Pain control after Thoracic Surgery

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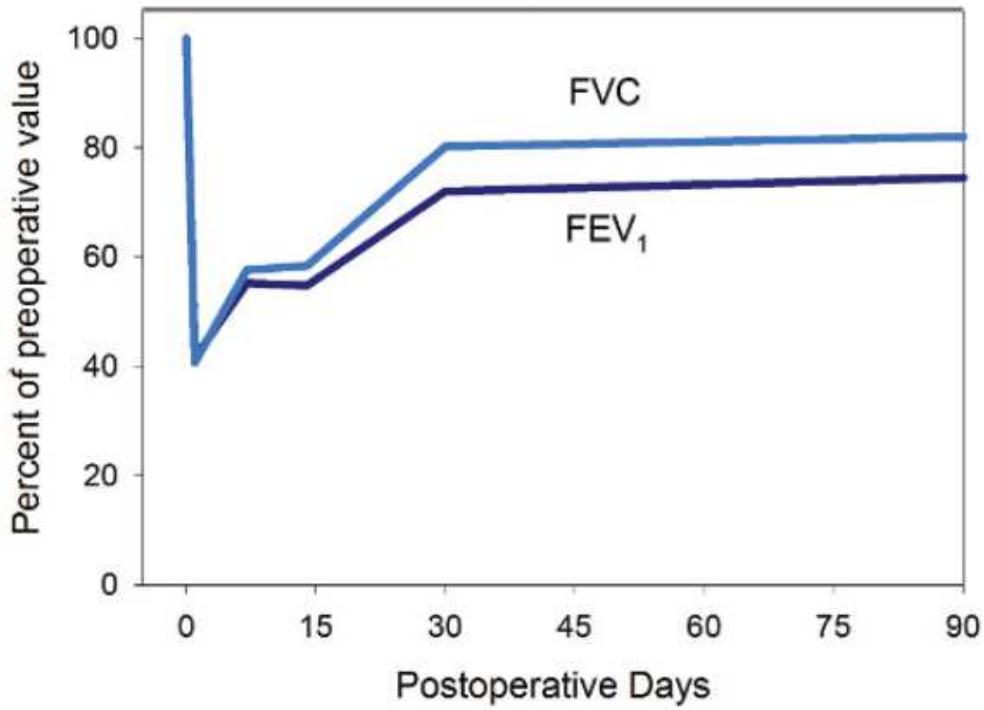
Pain after Thoracic Surgery

- 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.

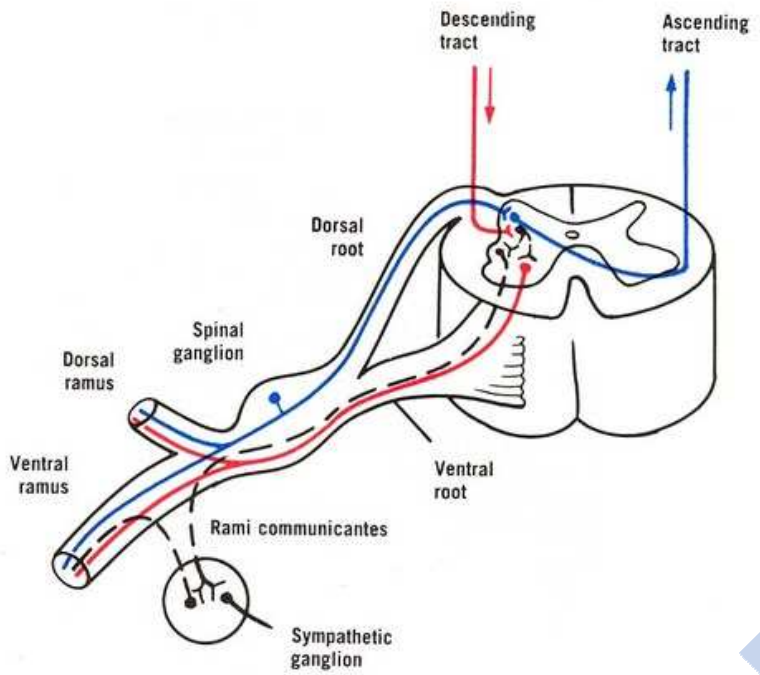
Post-thoracotomy pain & Pulmonary function

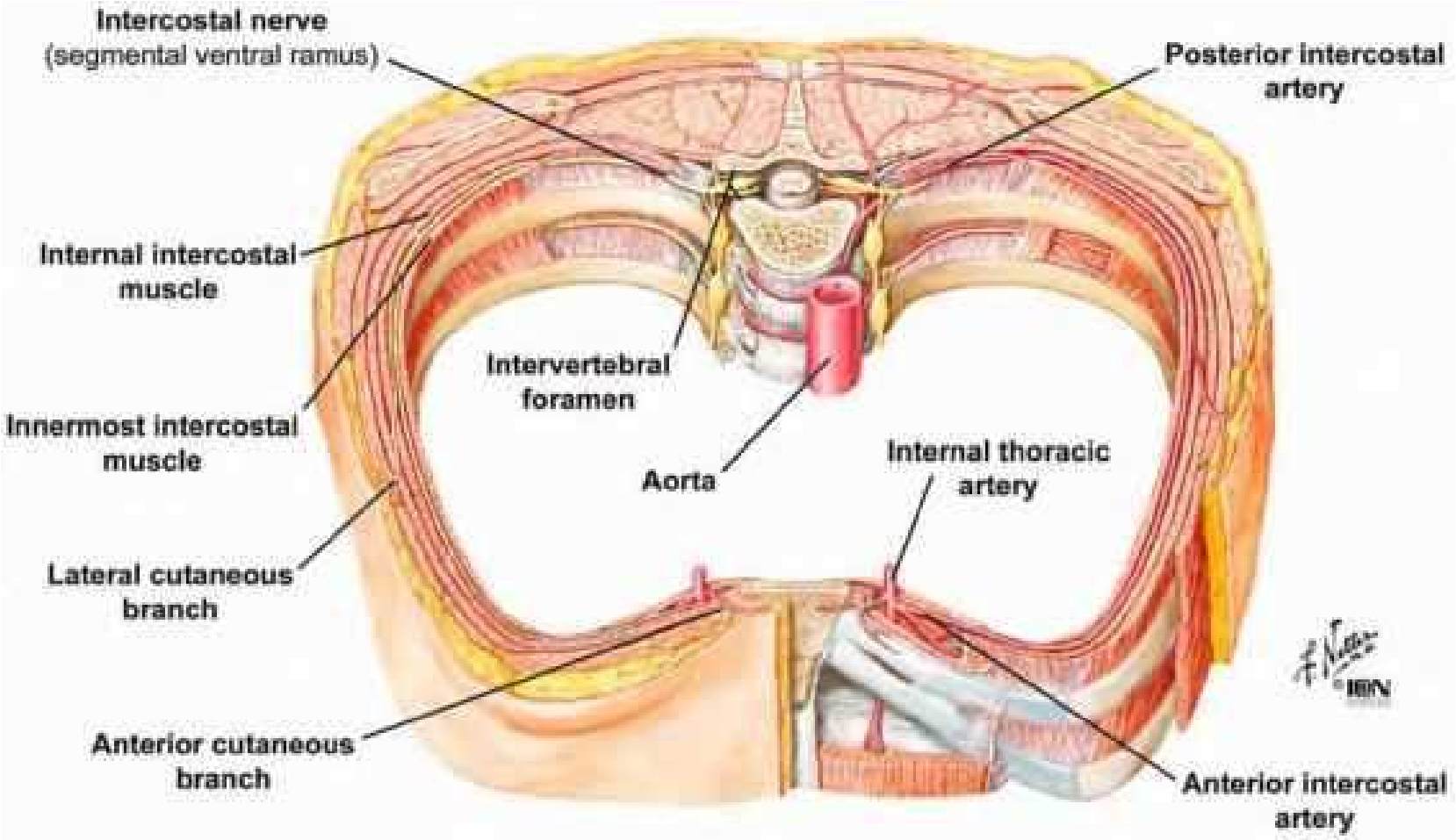
- Changes in pulmonary function
  - Reduced FVC, FRC
    - Reduced 10-15% in abdominal surgery
    - Reduced 35% in thoracotomy
  - Aggravate atelectasis, shunting, hypoxemia
  - Reduced inspiration, effective coughing, expectoration



