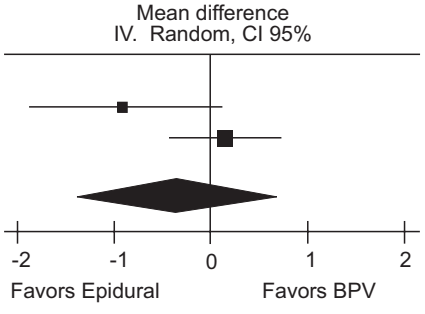
Study	Epidural Mean	SD	Total	PVB Mean	SD	Total	Weight	Mean difference IV, Random, 95% CI
Casati et al.	3.23	4.64	21	3.3	4.99	21	13.8%	-0.07 [-2.98; 2.84]
Debreceni et al.	3.74	1.95	25	5.78	0.89	22	28.5%	-2.04 [-2.98; -1.19]
Matthews et al.	1.3	0.9	9	1.4	1.5	10	26.7%	-0.10 [-1.20; 1.00]
Richardson et al.	1.32	1.07	49	0.86	0.78	46	31.0%	0.46 [0.09; 0.83]
Total (95% CI)			104			99	100%	-0.48 [-1.91; 0.96]
Heterogeneity: $Tau^2 = 1.70$; $Chi^2 = 27.89$, df = 3 (p = 0.00001), $I^2 = 89\%$.								
Test for overall effect: Z = 0.65 (p = 0.52).								



This table presents the summary of the comparative meta-analysis results for pain at rest treatments, 12 hours after surgery. Data from four studies were used. Forest plot shows the weighted mean difference between group scores and respective 95% confidence intervals. Note that there were no statistically significant differences in the first and third studies, as indicated by the 95% confidence intervals crossing the vertical line of zero-effect. In the second study, the mean weighted difference between treatments favored epidural block, unlike the fourth study that favored paravertebral block. Diamond graph summarizing the meta-analysis results also crossed the line of zero-effect. This is numerically indicated by the value of Z, whose corresponding p was greater than 0.05. We conclude, therefore, that there was no statistically significant difference between both treatments regarding the parameter studied. Heterogeneity test results are shown in the figure. Note that there was statistically significant heterogeneity (p = <0.01), which reflected in the high level of heterogeneity I^2. IV, interval variable; random, random effect; CI, confidence interval.

Figure 5 Assessment of pain at rest after 16 hours.

Study	Epidural Mean	SD	Total	PVB Mean	SD	Total	Weight	Mean difference IV, Random, 95% CI
Bimston et al.	1.07	0	21	2.28	0	29		Non-assessable
Debreceni et al.	4.39	1.54	25	5.26	1.98	22	41.6%	-0.87 [-1.89; 0.15]
Richardson et al.	1.9	1.53	49	1.7	1.23	46	58.4%	0.20 [-0.36; 0.76]
Total (95% CI)			95			97	100%	-0.25 [-1.28; 0.79]
Heterogeneity: $Tau^2 = 0.40$; $Chi^2 = 3.24$, df = 1 (p = 0.07) $I^2 = 69\%$.								
Test for overall effect: Z = 0.46 (p = 0.64).								



This table presents the summary of the comparative meta-analysis results for pain at rest treatments, 16 hours after surgery. We used data from three studies. Forest plot shows the weighted mean difference between group scores and respective 95% confidence intervals of each group. In the first study, we did not evaluate the sample standard deviation, making it impossible to calculate the confidence interval of the study. Note that all other 95% confidence intervals crossed the vertical line of zero-effect. Diamond graph summarizing the meta-analysis results also crossed the line of zero-effect. This is numerically indicated by the value of Z, whose corresponding p was greater than 0.05. We conclude, therefore, that there was no statistically significant difference between both treatments regarding the parameter studied. Results of heterogeneity tests are shown in the figure. Note that there was statistically significant heterogeneity (p = 0.07). IV, interval variable; random, random effect; CI, confidence interval.

