# Pain control after Thoracic Surgery

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# Pain after Thoracic Surgery

- Thoracic surgery: one of the most painful surgical procedure
- Post-operative pain
  - Lead to poor outcome
    - Atelectasis, pneumonia, longer hospital stay, poor quality of life
    - Chronic post-thoracotomy pain syndrome
- Sources of pain
  - Surgical incision, Rib damage or resection, Chest tubes, etc.

## Post-thoracotomy pain & Pulmonary function

- Changes in pulmonary function
  - Reduced FVC, FRC
    - Reduced 10-15% in abdominal surgery
    - Reduced 35% in thoracotomy
  - Aggravate atelectasis, shunting, hypoxemia
  - Reduced inspiration, effective coughing, expectoration



## Pathophysiology of thoracotomy pain

- Nociceptive somatic afferent
  - Main source of pain
  - Arise from intercostal nerve
    - Chest wall, pleura, skin incision, trocar insertion, muscle splitting, rib retraction, chest tube
  - Transmitted to ipsilateral dorsal horn of spinal cord





## Pathophysiology of thoracotomy pain

- Inflammatory mediators: prostaglandins, bradykinin, histamine, potassium → direct activate nociceptive receptors (primary sensitization)
- Hyperexcitability of dorsal horn neuron → glutamate release → activate NMDA receptors → increase of spinal cord neurons response (central sensitization)



## Pain control after thoracic surgery

- Minimize the sources of pain
- Blockage of pain transmission/ transduction
- Blockage of inflammation
- Blockage of pain perception



# Surgical techniques

# Posterolateral thoracotomy



## Muscle sparing thoracotomy



### A Meta-Analysis Comparing Muscle-Sparing and Posterolateral Thoracotomy

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Fig 2. Forest plot for weighted mean difference for the effects on internal rotation between posterolateral thoracotomy (PLT) and muscle-sparing thoracotomy (MST) groups 30 days after the operation. The solid squares denote mean difference, the horizontal lines represent the 95% confidence intervals (CI), and the diamond denotes the weighted mean differences. (DL = DerSimion Laird.)



Fig 3. Forest plot for weighted mean difference postoperative pain scores between posterolateral thoracotomy (PLT) and muscle-sparing thoracotomy (MST) groups on postoperative day 7. The solid squares denote mean difference, the horizontal lines represent the 95% confidence intervals (CI), and the diamond denotes the weighted mean differences. (DL = DerSimion Laird.)

## Fixation of rib



## Pericostal / Intracostal suture



## Intracostal Sutures Decrease the Pain of Thoracotomy

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Table 4. Mean Pain Scores With Standard Deviations at 2 Weeks, and 1, 2, and 3 Months After Thoracotomy for the Two Groups

	Pericostal	Intracostal		
2	Group	Group	p Value	
2 weeks	5.5 ± 1.4	3.3 ± 1.9	0.004	
1 month	$3.8 \pm 1.3$	$1.7 \pm 1.4$	0.001	
2 months	$2.3 \pm 1.0$	$1.1 \pm 0.9$	< 0.001	
3 months	$1.6 \pm 0.8$	$0.6 \pm 0.7$	< <mark>0.00</mark> 1	



*Fig 3. Mean pain scores with standard deviations.* ( $\blacklozenge = P$  group;  $\blacksquare = I$  group.)

## Intercostal flap



### Intercostal Muscle Flap for Decreasing Pain After Thoracotomy: A Prospective Randomized Trial

Amr Mohammad Allama, MD



Table 2.	Posto	perative	Data
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Variable	$\frac{IMF Group}{(n = 60)}$	$\frac{PCS Group}{(n = 60)}$	p Value
Postoperative FEV <sub>1</sub> (% predicted)	63.28 ± 8.84	62.83 ± 10.2	0.797
Time to ambulation (hours)	15.31 ± 3	17. <mark>4</mark> 3 ± 4.61	0.003ª
Pain score (0-10)			
Day 1	5.17 ± 0.99	5.6 ± 1.15	0.029 <sup>a</sup>
Day 2	4.18 ± 0.96	4.62 ± 1.11	0.024 <sup>a</sup>
Day 3	$\textbf{3.28} \pm \textbf{0.96}$	$3.72\pm0.97$	0.016 <sup>a</sup>
Day 4	$\textbf{2.63} \pm \textbf{0.86}$	$3\pm0.97$	0.019 <sup>a</sup>
Day 5	$1.92\pm0.81$	$2.27 \pm 0.94$	0.034 <sup>a</sup>
Day 6	$1.5\pm0.62$	$1.78\pm0.76$	0.04 <sup>a</sup>
Day 7	$1.15\pm0.48$	$1.4 \pm 0.56$	0.012 <sup>a</sup>
Number of analgesic doses injected in the epidural catheter	$3\pm0.9$	3.6 ± 1.1	0.002 <sup>a</sup>
Complications			0.959
Air leak	6 (10%)	5 (8.3%)	
Empyema	1 (1.7%)	1 (1.7%)	
Bleeding	1 (1.7%)	2 (3.3%)	
Wound infection	3 (5%)	2 (3.3%)	
Chest tube drainage (mL)	$\textbf{480.8} \pm \textbf{184.1}$	458.3 ± 173.5	0.506
Hospital stay (days)	4.6 ± 2.7	4.7 ± 2.3	0.429
Return to normal daily activities (days)	13.25 ± 4	14.8 ± 3.3	0.024 <sup>a</sup>