Pathophysiology of thoracotomy pain

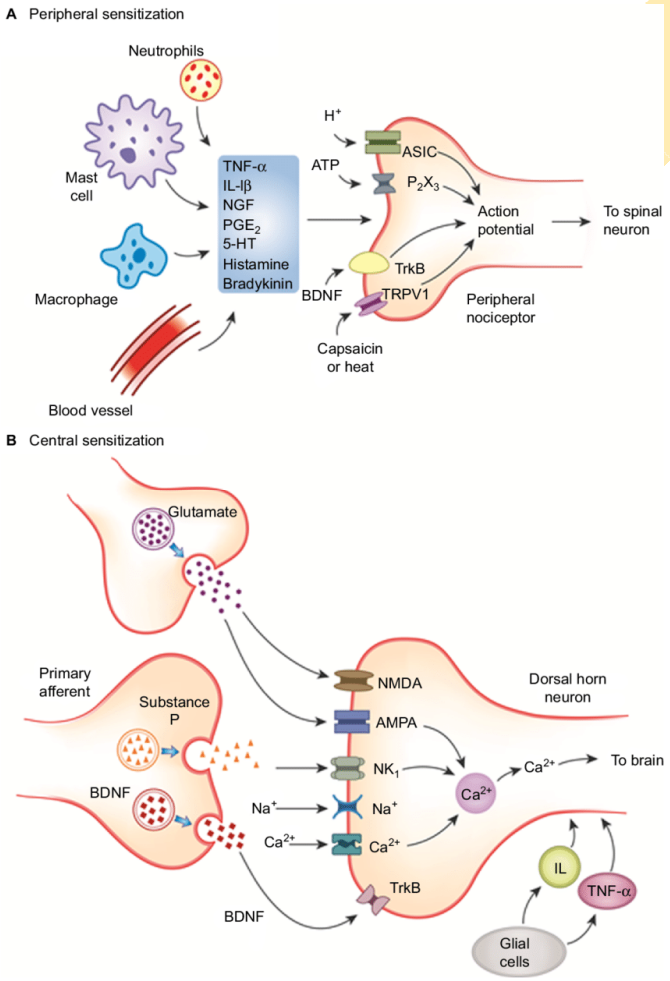
- Nociceptive somatic afferent
  - Main source of pain
  - Arise from intercostal nerve
    - Chest wall, pleura, skin incision, trocar insertion, muscle splitting, rib retraction, chest tube
  - Transmitted to ipsilateral dorsal horn of spinal cord




Intercostal nerve
(segmental ventral ramus)
Posterior intercostal artery
Internal intercostal muscle
Intervertebral foramen
Innermost intercostal muscle
Aorta
Internal thoracic artery
Lateral cutaneous branch
Anterior cutaneous branch
Anterior intercostal artery

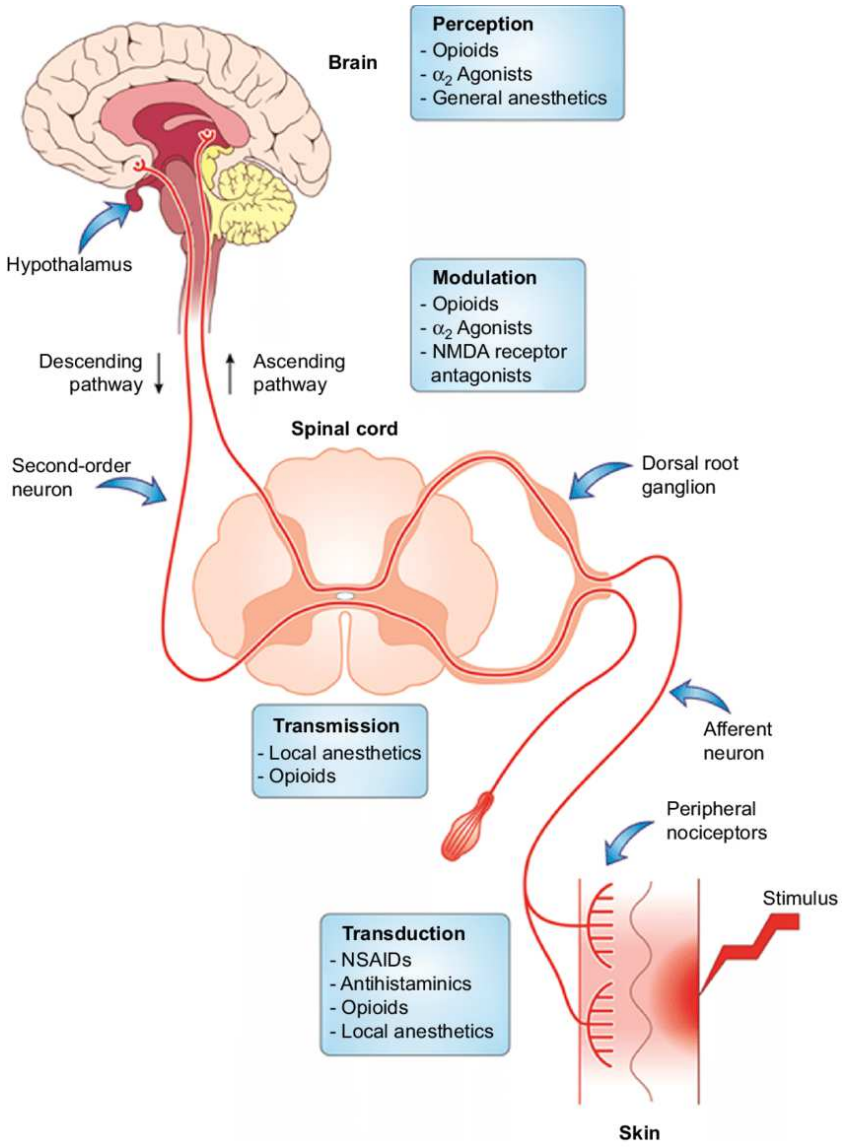
Pathophysiology of thoracotomy pain

- 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)