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Abstract
Background and objective: Thoracotomy is a procedure associated with postoperative severe pain. Epidural block (EB) is considered the gold standard for its control. Paravertebral block (PVB) is an option for the management of postoperative pain. The aim of this study was to evaluate by meta-analyses the effectiveness of continuous thoracic epidural and paravertebral blocks for pain management after thoracotomy and the incidence of adverse effects.
Method: The study was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) protocol. We analyzed primary (postoperative pain at rest) and secondary outcomes (urinary retention, nausea, vomiting, hypotension). We estimated the weighted mean difference for continuous variables and odds ratios for categorical variables.
Results: We included eight prospective, randomized, controlled studies. Meta-analysis showed no statistically significant differences between the two techniques regarding the outcomes of postoperative pain at rest at four, eight, 12, 16, 20, 24, 36, and 48 hours. Incidence of urinary retention was higher in EP group (OR = 7.19, CI95 = 1.87 to 27.7). The occurrence of hypotension was higher in PVB group (OR = 10.28, 95 = 2.95 to 35.77). There was no statistically significant difference between both groups regarding the outcome nausea/vomiting (OR = 3.00, CI95 = 0.49 to 18.45).
Conclusion: There were no statistically significant differences in pain relief after thoracotomy between EB and PVB. PVB showed a lower incidence of side effects with reduced frequency of urinary retention and hypotension.

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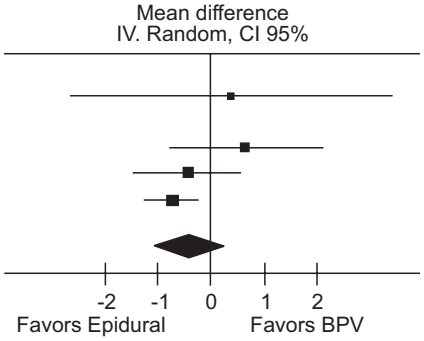
Figure 8 Assessment of pain at rest after 48 hours.

Study	Epidural Mean	SD	Total	PVB Mean	SD	Total	Weight	Mean difference IV, Random, 95% CI
Bimston et al.	1.19	0	21	1.79	0	29		Non-assessable
Casati et al.	3.18	5.59	21	2.59	4.26	21	4.8%	0.59 [-2.42; 3.60]
Gulbahar et al.	2.78	0	19	2.88	0	25		Non-assessable
Kaiser et al.	2.25	2.52	15	1.49	1.31	15	17.2%	0.76 [-0.68; 2.20]
Perttunen et al.	1.41	1.6	15	1.91	1.19	15	27.8%	-0.50 [-1.51; 0.51]
Richardson et al.	0.6	0.59	49	1.4	1.69	46	50.2%	-0.80 [-1.32; -0.28]
Total (95% CI)			140			151	100%	-0.38 [-1.07; 0.30]

Heterogeneity: $Tau^2 = 0.17$ $Chi^2 = 4.64$, df = 3 (p = 0.20), $I^2 = 35\%$.
Test for overall effect: Z = 1.09 (p = 0.27).

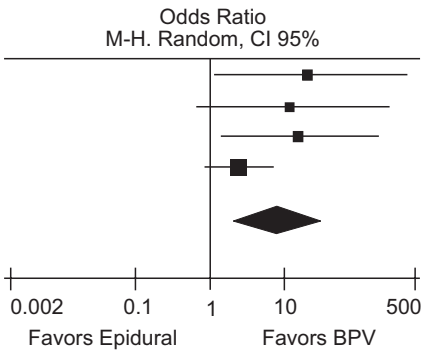


This table presents a summary of the comparative meta-analysis results for pain at rest treatments, 48 hours after surgery. We used data from six studies. Forest plot shows the weighted mean difference between group scores and respective 95% confidence intervals of each group. Standard deviations of samples were not assessed in the first and third studies, precluding the calculation of their confidence intervals. Note that except for the sixth study, whose weighted mean difference favored the epidural treatment, all 95% confidence intervals of other studies crossed the vertical line of zero-effect. Diamond graph summarizing the meta-analysis results also crossed the line of zero-effect. This is numerically indicated by the value of Z, whose corresponding p was greater than 0.05. We conclude, therefore, that there was no statistically significant difference between both treatments regarding the parameter studied. Results of heterogeneity tests are shown in the figure. Note that there was no statistically significant heterogeneity (p = 0.20). IV, interval variable; random, random effect; CI, confidence interval.

Figure 9 Incidence of urinary retention.

Study	Epidural Events	Total	PVB Events	Total	Weight	Odds ratio M-H, Random; 95% CI
Bimston et al.	6	20	0	30	16.2%	27.34 [1.44; 519.12]
Gulbahar et al.	4	19	0	25	15.8%	14.81 [0.75; 294.19]
Matthews et al.	6	9	1	10	20.8%	18.00 [1.50; 216.62]
Richardson et al.	11	49	5	46	47.1%	2.37 [0.75; 7.46]
Total (95% CI)		97		11	100%	7.19 [1.87; 27.70]
Total events	27		6			

Heterogeneity: $Tau^2 = 0.66$, $Chi^2 = 4.53$, df = 3 (p = 0.21), $I^2 = 34\%$.
Test for overall effect: Z = 2.87 (p = 0.004).