<sup>a</sup> Statistically significant difference (p < 0.05).

# Pain after posterolateral versus nerve-sparing thoracotomy: A randomized trial





Does a Multimodal No-Compression Suture Technique of the Intercostal Space Reduce Chronic Postthoracotomy Pain? A Prospective Randomized Study



Figure 2. (A and A1) Intercostal muscle flap preparation. (B and B1) The use of gauze to cover the ribs while using the retractor. (C and C1) Closure of the intercostal space. (D and D1) Neurovascular bundle preservation.

	<b>IINB Group</b>	IMF Group	p	95% CI of
Variable	(n = 151)	(n = 146)	Value	Difference
Mean operative time $\pm$ SD, min	73.7 ± 10.7	78.9 ± 17.0	0.0001	-10.000 to -3.800
Mean hospital stay $\pm$ SD, d	$4.6 \pm 1.3$	$3.6 \pm 1.2$	0.0001	0.714-1.260
Mean chest tube permanence $\pm$ SD, d	4.3 ± 1.1	$3.4 \pm 0.9$	0.0001	0.622-1.058
Mean postoperative FEV <sub>1</sub> at 1 mo $\pm$ SD, % of predicted value	68.8 ± 17.4	83.1 ± 7.4	0.023	-0.331 to -0.027
Mean postoperative FEV <sub>1</sub> at 6 mo $\pm$ SD, % of predicted value	72.8 ± 10.5	86.4 ± 12.8	0.013	-0.351 to -0.049
Mean postoperative 6MWT distance at 1 mo $\pm$ SD, m	311.1 ± 51.0	371.2 ± 54.8	0.0001	-74.177 to -50.103
Postoperative 6MWT distance at 6 mo $\pm$ SD, m	329.9 ± 54.8	395.7 ± 56.4	0.0001	-79.374 to -54.093
Atelectasis, n (%)	35 (23.2)	10 (6.8)	0.008	-0.042 to 0.108
Arrhythmias, n (%)	21 (13.9)	16 (10.9)	0.396	-0.040 to 0.128
Rib fracture occurrence, n (%)	17 (11.3)	14 (9.6)	0.345	-0.038 to 0.138

IINB, intrapleural intercostal nerve block; IMF, intercostal muscle flap harvesting and pericostal no-compression "edge" suture; CI, confidence interval; FEV<sub>1</sub>, forced expiratory volume in 1 second; 6MWT, 6-minute walking test.



### Pulmonary Function, Postoperative Pain, and Serum Cytokine Level After Lobectomy: A Comparison of VATS and Conventional Procedure

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Fig 1. Operative approach for lobectomy and postoperative pain measured by eleven-point pain scale. Data are shown as mean  $\pm$  standard deviation of the mean. \*p less than 0.05; \*\*p less than 0.01. (POD = postoperative day; VATS = video-assisted thoracic surgery.)



Fig 3. Correlation between postoperative pain and pulmonary function recovery rate. Pain was measured by an 11-point pain scale. (FEV<sub>1.0</sub> = forced expiratory volume in one second; FVC = forced vital capacity; VATS = video-assisted thoracic surgery; VC = vital capacity.)

## Single-incision thoracoscopic surgery and conventional video-assisted thoracoscopic surgery: a retrospective comparative study of perioperative clinical outcomes<sup>†</sup>

Kyoji Hirai<sup>a,\*</sup>, Shingo Takeuchi<sup>a</sup> and Jitsuo Usuda<sup>b</sup>



**Figure 3:** NRS evaluation after operation. The NRS was significantly lower in the SITS group than in the c-VATS group at 7 and 30 days after operation. \**P* < 0.05. NRS: Numeric Rating scale; c-VATS: conventional video-assisted thoracoscopic surgery; SITS: single-incision thoracoscopic surgery; POD: postoperative day.