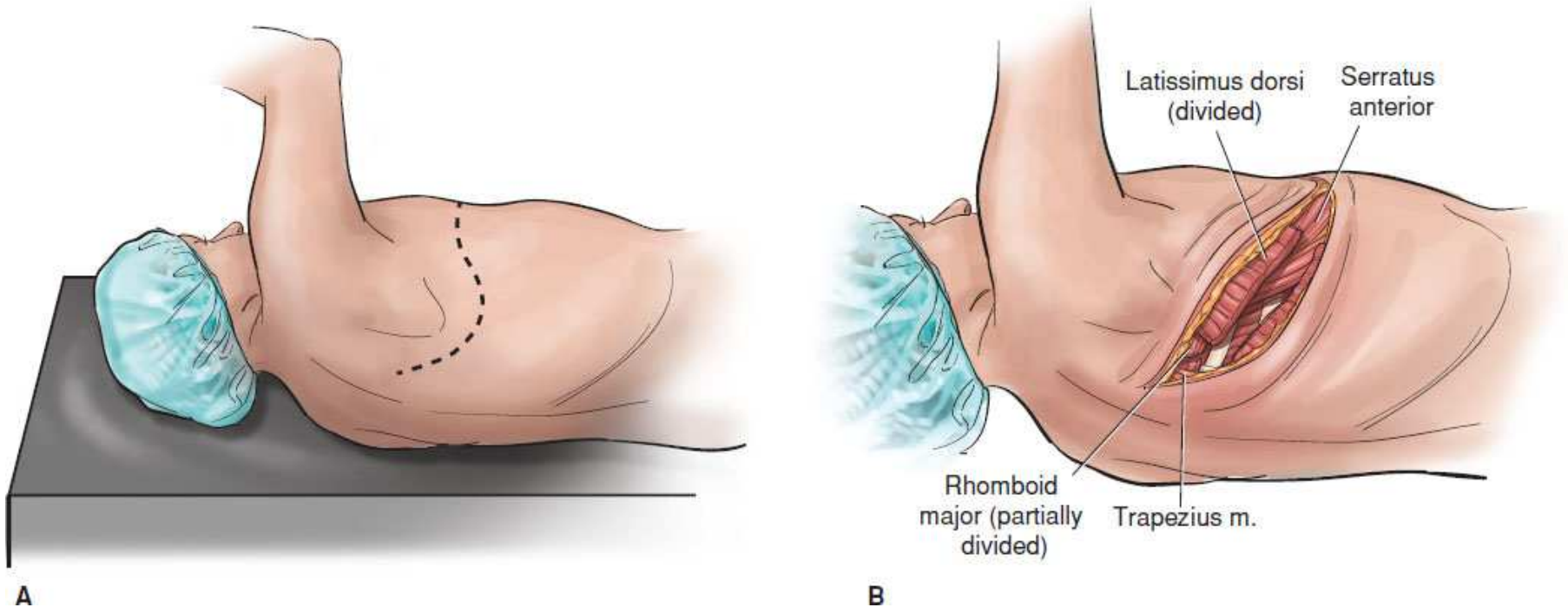
Pain control after thoracic surgery

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

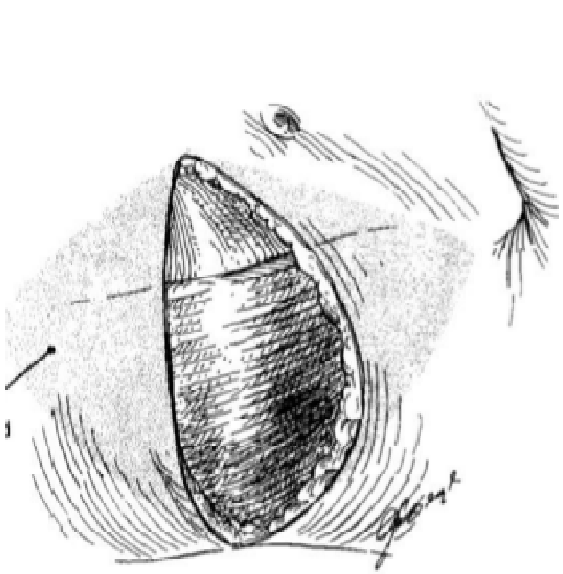


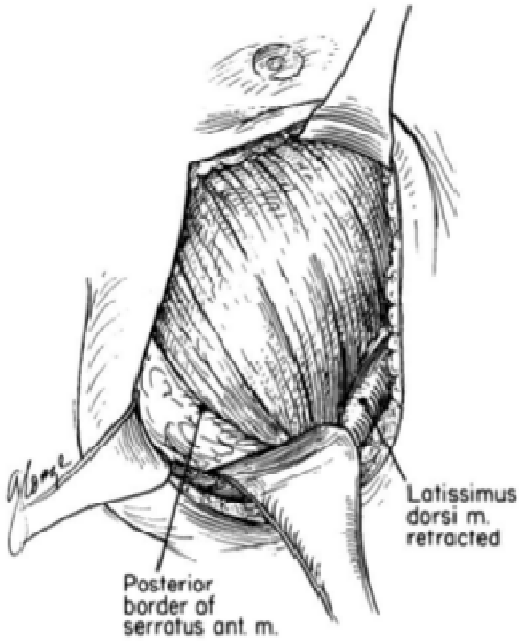
Surgical techniques

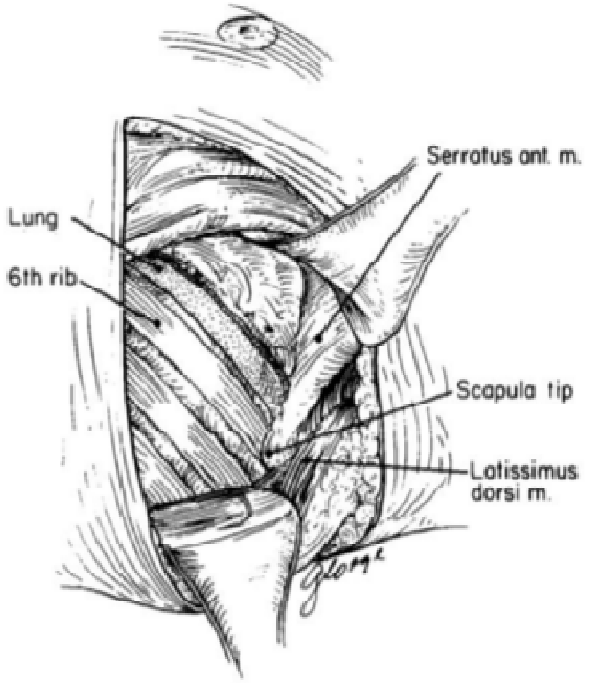
Posterolateral thoracotomy



Muscle sparing thoracotomy







A Meta-Analysis Comparing Muscle-Sparing and Posterolateral Thoracotomy

Mohammed M. Uzzaman, MRCS, MS, J. Daniel Robb, FRCS, MRCP,
Peter C. E. Mhandu, MRCS, MCChB, Habib Khan, MRCS, MBBS,
Kamran Baig, FRCS, MD, Sanjay Chaubey, MRCS, and Donald C. Whitaker, FRCS, MD

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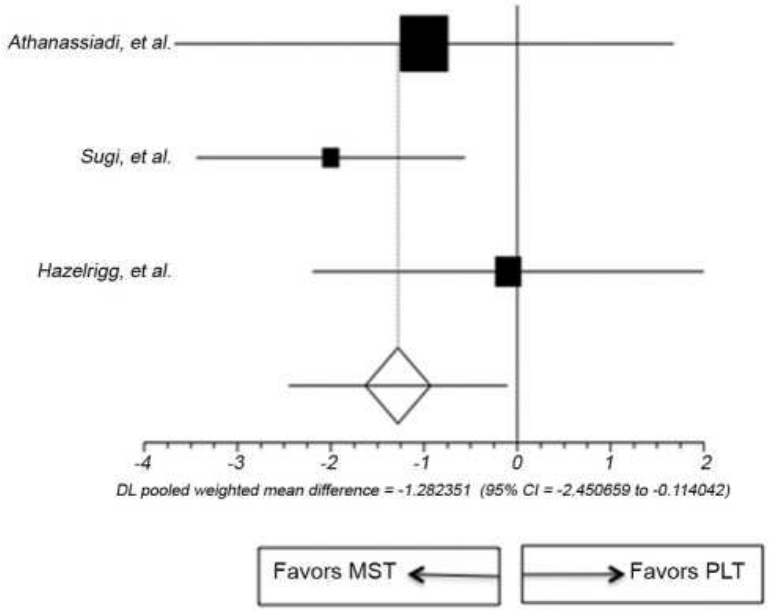


Fig 2. Forest plot for weighted mean difference for the effects on internal rotation between posterolateral thoracotomy (PLT) and muscle-sparing thoracotomy (MST) groups 30 days after the operation. The solid squares denote mean difference, the horizontal lines represent the 95% confidence intervals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

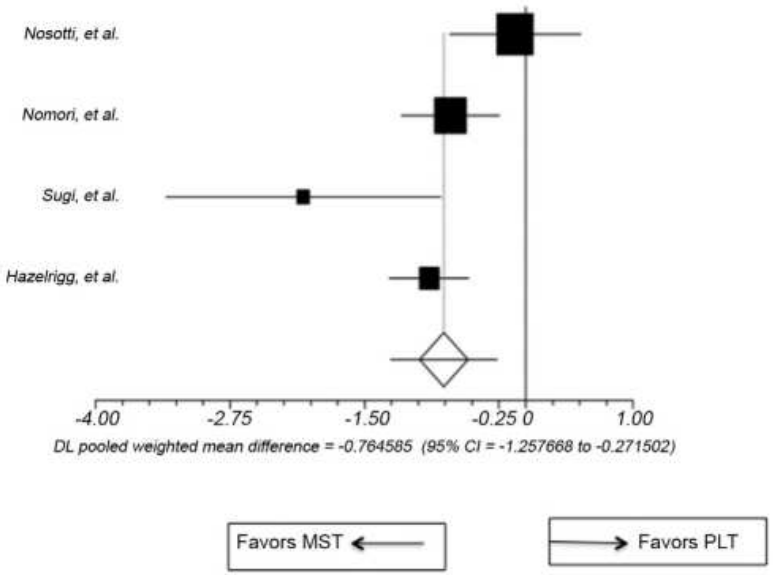
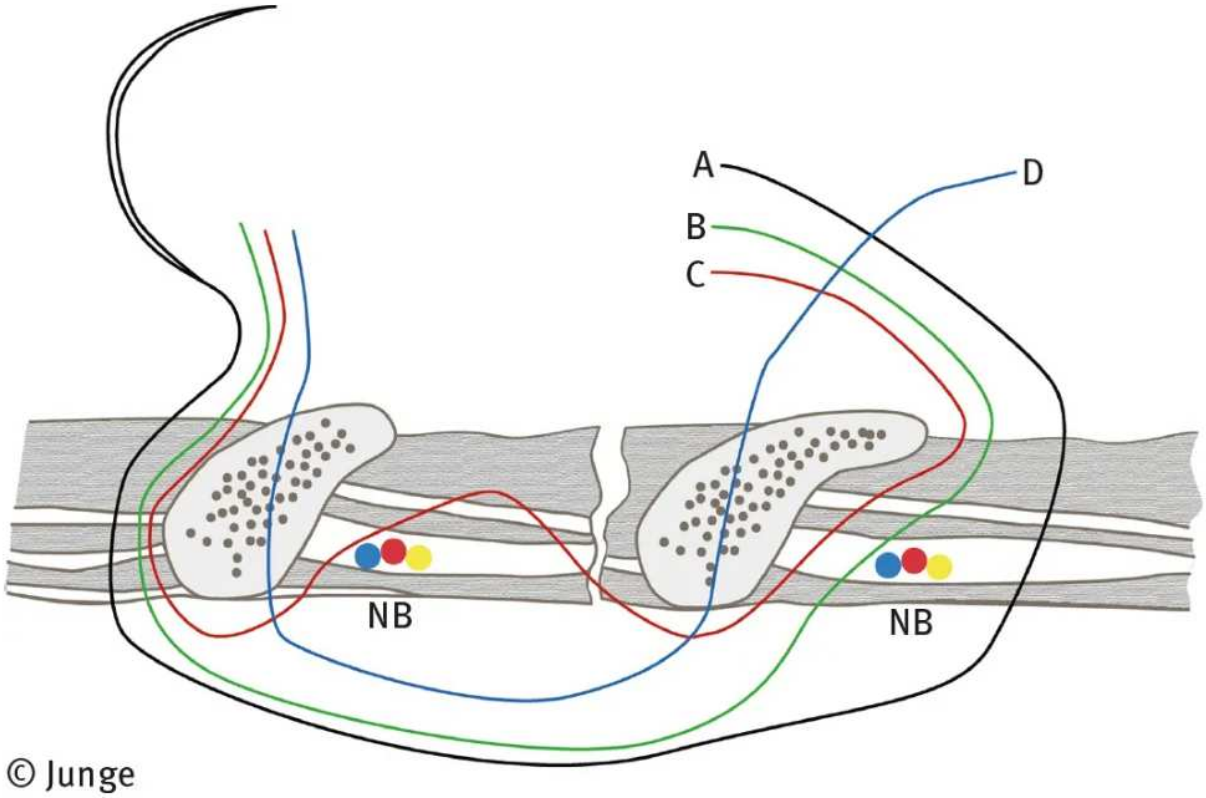
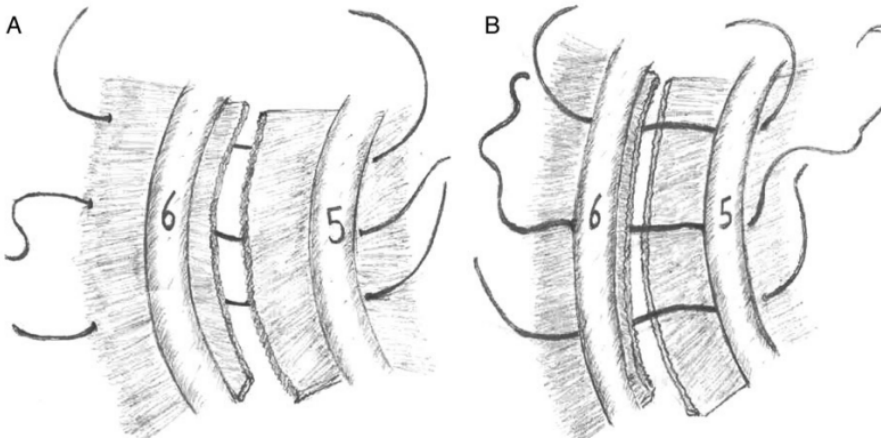