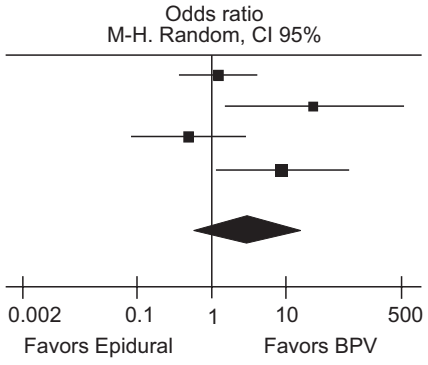


This table presents a summary of the comparative meta-analysis results of treatments regarding the postoperative incidence of urinary retention. Data from four studies were used. Forest plot shows odds ratio for event occurrence in Group EB compared to group PVB with the respective 95% confidence intervals of each group. Note that in studies 1 and 3, the lower confidence interval did not reach the vertical line of equal probabilities (OR = 1), while this line was crossed over in studies 2 and 4. Diamond graph summarizing the meta-analysis results did not cross the line of equal probabilities. This is numerically indicated by the value of Z, whose corresponding p was greater than 0.05. We conclude, therefore, that there was statistically significant difference between both treatments regarding the parameter studied, and the probability of urinary retention occurrence was higher among patients who underwent EB. The image shows results of heterogeneity tests. Note that there was no statistically significant heterogeneity (p = 0.21; $I^2 = 34\%$). M-H, Mantel-Haenszel; random, random effect; CI, confidence interval.

Figure 10 Incidence of nausea and vomiting.

Study	Epidural Events	Total	Events	PVB Total	Weight	Odds ratio M-H, Random, 95% CI
Bimston et al.	6	20	8	30	30.9%	1.18 [0.34; 4.13]
Gulbahar et al.	8	19	0	25	18.6%	37.70 [2.00; 710.13]
Matthews et al.	11	15	13	15	26.1%	0.42 [0.06; 2.77]
Richardson et al.	10	49	1	46	24.4%	11.54 [1.41; 94.21]
Total (95% CI)		103		116	100%	3.00 [0.49; 18.45]
Total events	35		22			

Heterogeneity: $Tau^2 = 2.37$; $Chi^2 = 10.54$, df = 3 (p = 0.01), $I^2 = 72\%$.
Test for overall effect: Z = 1.19 (p = 0.24).

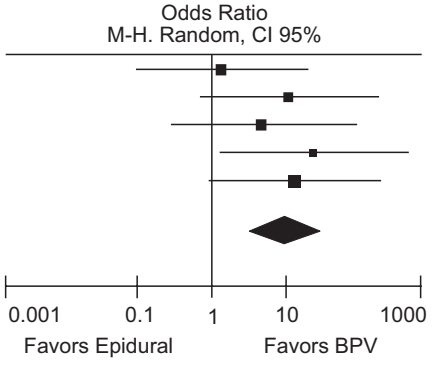


This table presents the summary of the comparative meta-analysis results of treatments regarding the incidence of postoperative nausea and vomiting. We used data from four studies. Forest plot shows odds ratio for event occurrence in Group EB compared to Group PVB with the respective 95% confidence intervals of each group. Note that in studies 2 and 4, the lower confidence interval did not reach the vertical line of equal probabilities (OR = 1), while this line was crossed over in studies 1 and 3. Diamond graph summarizing the meta-analysis results crossed the line of equal probabilities. This is numerically indicated by the value of Z, whose corresponding p was greater than 0.05. We conclude, therefore, that there was no statistically significant difference between both treatments regarding the parameter studied. Results of heterogeneity tests are shown in the figure. Note that there was statistically significant heterogeneity (p = 0.01; $I^2 = 72\%$). M-H, Mantel-Haenszel; random, random effect; CI, confidence interval.

Figure 11 Incidence of hypotension.