Frequency of symptoms related to neuropathic

**Figure 5:** Frequency of symptoms related to neuropathic wound pain after surgery. Frequency of allodynia, hypaesthesia, hyperalgesia and numbness but not aching sensation was significantly lower in the SITS group than in the c-VATS group. \*P < 0.05, \*\*P < 0.01. c-VATS: conventional video-assisted thoracoscopic surgery; SITS: single-incision thoracoscopic surgery.

### The impact of chest tube removal on pain and pulmonary function after pulmonary resection<sup>†</sup>

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#### Table 1: Patients' characteristics

Gender	Male (78), female (26)
Age	64.4 (15.2)
Height (cm)	169.6 (8.7)
Weight (kg)	76.5 (14.3)
Diagnosis (n)	Neoplastic 78, non-neoplastic 2
Approach (n)	Thoracotomy 69, VATS 35
Side (n)	Right 45, left 59
Type of operation (n)	Lobectomy 51, wedge 53
1	

Results are expressed as means ± standard deviation, unless otherwise specified. VATS: video-assisted thoracoscopic surgery.

Table 2: Comparison of the pre- and post-removal pain and FEV1

Variables	Pre-removal	Post-removal	P-value		
Static pain	2.6 (2)	1.5 (1.5)	< 0.0001		
Dynamic pain	4.1 (2.1)	2.4 (1.9)	< 0.0001		
FEV1 (I/s)	1.5 (0.8)	1.7 (0.9)	0.0004		
FEV1%	53 (24.7)	60.2 (30.8)	0.0004		

Results are expressed as means ± standard deviation unless otherwise indicated. FEV1: forced expiratory volume within the first second.

# Regional analgesia



## The Comparative Effects of Postoperative Analgesic Therapies on Pulmonary Outcome: Cumulative Meta-Analyses of Randomized, Controlled Trials

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Figure 2. Epidural local anesthetics versus systemic opioids: incidence of pulmonary infection based on the random effects model of Der Simonian and Laird. The cumulative meta-analysis is shown on the right. CI = confidence interval.





Figure 4. Epidural opioids versus systemic opioids: incidence of pulmonary complications based on the random effects model of Der Simonian and Laird. The cumulative meta-analysis is shown on the right. CI = confidence interval.

Figure 3. Epidural local anesthetics versus systemic opioids: incidence of pulmonary complications based on the random effects model of Der Simonian and Laird. The cumulative meta-analysis is shown on the right. CI = confidence interval.

## Pre-emptive analgesia

- Anti-nociceptive treatment started before the noxious stimulus
- To prevent the establishment of altered central processing of sensory input that amplifies postoperative pain
- Decrease acute postoperative pain
- Inhibit the development of chronic postoperative pain
- Pre-incisional thoracic epidural analgesia, paravertebral blocks, NMDA antagonists, systemic opioids

#### Clinical Study

#### The Effectiveness of Preemptive Thoracic Epidural Analgesia in Thoracic Surgery

Engin Erturk,<sup>1</sup> Ferdane Aydogdu Kaya,<sup>1</sup> Dilek Kutanis,<sup>1</sup> Ahmet Besir,<sup>1</sup> Ali Akdogan,<sup>1</sup> Sükran Geze,<sup>1</sup> and Ersagun Tugcugil<sup>2</sup>









FIGURE 3: Total analgesic requirement. <sup>†</sup>: P = 0.004 when tramadol amount at 1st postoperative hour in Group C was compared with those in Group P. <sup>‡</sup>: P = 0.032 when tramadol amount at 24th postoperative hour in Group C was compared with those in Group P.

FIGURE 1: Patient's demand count on PCEA pump when Group C is compared to Group P (\*: P = 0.013, \*: P = 0.000, \*: P = 0.002, \*: P = 0.001, a: P = 0.000, and  $\beta$ : P = 0.000).

FIGURE 2: Pump's delivery count on PCEA pump when Group C is compared to Group P (\*: P = 0.013, <sup>†</sup>: P = 0.000, <sup>‡</sup>: P = 0.002, <sup>#</sup>: P = 0.001, <sup>a</sup>: P = 0.000, and <sup>β</sup>: P = 0.000).

-	Group C	Group P	P value	
Postoperative 1st hour	$4.05 \pm 2.18^{\beta}$	$1.90 \pm 1.21$	0.002	
Postoperative 2nd hour	$3.45 \pm 2.23^{\alpha}$	$1.40 \pm 0.94$	0.001	
Postoperative 4th hour	$2.60 \pm 1.93^{*}$	$1.20 \pm 0.83$	0.009	
Postoperative 6th hour	$1.45 \pm 1.27$	$1.05 \pm 1.63$	0.134	
Postoperative 12th hour	$1.10 \pm 1.37$	$0.50 \pm 0.82$	0.134	
Postoperative 24th hour	$0.75 \pm 1.02$	$0.35 \pm 0.81$	0.192	

TABLE 3: Postoperative pain score at rest (VASr) (mean ± SD).