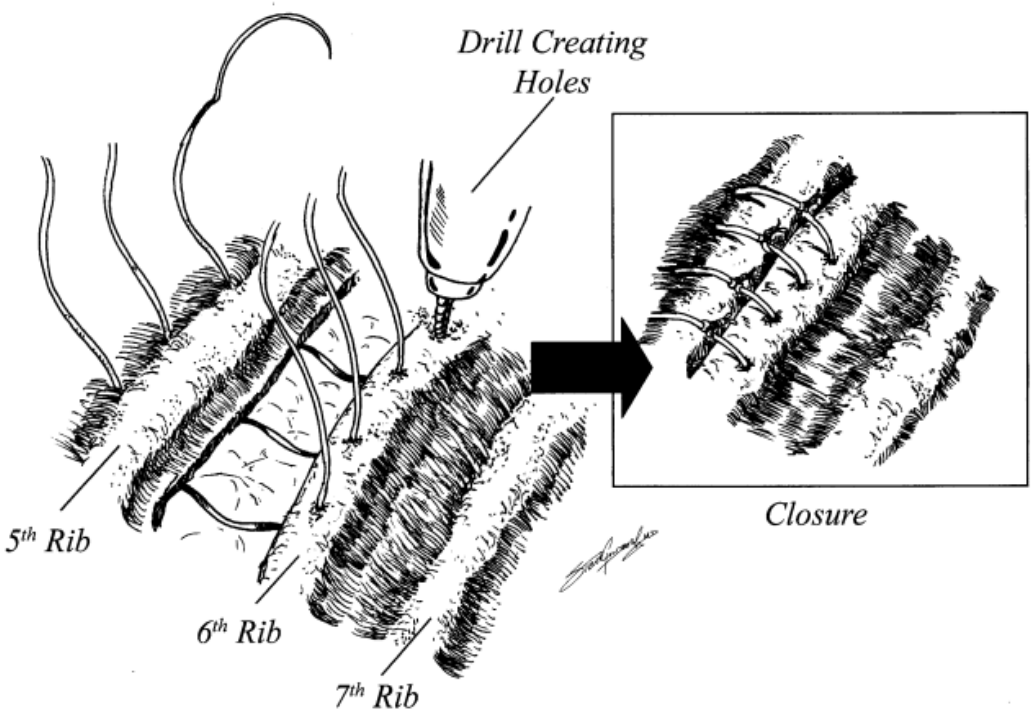
Fig 3. Forest plot for weighted mean difference postoperative pain scores between posterolateral thoracotomy (PLT) and muscle-sparing thoracotomy (MST) groups on postoperative day 7. The solid squares denote mean difference, the horizontal lines represent the 95% confidence intervals (CI), and the diamond 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 Group	Intracostal Group	*p* Value
2 weeks	5.5 ± 1.4	3.3 ± 1.9	0.004
1 month	3.8 ± 1.3	1.7 ± 1.4	0.001
2 months	2.3 ± 1.0	1.1 ± 0.9	< 0.001
3 months	1.6 ± 0.8	0.6 ± 0.7	< 0.001

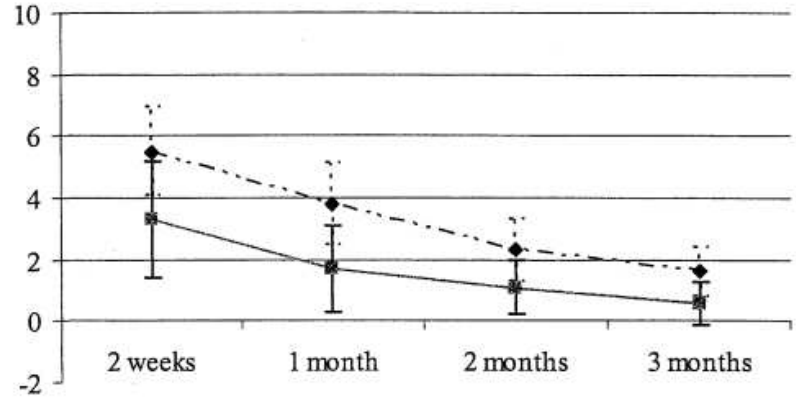
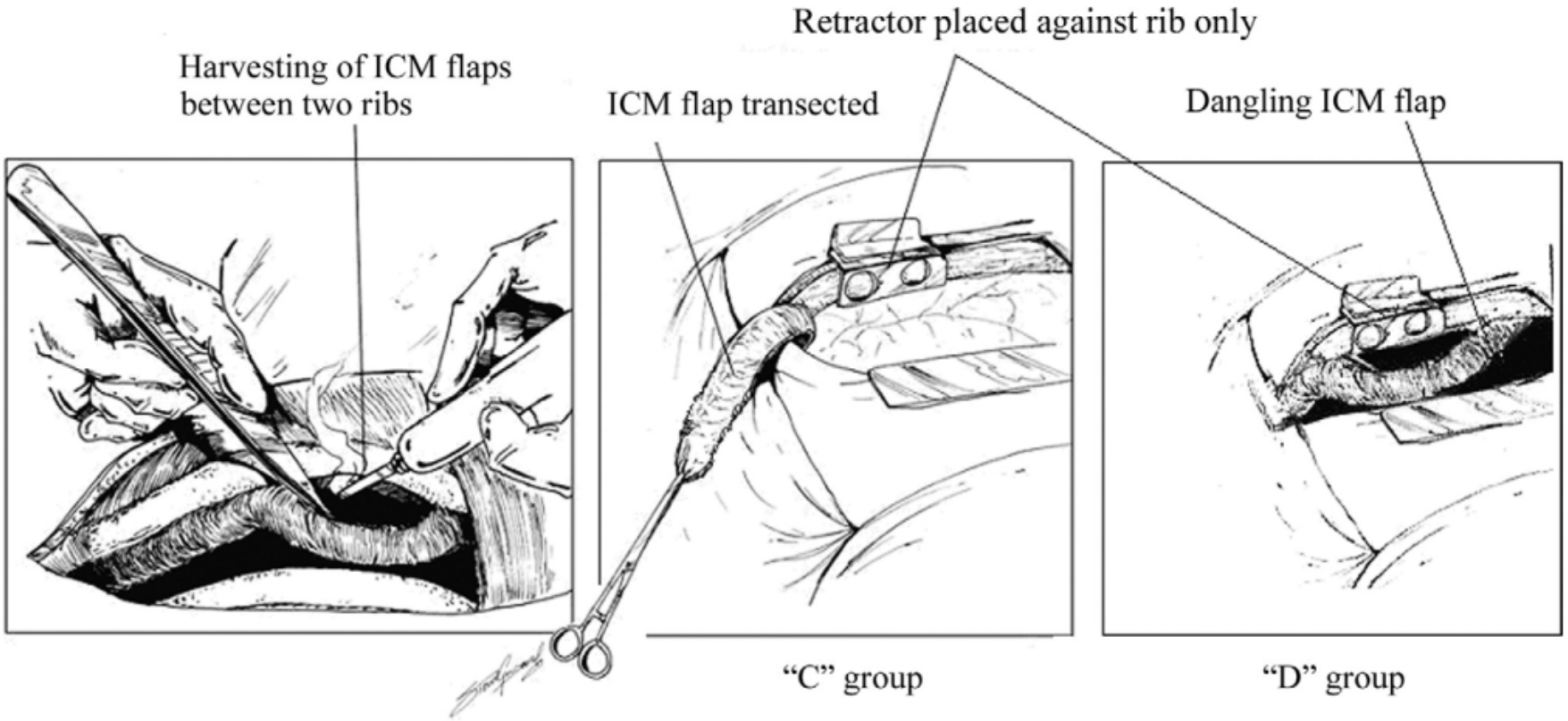


Fig 3. Mean pain scores with standard deviations. (◆ = P group; ▫ = I group.)