Study	Epidural Events	Total	Events	PVB Total	Weight	Odds ratio M-H, Random; 95% CI
Bimston et al.	1	20	1	30	35.5%	1.53 [0.09; 25.90]
Casati et al.	4	21	0	21	18.6%	11.06 [0.56; 219.68]
Gulbahar et al.	2	19	0	25	17.8%	7.29 [0.33; 161.20]
Richardson et al.	7	49	0	46	20.4%	16.41 [0.91; 296.12]
Total (95% IC)		118		132	100%	10.28 [2.95; 35.77]
Total events	20		1			

Heterogeneity: $Tau^2 = 2.59$, df = 4 (p = 0.63), $I^2 = 0\%$.
Test for overall effect: Z = 3.66 (p = 0.0003).



Summary of the comparative meta-analysis results of treatments regarding the incidence of postoperative hypotension. Data from five studies were used. Forest plot shows odds ratio for event occurrence in Group PVB compared to Group EB, with the respective 95% confidence intervals. Note that on study 4, the lower confidence interval did not reach the vertical line of equal probabilities (OR = 1), which indicates that the probability of hypotension occurrence was higher among patients who underwent PVB, while this line was crossed over in other studies. Diamond graph summarizing the meta-analysis results did not cross the line of equal probabilities. This is numerically indicated by the value of Z, whose corresponding p was greater than 0.05. We conclude, therefore, that there was statistically significant difference between both treatments regarding the parameter studied. Results of heterogeneity tests are shown in the image. Note that there was no statistically significant heterogeneity (p = 0.63; $I^2 = 0\%$). M-H, Mantel-Haenszel; random, random effect; CI, confidence interval.

As for secondary outcomes, the effect sizes observed in comparisons between epidural and paravertebral blocks regarding the outcomes urinary retention and hypotension were 0.62 and 0.67, respectively, with estimated robustness of 99% in both comparisons, considering the probability of Type I error equal to 5%. These findings suggest that conclusions on the lower incidence of urinary retention and hypotension are consistent enough to disregard the need for further studies and provide level-1A of evidence and grade-A of recommendation.[23]

Regarding the outcome for nausea and vomiting, the robustness found for comparisons between anesthetic approaches was 71%. The sample size calculation associated with 80% power and type I error probability equal 5% in groups of equal size yielded the estimate that 135 patients should have been included in each group, resulting in a sample of 270 patients. For the same level of Type I error, samples of 360, 446, and 702 patients would be required to obtain a power of 90%, 95%, and 99%, respectively. We conclude that the number of cases included in meta-analyses of the outcome nausea and vomiting was insufficient to reach level-1A of evidence and that more studies are needed to clarify this aspect.

Discussion

The results of this meta-analysis may be summarized as follows: (a) it was not possible to detect statistically significant differences between the two anesthetic approaches regarding pain levels and incidence of nausea and vomiting during the first 48 hours of the postoperative period; (b) epidural analgesia was associated with a higher likelihood of urinary retention and hypotension in the postoperative period.

However, these results may have been biased by the heterogeneity of the studies included in the meta-analyses. Except for the coefficients of heterogeneity smaller than 30% shown by studies measuring pain outcomes at 24 hours postoperatively and hypotension, all other study sets used for meta-analyses of other outcomes showed high coefficients of heterogeneity. These findings may be due to the small number of patients included in each study, inclusion of poor quality studies and/or small number of studies available for the meta-analyses proposed. We also found that the confidence intervals of the weighted mean differences between study sets varied in amplitude, suggesting insufficient sample sizes in the studies available. The aforementioned features may be responsible for the wide confidence intervals of the total effects estimated by meta-analyses. Therefore, the lack of significant differences may have been the result of Type II statistical error.

In addition to the limitation due to the lack of high quality prospective, randomized, controlled trials available at the time of this systematic review, the lack of comparisons between techniques may be considered a limitation regarding pain on movement and deep inspiration, assessed in only two studies.[3,21] It is worth mentioning that we used a digital method for data extraction available only in graphical form, which may be responsible for the inaccuracy in values. However, this method is accepted as an option when the original values are not available.[24]

The present study was an attempt to refine the inclusion criteria in order to get a lower heterogeneity of techniques and outcomes concerning the systematic review of studies by Davies et al.[9] Therefore, the trials were limited to studies that compared exclusively epidural analgesia and continuous thoracic paravertebral block in patients undergoing lateral thoracotomy. The application of these limits has highlighted the lack of data for decisions based on evidence level 1A (meta-analysis of prospective, randomized, controlled studies with low heterogeneity) regarding the superiority of one technique over another for postoperative pain management and the incidence of nausea and vomiting. From this systematic review, it is clear that epidural analgesia is associated with a higher incidence of arterial hypotension and urinary retention when it is used for pain control after thoracotomy in adult patients, with evidence level 1A.[23]

Conflicts of interest

The authors declare no conflicts of interest.