<sup>B</sup>When VASr scores at 1st postoperative hour in Group C were compared with those in Group P. <sup>a</sup>When VASr scores at 2nd postoperative hour in Group C were compared with those in Group P.

\*When VASr scores at 4th postoperative hour in Group C were compared with those in Group P.

	Group C	Group P	P value					
Postoperative 1st hour	$4.95 \pm 2.01^{\beta}$	3.15 ± 1.22	0.007					
Postoperative 2nd hour	$4.40 \pm 2.08^{\alpha}$	$2.55 \pm 1.14$	0.004					
Postoperative 4th hour	$3.50 \pm 1.76^*$	$2.20 \pm 0.95$	0.009					
Postoperative 6th hour	$2.55 \pm 1.31$	$2.10 \pm 1.48$	0.192					
Postoperative 12th hour	$2.20 \pm 1.54$	$1.40 \pm 0.94$	0.108					
Postoperative 24th hour	$1.60 \pm 1.18$	$1.05 \pm 1.05$	0.121					

#### TABLE 4: Postoperative pain score at coughing (VASc) (mean ± SD).

<sup>B</sup>When VASr scores at 1st postoperative hour in Group C were compared with those in Group P. "When VASr scores at 2nd postoperative hour in Group C were compared with those in Group P.

\*When VASr scores at 4th postoperative hour in Group C were compared with those in Group P.

#### Preemptive Low-dose Epidural Ketamine for Preventing Chronic Postthoracotomy Pain: A Prospective, Double-blinded, Randomized, Clinical Trial

Ho-Geol Ryu, MD,\* Chul-Joong Lee, MD,† Young-Tae Kim, MD,‡ and Jae-Hyon Bahk, MD, PhD§

	$\begin{array}{c} \text{Group K} \\ \text{(n = 65)} \end{array}$	Group KF (n = 68)				
Sex (M:F)	45:20	44:24				
Age (y)	56.9 (19-76)	58.9 (20-78)				
Weight (kg)	63.2 (9.1)	63.6 (9.8)				
Height (cm)	162.8 (10.1)	162.7 (7.8)				
Type of surgery	Lobectomy (48)	Lobectomy (51)				
(no. cases)	Wedge resection (10)	Wedge resection (7)				
	Pneumonectomy (3) Bilobectomy (2)	Pneumonectomy (5 Bilobectomy (2)				
Duration of	Esophagectomy (2) 272 (69)	Esophagectomy (3) 261 (77)				

Data are mean (SD or range) unless otherwise specified.

Group K indicates group with preemptive epidural ketamine; Group KF, group without preemptive epidural ketamine.

 TABLE 2. Visual Analog Scale Pain Scores at 2 Weeks and 3

 Months and Number of Patients Having Allodynia With Light

 Touch and Numbness 3 Months After Thoracotomy

	Group K (n = 65)	Group KF (n = 68)	P
Pain at rest at 3 mo [n/N (%)]	33/65 (51%)	29/68 (43%)	0.348
Pain with movement (coughing) at 3 mo [n/N (%)]	44/65 (68%)	50/68 (74%)	0.46
Allodynia with light touch at 3 mo [n/N (%)]	9/65 (14%)	4/68 (6%)	0.122
Numbness at 3 mo [n/N (%)]	21/65 (32%)	27/68 (40%)	0.182
VAS at rest at 2 wk	25 (0-75)	25 (0-75)	0.727
VAS at rest at 3 mo	0 (0-90)	0 (0-75)	0.644
VAS with movement (coughing) at 2 wk	50 (0-100)	50 (0-100)	0.539
VAS with movement (coughing) at 3 mo	25 (0-90)	25 (0-75)	0.373

Data are proportions or median (range).

Group K indicates group with preemptive epidural ketamine; Group KF, group without preemptive epidural ketamine; VAS, visual analog scale.