Intercostal flap



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

Amr Mohammad Allama, MD

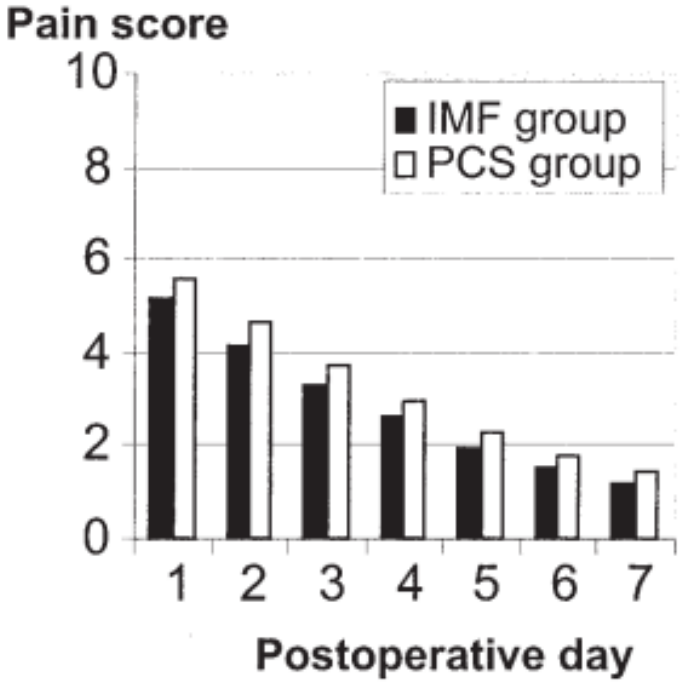
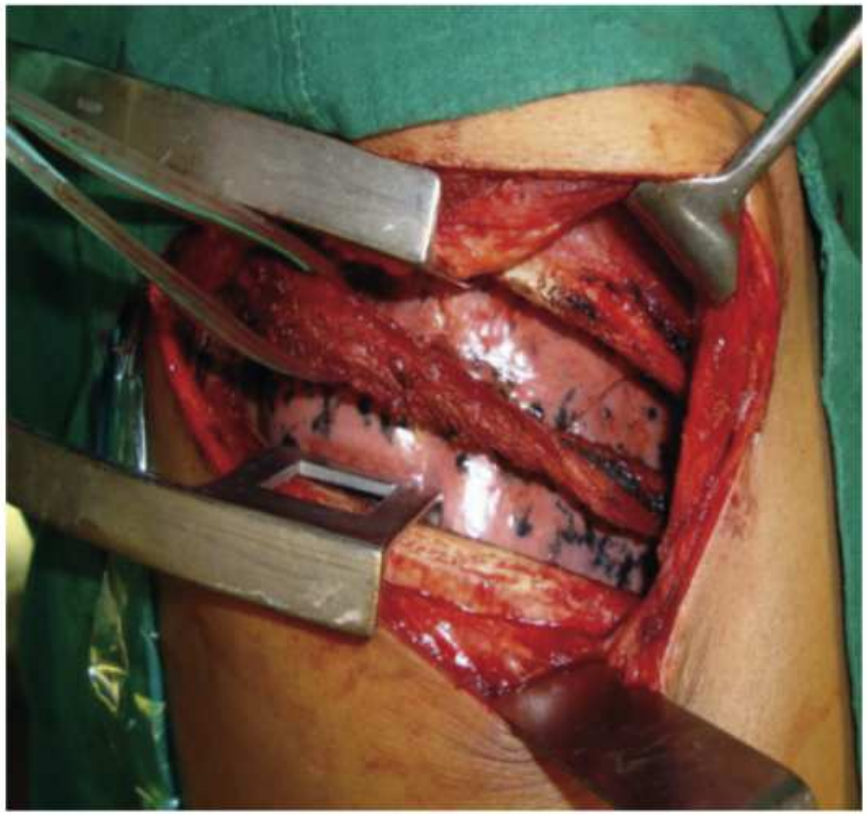


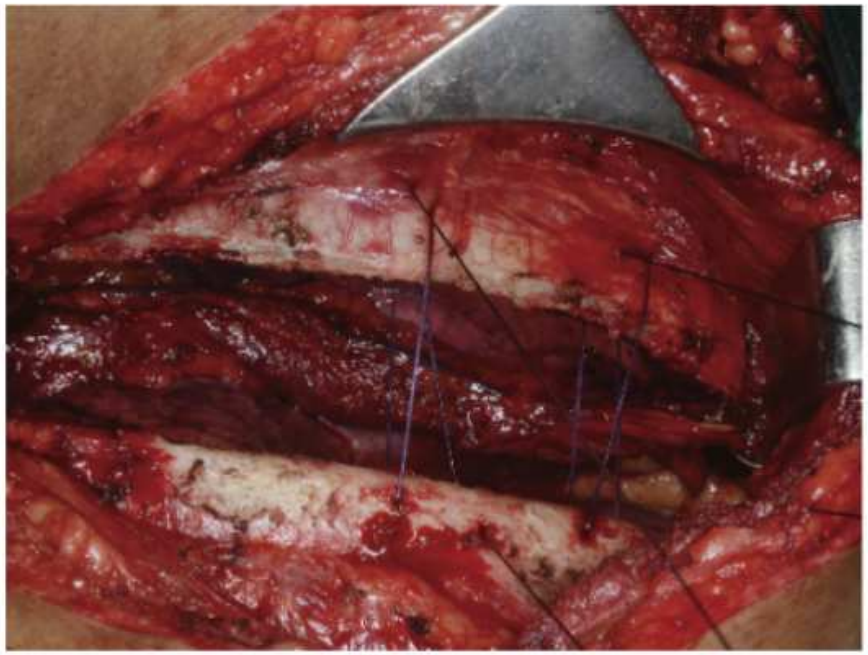
Table 2. Postoperative Data

Variable	IMF Group (n = 60)	PCS Group (n = 60)	*p* Value
Postoperative FEV_1 (% predicted)	63.28 ± 8.84	62.83 ± 10.2	0.797
Time to ambulation (hours)	15.31 ± 3	17.43 ± 4.61	0.003[a]
Pain score (0–10)			
Day 1	5.17 ± 0.99	5.6 ± 1.15	0.029[a]
Day 2	4.18 ± 0.96	4.62 ± 1.11	0.024[a]
Day 3	3.28 ± 0.96	3.72 ± 0.97	0.016[a]
Day 4	2.63 ± 0.86	3 ± 0.97	0.019[a]
Day 5	1.92 ± 0.81	2.27 ± 0.94	0.034[a]
Day 6	1.5 ± 0.62	1.78 ± 0.76	0.04[a]
Day 7	1.15 ± 0.48	1.4 ± 0.56	0.012[a]
Number of analgesic doses injected in the epidural catheter	3 ± 0.9	3.6 ± 1.1	0.002[a]
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)	480.8 ± 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[a]