References

1. Joshi GP, Bonnet F, Shah R et al. - A systematic review of randomized trials evaluating regional techniques for postthoracotomy analgesia. Anesth Analg, 2008;107:1026-1040.
2. Richardson J, Sabanathan S, Shah R - Post-thoracotomy spirometric lung function: the effect of analgesia. A review. J Cardiovasc Surg (Torino), 1999;40:445-456.
3. Richardson J, Sabanathan S, Jones J et al. - A prospective, randomized comparison of preoperative and continuous balanced epidural or paravertebral bupivacaine on post-thoracotomy pain, pulmonary function, and stress responses. Br J Anaesth, 1999;83:387-392.
4. Liu S, Carpenter RL, Neal JM - Epidural anesthesia and analgesia. Their role in postoperative outcome. Anesthesiology, 1995;82:1474-1506.
5. Bimston DN, McGee JP, Liptay MJ et al. - Continuous paravertebral extrapleural infusion for post-thoracotomy pain management. Surgery, 1999;126:650-656; discussion 656-657.
6. Debreceni G, Molnar Z, Szelig L et al. - Continuous epidural or intercostal analgesia following thoracotomy: a prospective randomized double-blind clinical trial. Acta Anaesthesiol Scand, 2003;47:1091-1095.
7. Gulbahar G, Kocer B, Muratli SN et al. - A comparison of epidural and paravertebral catheterisation techniques in post-thoracotomy pain management. Eur J Cardiothorac Surg, 2010;37:467-472.
8. Matthews PJ, Govenden V - Comparison of continuous paravertebral and extradural infusions of bupivacaine for pain relief after thoracotomy. Br J Anaesth, 1989;62:204-205.
9. Davies RG, Myles PS, Graham JM - A comparison of the analgesic efficacy and side-effects of paravertebral vs epidural blockade for thoracotomy – A systematic review and meta-analysis of randomized trials. Br J Anaesth, 2006;96:418-426.
10. Moher D, Liberati A, Tetzlaff J et al. - Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. BMJ, 2009;339:b2535.
11. Jadad AR, Moore RA, Carroll D et al. - Assessing the quality of reports of randomized clinical trials: is blinding necessary? Control Clin Trials, 1996;17:1-12.
12. Hasson F, Keeney S, McKenna H - Research guidelines for the Delphi survey technique. J Adv Nurs, 2000;32:1008-1015.
13. Hozo SP, Djulbegovic B, Hozo I - Estimating the mean and variance from the median, range, and the size of a sample. BMC Med Res Methodol, 2005;5:13.

14. Mitchell M - Engauge Digitizer 4.1. 2002, Available at: www.fftw.org. Accessed 09/10/2011.
15. Collaboration TC - RevMan for MacOs X version 5.1.4. Available at: Accessed: 10/09/2011.
16. Higgins JP, Thompson SG, Deeks JJ et al. - Measuring inconsistency in meta-analyses. BMJ, 2003;327:557-560.
17. Borenstein M HL, Rothstein H - Introduction to Meta-Analysis. 2007, available at: www.meta-analysis.com. Accessed: 09/10/2011.
18. Erdfelder E, Faul F, Buchner A - Gpower: a general power analysis program 3.1.2 Edition, 1996.
19. Kaiser AM, Zollinger A, De Lorenzi D et al. - Prospective, randomized comparison of extrapleural versus epidural analgesia for postthoracotomy pain. Ann Thorac Surg, 1998;66:367-372.
20. Perttunen K, Nilsson E, Heinonen J et al. - Extradural, paravertebral, and intercostal nerve blocks for post-thoracotomy pain. Br J Anaesth, 1995;75:541-547.
21. Casati A, Alessandrini P, Nuzzi M et al. - A prospective, randomized, blinded comparison between continuous thoracic paravertebral and epidural infusion of 0.2% ropivacaine after lung resection surgery. Eur J Anaesthesiol, 2006;23:999-1004.
22. Cohen J - Statistical power analysis for the behavioral sciences. 2nd ed. 1988.
23. Oxford Centre for Evidence Based Medicine. Available at: http://www.cebm.net/. Accessed: 09/11/2011.
24. Lan X, Zhang MM, Pu CL et al. - Impact of human leukocyte antigen mismatching on outcomes of liver transplantation: a meta-analysis. World J Gastroenterol, 2010;16:3457-3464.