# Thoracic epidural analgesia

- Failure rate: 15%
- Complication
  - Hypotension
  - Respiratory depression
  - Epidural hematoma
  - Epidural abscess
  - Urinary retention
- Contraindication: coagulopathy including anticoagulation

# Thoracic Paravertebral block



## Thoracic Paravertebral block

- Failure rate: lower than TEA
- Provide comparable pain relief
- Less systemic side effects
  - Hypotension, urinary retention, nausea, vomiting

### A Comparison of the Analgesia Efficacy and Side Effects of Paravertebral Compared with Epidural Blockade for Thoracotomy: An Updated Meta-Analysis

Xibing Ding<sup>1,2</sup><sup>9</sup>, Shuqing Jin<sup>1,2</sup><sup>9</sup>, Xiaoyin Niu<sup>2</sup>, Hao Ren<sup>2</sup>, Shukun Fu<sup>1</sup>, Quan Li<sup>1,2</sup>\*

А									В										
	PVB			EPI			Mean Difference	Mean Difference			PVB		1	EPI			Mean Difference		Mean Difference
Study or Subgroup	Mean SD	Total	Mean	SD	Total	Weight	IV, Random, 95% CI	IV. Random, 95% CI	Study or Subgroup	Mean	SD	Total	Mean	SD	Total	Weight	IV. Random. 95% CI		IV. Random, 95% Cl
A Casati et al 2006	3 2	21	2.7	1.8	21	9.5%	0.30 [-0.85, 1.45]		A Casati et al 2006	3.5	2.5	21	3.4	2.3	21	4.7%	0.10 [-1.35, 1.55]		
Bimston et al 1999	26 12	30	1.2	1.2	20	13.4%	1.40 (0.72, 2.08)		Bimston et al 1999	3.3	1.9	30	1.3	1.9	20	7.0%	2.00 [0.92, 3.08]		
De Cosmo et al. 2002	37 08	25	22	2.1	25	11.6%	1 50 (0 62 2 38)		De Cosmo et al 2002	3.6	1	25	3.7	2.5	25	7.2%	-0.10 [-1.16, 0.96]		
Dhole et al 2001	45 2.19	20	42	4.5	20	4.4%	0.30 [-1.89, 2.49]		Jay S et al 2012	3.6	0.6	25	3.4	0.3	25	16.2%	0.20 [-0.06, 0.46]		-
lay S et al 2012	33 04	25	34	0.4	25	18 5%	-0 10 1-0 32 0 121	*	Kaiser et al 1998	4	5.28	13	4.25	4.73	13	0.9%	-0.25 [-4.10, 3.60]	-	
Motthows at al 1989	13 11	10	13	1.2	0	10.4%	0.00 [-1.04 1.04]		Leaver et al.2006	4.07	1.82	14	4.13	2.45	15	4.2%	-0.06 [-1.62, 1.50]		
Mehte et al 2008	2 04 1 76	17	1.53	1 43	10	10.2%	0.51 L0 55 1 57		Luketich et al 2005	2.6	1.5	47	2.4	1.5	44	11.8%	0.20 [-0.42, 0.82]		
Meesing at al 2000	3 27	12	1.00	2.5	12	4 8%	1.00 [-1.08, 3.08]		Matthews et al 1989	0.6	0.6	7	1.2	0.8	9	10.9%	-0.60 [-1.29, 0.09]		
Resturge at al 2009	71 10	12	82	2.5	12	7 79/	1.00 [-1.00, 3.00]		Mehta et al. 2008	1 33	1.37	17	0.79	1.18	19	9.2%	0.54 [-0.30, 1.38]		
Pertunen et al 1995	1.1 1.9	10	0.2	4.75	10	2.00/	-1.10 [-2.55, 0.55]		Messina et al 2009	1	14	12	1	21	12	4.8%	0.00 [-1.43, 1.43]		
Totione et al 2011	1.03 /	40	2.20	4./0	49	3.0%	-0.02 [-3.04, 1.00]		Pertunen et al 1995	7	1.6	15	6.8	2	15	5.5%	0.20 [-1.10, 1.50]		
raijana et al 2011	1.0 1.0	10	2.1	2.3	10	1.170	-0.30 [-1.75, 1.15]		Richardson et al 1999	15	15	46	2 38	206	40	10.5%	-0.88 (-1.60 -0.16)		
Tatal (DEM CO		007			024	100 00/	0.961.040.0501	-	Tatiana et al. 2011	0.8	13	16	13	17	16	7 2%	0.50[-1.00, -0.10]		
10tai (95% CI)		231			231	100.0%	0.30 [-0.16, 0.69]		Tagana et al 2011	0.0	1.0	10	1.5	1.1	10	1.2.70	-0.00 [-1.00, 0.00]		
Heterogeneity: Tau* = 0	.44; Chi* = 31.	/1, df =	10 (P =	0.0004	4); 1* =	68%		-2 -1 0 1 2	Total (95% CD			288			283	100.0%	0.06 (-0.31 0.42)		•
Test for overall effect: Z	= 1.30 (P = 0.	19)						PVB EPI	Heteresesity Tev? = 5	100- Chi	1 - 00	200	10 (D -	0.040	203	100.070	0.00 [-0.51, 0.42]	_	
									Heterogeneity: Tau- = L	1.20; Chi	(D = 0.)	su, di =	12 (P =	0.010	); I* = 34	+ 70		-4	-2 0 2 4
									Test for overall effect, 2	0.30 (	(P = 0.	0							PVB EPI
C									D										
0									D										
	PVB			FPI			Mean Difference	Mean Difference			PVB		1	PI			Mean Difference		Mean Difference
Study or Subaroup	Mean SD	Total	Mean	sn	Total	Weight	IV Fixed 95% CI	IV Fixed 95% Cl	Study or Subgroup	Mean	SD	Total I	Aean	SD	Total	Weight	IV. Fixed, 95% Cl		IV. Fixed, 95% Cl
A Constituted 2006	25 17	24	2	2.6	24	2 20%	0 50 / 1 70 0 701		Kaiser et al 1998	15.3	24	13	21	34.9	13	2 1%	-5 70 [-28 72 17 32]		
Rimeton et al 1000	12 13	30	1.9	1 2	20	6 7%	0.60[.1.34_0.14]		Kunihisa et al 2011	9.4	8.2	20	8	5.8	20	56.3%	1.40 [-3.00, 5.80]		-
De Coorre et al 2002	1.2 1.3	00	1.0	1.0	20	0.770	0.00[1.04, 0.14]		Leaver et al 2006	43.6	18.2	14	322 4	7.55	15	1.6%	11 40 1-14 48 37 281		
De Cosmo et al 2002	3.4 1	25	3	1.4	25	0.0%	0.40[-0.27, 1.07]		Medha et al 2009	11.2	95	15	92	5.1	15	36.6%	2.00 (-3.46, 7.46)		+
Jay S et al 2012	2.8 0.3	20	2.9	0.0	25	02.4%	-0.10[-0.36, 0.16]		Perttunen et al 1995	68.2	26.2	15	80.5	31.4	15	2.5%	-12 30 [-33 00 8 40]		
Kalser et al 1998	3./5 4.45	13	5.63	4.45	13	0.3%	-1.88 [-5.30, 1.54]		Richardson et al 1999	85.5	103.8	46	105.8	72.9	49	0.8%	-20 30 [-56 58, 15 98]	_	
Leaver et al.2006	4 1.95	14	4,10	2.08	15	1.770	-0.16[-1.63, 1.31]	-											
Luketich et al 2005	2.4 1.6	4/	2.3	1.2	44	10.8%	0.10[-0.48, 0.68]		Total (95% CI)			123			127	100.0%	1.11 [-2.20, 4.41]		•
Menta et al 2008	1 1.04	17	1.53	1.20	19	0.4%	-0.53 [-1.28, 0.22]		Heterogeneity: Chi <sup>2</sup> = 4.0	01. df = 5	5 (P = 0	.55): 1 <sup>2</sup> =	0%				0: S. S.	+	+ + + +
Messina et al 2009	2 3.2	12	2	2	12	0.8%	0.00 [-2.14, 2.14]		Test for overall effect: Z	= 0.66 (P	= 0.51	)						-50	-25 0 25 50
Perttunen et al 1995	5.8 1.75	15	5.4	1.95	15	2.1%	0.40 [-0.93, 1.73]					π							PVB EPI
Richardson et al 1999	1 2.3	46	1,25	1.25	49	6.4%	-0.25 [-1.00, 0.50]												
Tatjana et al 2011	0.9 1.7	16	1.6	1,9	16	2.3%	-0.70 [-1.95, 0.55]												
Total (95% CI)		281			274	100.0%	-0.13 [-0.32, 0.06]	•											
Heterogeneity: Chi2 = 8.	53. df = 11 (P	= 0.67	$1^2 = 0.9$	6			_												
Test for overall effect: Z	:= 1.31 (P = 0	.19)						-4 -2 0 2 4 PVB EPI											