[a] 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

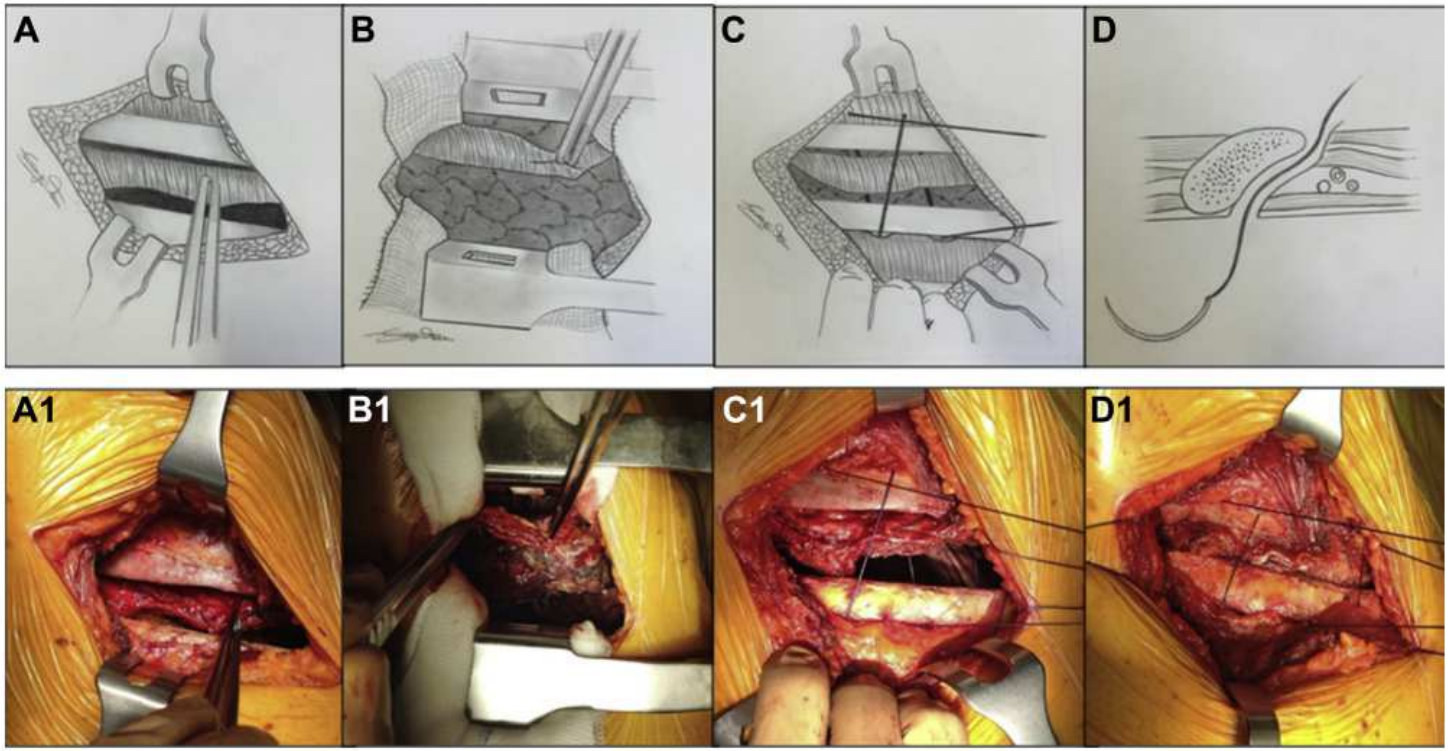
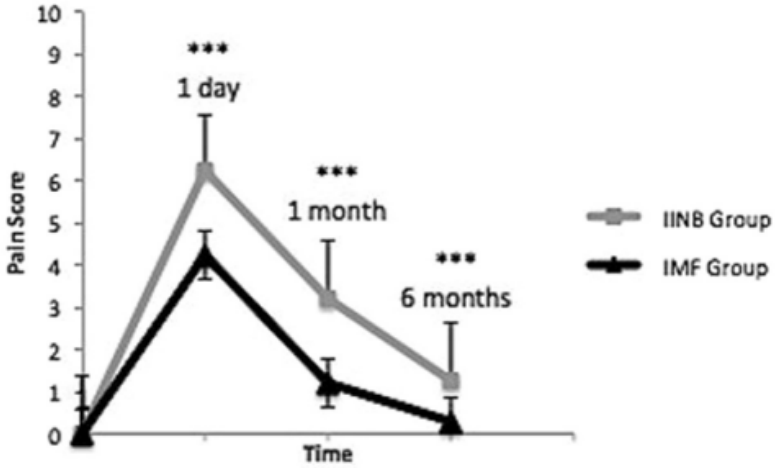


Figure 2. (*A* and *A1*) Intercostal muscle flap preparation. (*B* and *B1*) The use of gauze to cover the ribs while using the retractor. (*C* and *C1*) Closure of the intercostal space. (*D* and *D1*) Neurovascular bundle preservation.

Variable	IINB Group (n = 151)	IMF Group (n = 146)	*p* Value	95% CI of Difference
Mean operative time ± SD, min	73.7 ± 10.7	78.9 ± 17.0	0.0001	-10.000 to -3.800
Mean hospital stay ± SD, d	4.6 ± 1.3	3.6 ± 1.2	0.0001	0.714-1.260
Mean chest tube permanence ± SD, d	4.3 ± 1.1	3.4 ± 0.9	0.0001	0.622-1.058
Mean postoperative FEV_1 at 1 mo ± SD, % of predicted value	68.8 ± 17.4	83.1 ± 7.4	0.023	-0.331 to -0.027
Mean postoperative FEV_1 at 6 mo ± 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 ± SD, m	311.1 ± 51.0	371.2 ± 54.8	0.0001	-74.177 to -50.103
Postoperative 6MWT distance at 6 mo ± 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_1, 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

Itaru Nagahiro, MD, Akio Andou, MD, Motoi Aoe, MD, Yoshifumi Sano, MD, Hiroshi Date, MD, and Nobuyoshi Shimizu, MD

Department of Surgery II, Okayama University Medical School, Okayama, Japan

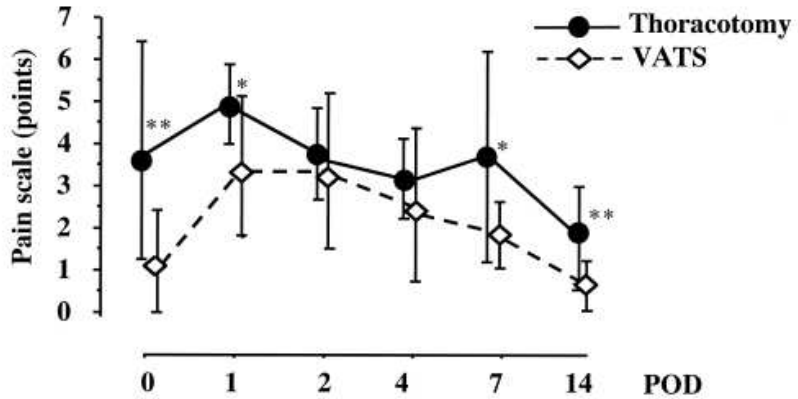


*Fig 1. Operative approach for lobectomy and postoperative pain measured by eleven-point pain scale. Data are shown as mean ± standard deviation of the mean. *p less than 0.05; **p less than 0.01. (POD = postoperative day; VATS = video-assisted thoracic surgery.)*

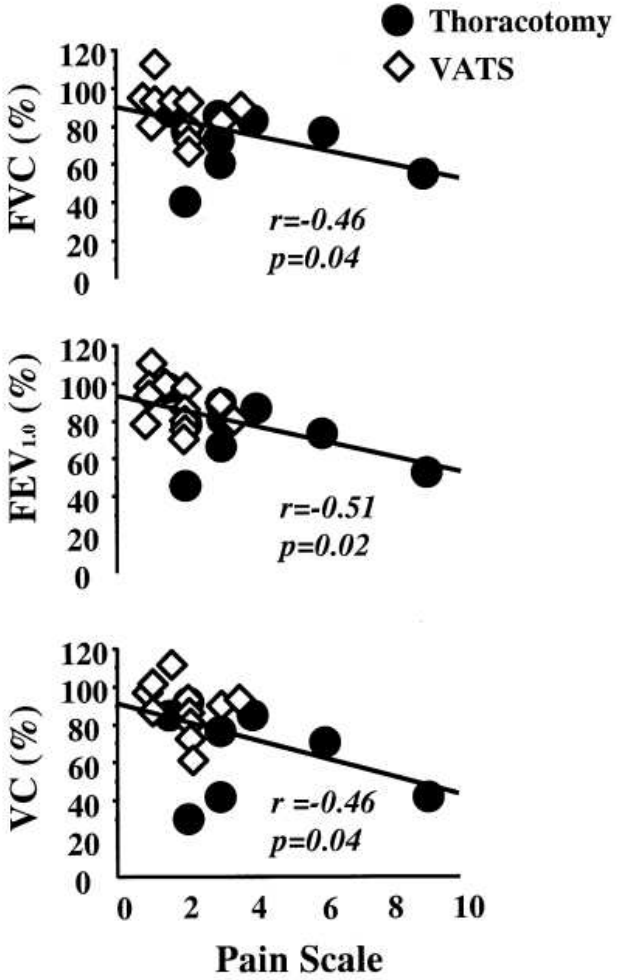


Fig 3. Correlation between postoperative pain and pulmonary function recovery rate. Pain was measured by an 11-point pain scale. ($FEV_{1.0}$ = forced expiratory volume in one second; FVC = forced vital capacity; VATS = video-assisted thoracic surgery; VC = vital capacity.)

Single-incision thoracoscopic surgery and conventional video-assisted thoracoscopic surgery: a retrospective comparative study of perioperative clinical outcomes†

Kyoji Hirai[a,*], Shingo Takeuchi[a] and Jitsuo Usuda[b]

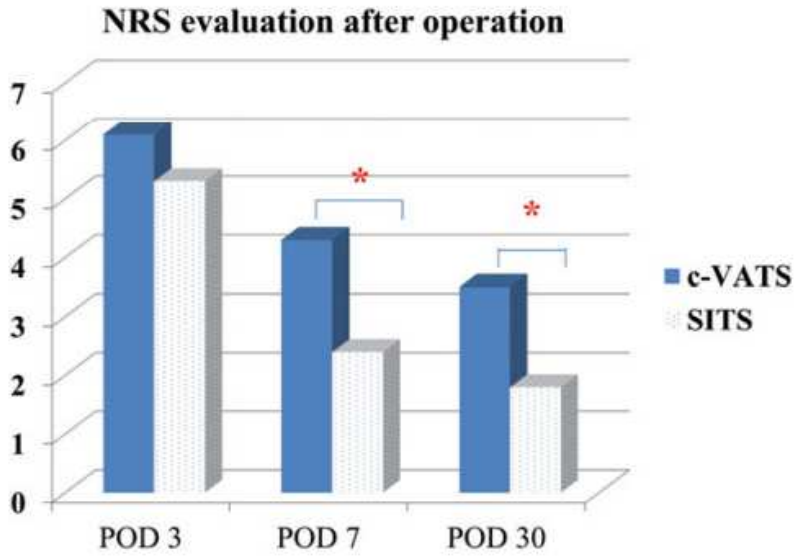


Figure 3: NRS evaluation after operation. The NRS was significantly lower in the SITS group than in the c-VATS group at 7 and 30 days after operation. *$P < 0.05$. NRS: Numeric Rating scale; c-VATS: conventional video-assisted thoracoscopic surgery; SITS: single-incision thoracoscopic surgery; POD: postoperative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

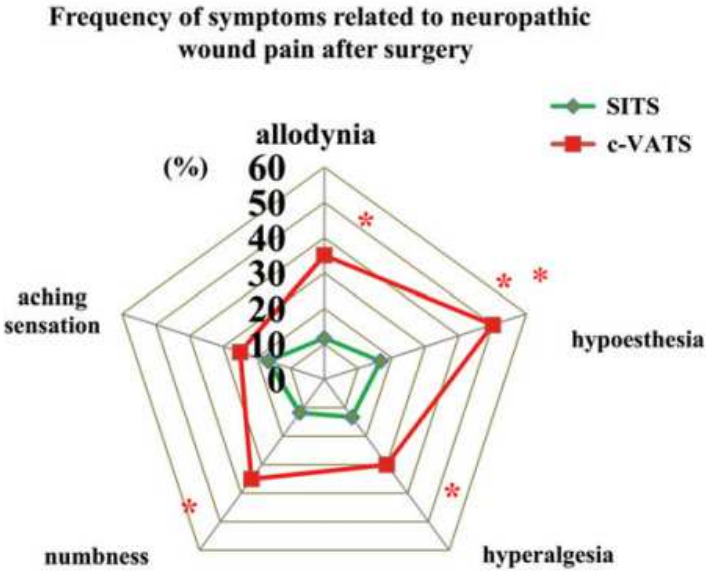


Figure 5: Frequency of symptoms related to neuropathic wound pain after surgery. Frequency of allodynia, hypaesthesia, hyperalgesia and numbness but not aching sensation was significantly lower in the SITS group than in the c-VATS group. *$P < 0.05$, **$P < 0.01$. c-VATS: conventional video-assisted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

The impact of chest tube removal on pain and pulmonary function after pulmonary resection†

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Department of Thoracic Surgery, United Hospitals of Ancona, Ancona, Italy

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

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

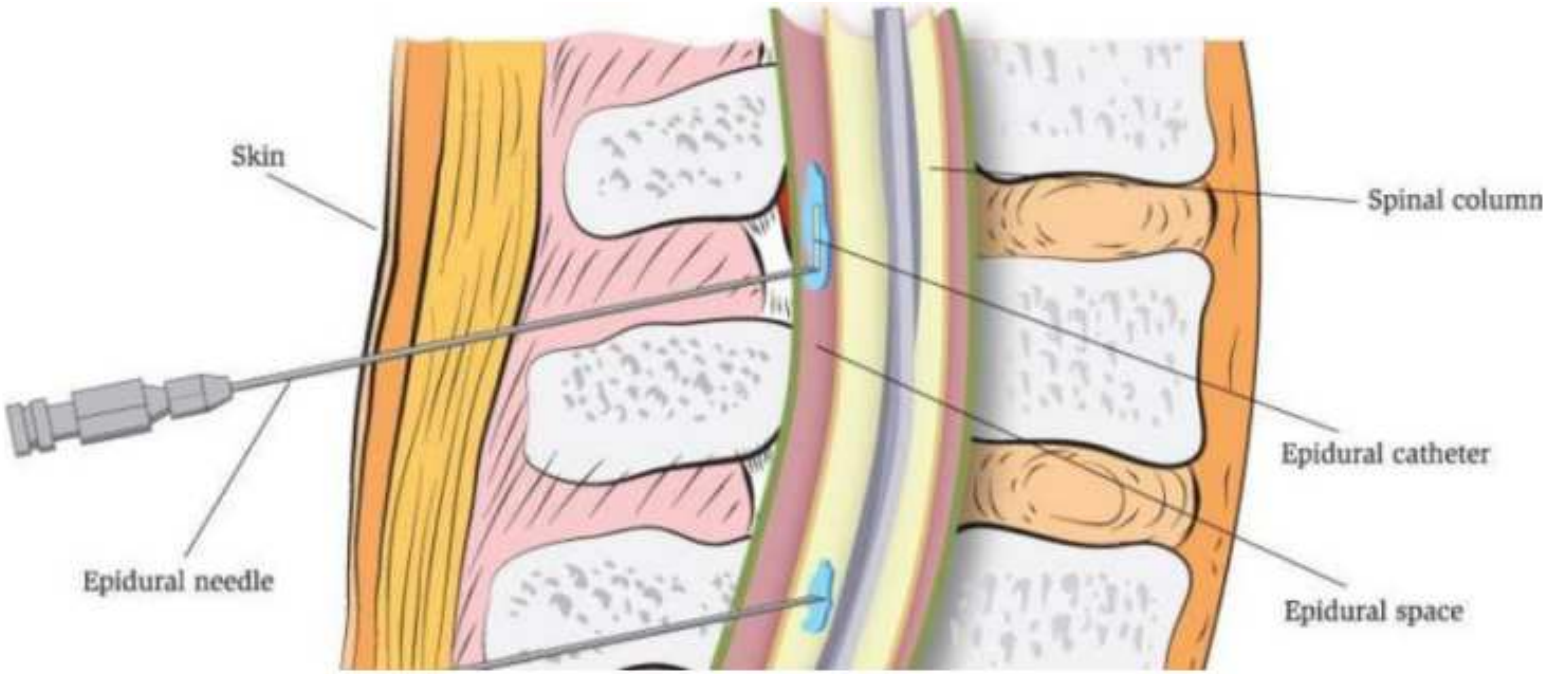
Variables	Pre-removal	Post-removal	*P*-value
Static pain	2.6 (2)	1.5 (1.5)	<0.0001
Dynamic pain	4.1 (2.1)	2.4 (1.9)	<0.0001
FEV1 (l/s)	1.5 (0.8)	1.7 (0.9)	0.0004
FEV1%	53 (24.7)	60.2 (30.8)	0.0004

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

Regional analgesia

Thoracic epidural analgesia (TEA)

Traditionally "Gold standard" for post-thoracotomy analgesia



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

Jane C. Ballantyne, MB BS, FRCA*†, Daniel B. Carr, MD, ABPM‡, Sarah deFerranti, MD, MPH‡§, Thomas Suarez, MD*, Joseph Lau, MD‡§, Thomas C. Chalmers, MD†[1], Italo F. Angelillo, DDS, MPH†, and Frederick Mosteller, PhD†

*Massachusetts General Hospital Pain Center, Department of Anesthesiology, Massachusetts General Hospital; †Technology Assessment Group, Harvard School of Public Health; and ‡Departments of Medicine and Anesthesiology and §Division of Clinical Care, New England Medical Center, Tufts University School of Medicine, Boston, Massachusetts

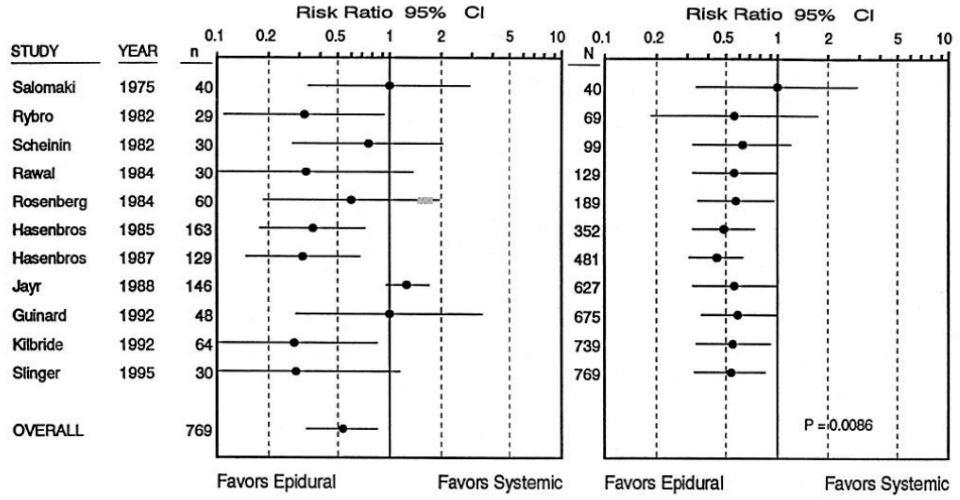


Figure 1. Epidural opioids versus systemic opioids: incidence of atelectasis based on the random effects model of Der Simonian and Laird. The cumulative meta-analysis is shown on the right. CI = confidence interval.