Figure 2. Meta-analyses of postoperative analgesic efficacy of PVB compared with that of EPI A) VAS scores 4–8 h; B) VAS scores 24 h; C) VAS scores 48 h; D) morphine consumption 24 h.

А

	PVE	3	EPI	i.		Odds Ratio		Odds		
Study or Subgroup	Events Total		Events Total		Weight M-H, Fixed, 95%		i	M-H. Fixed	à	
Bimston et al 1999	0	30	6	20	23.2%	0.04 [0.00, 0.69]	-			
Gultekin et al 2009	0	25	4	19	15.2%	0.07 [0.00, 1.34]		-		
Kunihisa et al 2011	0	20	1	20	4.5%	0.32 [0.01, 8.26]	1.1			
Leaver et al.2006	10	14	13	15	10.9%	0.38 [0.06, 2.54]				
Matthews et al 1989	1	10	6	9	17.3%	0.06 [0.00, 0.67]				
Richardson et al 1999	5	46	11	49	28.9%	0.42 [0.13, 1.32]		-		
Total (95% CI)		145		132	100.0%	0.21 [0.10, 0.44]		•		
Total events	16		41							
Heterogeneity: Chi <sup>2</sup> = 4.	91, df = 5	(P = 0.	43); 12 = (	0%			0.000		10	600
Test for overall effect: Z	= 4.05 (P	< 0.00	01)				0.002	PVB	EPI	500

	PVB	£	EPI			Odds Ratio	Odds Ratio
Study or Subgroup	Events	Total	Events	Total	Weight	M-H. Fixed. 95% C	CI M-H, Fixed, 95% CI
Bimston et al 1999	7	30	7	20	18.3%	0.57 [0.16, 1.97]	· ···
De Cosmo et al 2002	0	25	2	25	7.0%	0.18 [0.01, 4.04]	
Gultekin et al 2009	0	25	5	19	17.4%	0.05 [0.00, 1.00]	·
Kunihisa et al 2011	12	20	11	20	12.5%	1.23 [0.35, 4.31]	· · · · ·
Leaver et al.2006	5	14	4	15	7.1%	1.53 [0.31, 7.44]	
Perttunen et al 1995	3	15	5	15	11.4%	0.50 [0.10, 2.63]	· · · · ·
Richardson et al 1999	2	46	10	49	26.4%	0.18 [0.04, 0.86]	
Total (95% CI)		175		163	100.0%	0.49 [0.28, 0.87]	•
Total events	29		44				NW X 10 10 10
Heterogeneity: Chi <sup>2</sup> = 8.	27, df = 6	(P = 0.)	22); 12 = 2	7%			
Test for overall effect: Z = 2.46 (P = 0.01)							PVB EPI

С

	PVE	1	EPI			Odds Ratio	00	ids Ratio
Study or Subgroup	Events	Total	Events	Total	Weight	M-H. Fixed. 95% C	I <u>M-H.</u> I	Fixed. 95% CI
A Casati et al 2006	0	21	4	21	9.2%	0.09 [0.00, 1.80]		-
Bimston et al 1999	1	30	1	20	2.4%	0.66 [0.04, 11.12]		-
De Cosmo et al 2002	0	25	3	25	7.2%	0.13 [0.01, 2.58]		
Dhole et al 2001	0	20	1	20	3.1%	0.32 [0.01, 8.26]	-	
Ghassan et al 2012	0	21	5	21	11.2%	0.07 [0.00, 1.35]		-
Gultekin et al 2009	0	25	2	19	5.8%	0.14 [0.01, 3.04]		-
Jay S et al 2012	0	25	3	25	7.2%	0.13 [0.01, 2.58]		
Leaver et al.2006	2	14	8	15	13.8%	0.15 [0.02, 0.89]		_
Matthews et al 1989	0	10	6	9	13.6%	0.03 [0.00, 0.58]		-
Medha et al 2009	1	15	6	15	11.7%	0.11 [0.01, 1.04]		
Richardson et al 1999	0	46	7	49	15.0%	0.06 [0.00, 1.10]		-
Total (95% CI)		252		239	100.0%	0.11 [0.05, 0.25]	+	
Total events	4		46					
Heterogeneity: Chi <sup>2</sup> = 3	.14, df = 1	0 (P = 0)	0.98); l <sup>2</sup> =	0%				1 10 10
Test for overall effect: Z	: = 5.37 (P	< 0.00	001)				0.001 0.1 P	1 10 100 VB EPI

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	PVE		EPI			Odds Ratio		0	dds Rat	io	
Study or Subgroup	Events	Total	Events	Total	Weight	M-H. Fixed, 95% C	1	M-H. I	Fixed, 9	5% CI	
Bimston et al 1999	4	30	3	20	17.1%	0.87 [0.17, 4.39]			-	-	
Jay S et al 2012	2	25	2	25	10.1%	1.00 [0.13, 7.72]			+	_	
Kaiser et al 1998	0	13	2	13	13.2%	0.17 [0.01, 3.92]			-	-	
Leaver et al.2006	2	14	3	15	13.6%	0.67 [0.09, 4.73]		-			
Medha et al 2009	2	15	1	15	4.7%	2.15 [0.17, 26.67]		_	-		
Richardson et al 1999	1	46	8	49	41.4%	0.11 [0.01, 0.95]					
Total (95% CI)		143		137	100.0%	0.51 [0.23, 1.11]			•		
Total events	11		19								
Heterogeneity: Chi* = 4.	.55, df = 5	(P = 0.	47); 12 = (	1%			1005	1	+	10	
Test for overall effect: Z = 1.69 (P = 0.09)						0.005	0.1 P	VB EP	10	200	

Figure 3. Meta-analyses of adverse side effect of PVB with that of EPI A) Urinary retention; B) nausea and vomiting; C) hypotension; D) rates of failed technique; E) pulmonary complications.

	PVE	5	EPI			Odds Ratio		Odds	Ratio	
Study or Subgroup	Events	Total	Events	Total	Weight	M-H, Fixed, 95% C	Ľ	M-H. Fixe	d. 95% CI	
A Casati et al 2006	5	21	4	21	7.3%	1.33 [0.30, 5.84]		-	_	
Dhole et al 2001	0	20	1	20	3.5%	0.32 [0.01, 8.26]	1			
Ghassan et al 2012	7	21	0	21	0.8%	22.24 [1.18, 420.36]				
Gultekin et al 2009	0	25	6	19	17.3%	0.04 [0.00, 0.78]	G <del></del>	• • •		
Jay S et al 2012	0	25	1	25	3.5%	0.32 [0.01, 8.25]	1		2.25	
Kaiser et al 1998	2	15	2	15	4.2%	1.00 [0.12, 8.21]				
Kunihisa et al 2011	0	20	1	20	3.5%	0.32 [0.01, 8.26]				
Leaver et al.2006	1	14	6	15	12.9%	0.12 [0.01, 1.13]	1	•		
Luketich et al 2005	4	47	9	44	20.4%	0.36 [0.10, 1.27]		-		
Medha et al 2009	0	15	3	15	8.1%	0.12 [0.01, 2.45]	-			
Perttunen et al 1995	0	17	2	19	5.5%	0.20 [0.01, 4.47]				
Richardson et al 1999	0	46	5	54	12.0%	0.10 [0.01, 1.80]				
Tatjana et al 2011	1	16	0	16	1.1%	3.19 [0.12, 84.43]		_	•	-
Total (95% CI)		302		304	100.0%	0.51 [0.30, 0.86]		•		
Total events	20		40			166 ES 1.05				
Heterogeneity: Chi <sup>2</sup> = 1	7.02, df =	12 (P =	0.15); P	= 29%			+		1	
Fest for overall effect: Z	= 2.55 (P	= 0.01	)				0.002	0.1 1 PVB	10 EPI	500

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## Intercostal nerve block





## Continuous local anesthetic agent infusion



#### **Original Article**

Efficacy of subpleural continuous infusion of local anesthetics after thoracoscopic pulmonary resection for primary lung cancer compared to intravenous patient-controlled analgesia





Table 2 Side effects and cause of early discontinuation								
Events	IV-PCA (n=36)	Р						
Side effects								
Nausea	6 (16.7%)	1 (3.4%)	0.116					
Dizziness	4 (11.1%)	1 (3.3%)	0.366					
Drowsiness	3 (8.3%)	1 (3.3%)	0.620					
Total	13 (36.1%)	3 (10.0%)	0.020					
Early discontinuation	12 (33.3%)	2 (6.7%)	0.014					
IV-PCA, intravenous patient-controlled analgesia.								

## Systemic analgesia



NSAID-nonsteroidal anti-inflammatory drug, PCA-patient-controlled analgesia.

## Guidelines for enhanced recovery after lung surgery: recommendations of the Enhanced Recovery After Surgery (ERAS<sup>®</sup>) Society and the European Society of Thoracic Surgeons (ESTS)

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Regional anaesthesia and pain relief			
Regional anaesthesia is recommended with the aim of reducing postoperative opioid use. Paravertebral blockade provides equivalent analgesia to epidural anaesthesia	High	Strong	
A combination of acetaminophen and NSAIDs should be administered regularly to all patients unless contraindications exist	High	Strong	
Ketamine should be considered for patients with pre-existing chronic pain	Moderate	Strong	
Dexamethasone may be administered to prevent PONV and reduce pain	Low	Strong	
Surgical technique: thoracotomy			
If a thoracotomy is required, a muscle-sparing technique should be performed	Moderate	Strong	
Intercostal muscle- and nerve-sparing techniques are recommended	Moderate	Strong	
Reapproximation of the ribs during thoracotomy closure should spare the inferior intercostal nerve	Moderate	Strong	
Surgical technique: minimally invasive surgery			
A VATS approach for lung resection is recommended for early-stage lung cancer	High	Strong	
Postoperative phase			
Chest drain management			
The routine application of external suction should be avoided	Low	Strong	
Digital drainage systems reduce variability in decision-making and should be used	Low	Strong	
Chest tubes should be removed even if the daily serous effusion is of high volume (up to 450 ml/ 24 h)	Moderate	Strong	
A single tube should be used instead of 2 after anatomical lung resection	Moderate	Strong	

# Thanks for attention