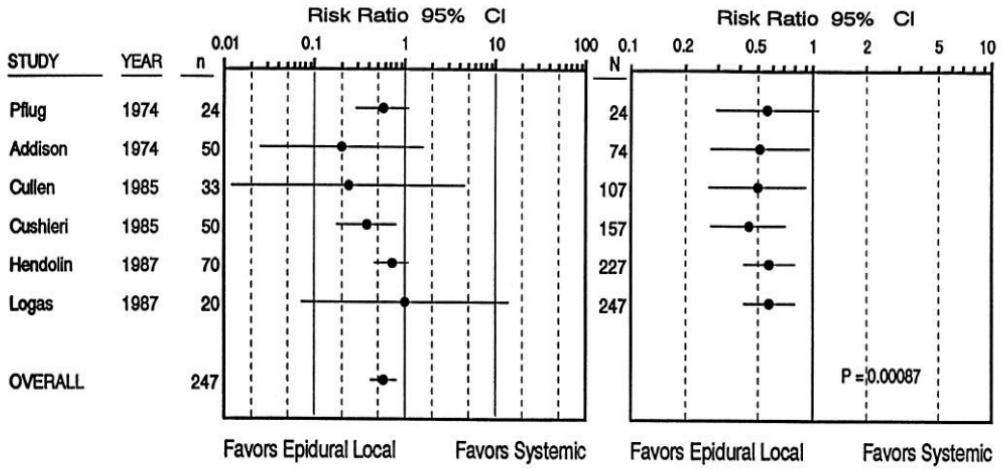


Figure 3. Epidural local anesthetics versus systemic opioids: incidence of pulmonary complications based on the random effects model of Der Simonian and Laird. The cumulative meta-analysis is shown on the right. CI = confidence interval.

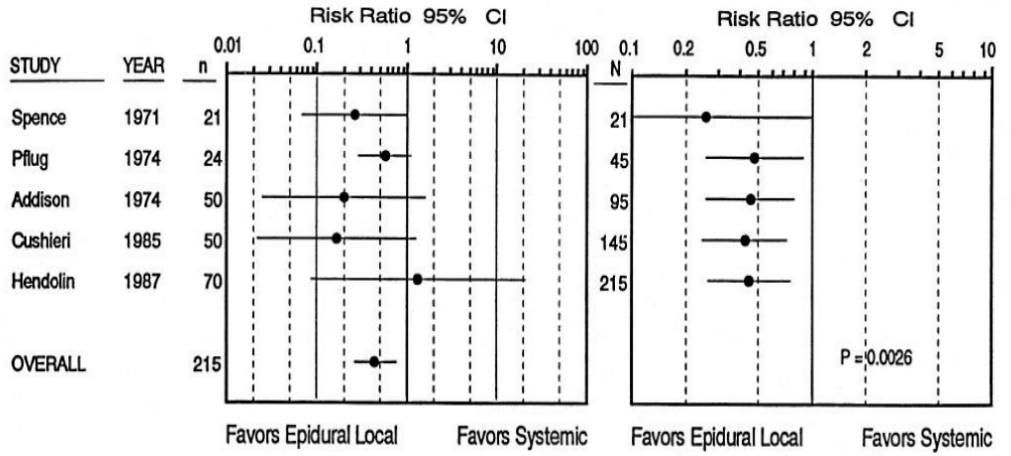


Figure 2. Epidural local anesthetics versus systemic opioids: incidence of pulmonary infection based on the random effects model of Der Simonian and Laird. The cumulative meta-analysis is shown on the right. CI = confidence interval.

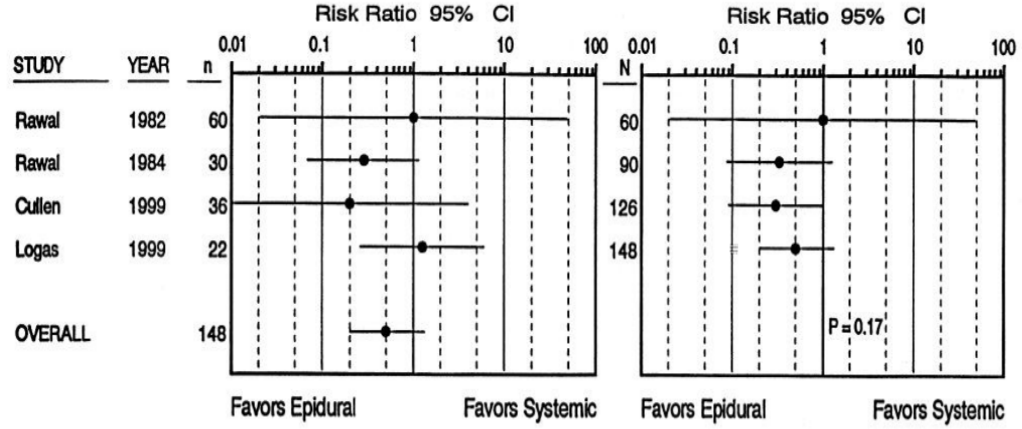


Figure 4. Epidural opioids versus systemic opioids: incidence of pulmonary complications based on the random effects model of Der Simonian and Laird. The cumulative meta-analysis is shown on the right. CI = confidence interval.

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,[1] Ferdane Aydogdu Kaya,[1] Dilek Kutanis,[1] Ahmet Besir,[1] Ali Akdogan,[1] Sükran Geze,[1] and Ersagun Tugcugil[2]

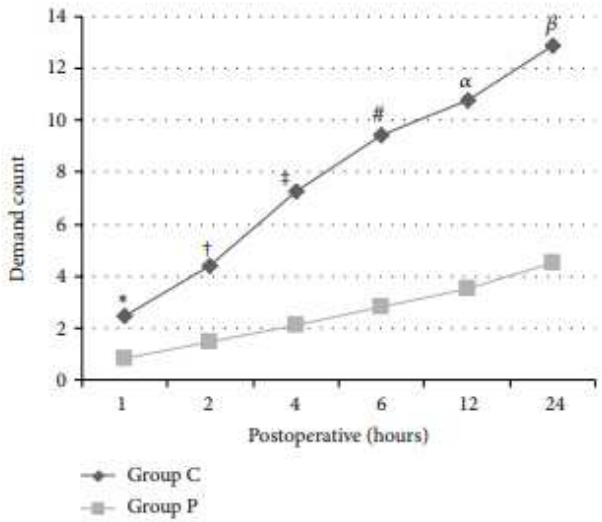


FIGURE 1: Patient's demand count on PCEA pump when Group C is compared to Group P (*: $P = 0.013$, †: $P = 0.000$, ‡: $P = 0.002$, $^{\#}$: $P = 0.001$, $^{\alpha}$: $P = 0.000$, and $^{\beta}$: $P = 0.000$).

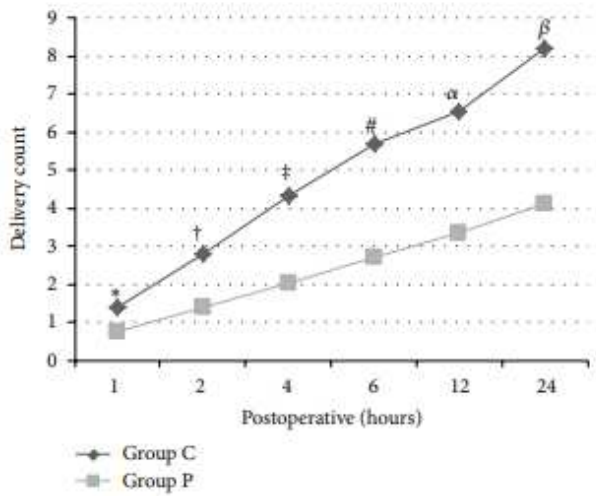


FIGURE 2: Pump's delivery count on PCEA pump when Group C is compared to Group P (*: $P = 0.013$, †: $P = 0.000$, ‡: $P = 0.002$, $^{\#}$: $P = 0.001$, $^{\alpha}$: $P = 0.000$, and $^{\beta}$: $P = 0.000$).

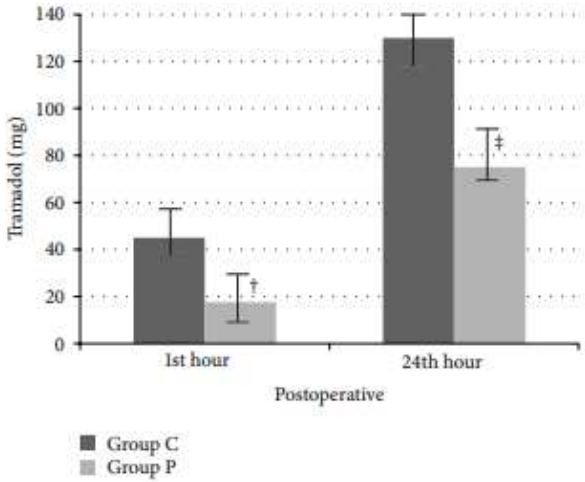


FIGURE 3: Total analgesic requirement. †: $P = 0.004$ when tramadol amount at 1st postoperative hour in Group C was compared with those in Group P. ‡: $P = 0.032$ when tramadol amount at 24th postoperative hour in Group C was compared with those in Group P.

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

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

$^{\beta}$When VASr scores at 1st postoperative hour in Group C were compared with those in Group P.
^{a}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.

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

	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 ± 2.08^{a}	2.55 ± 1.14	**0.004**
Postoperative 4th hour	$3.50 \pm 1.76^{*}$	2.20 ± 0.95	**0.009**
Postoperative 6th hour	2.55 ± 1.31	2.10 ± 1.48	0.192
Postoperative 12th hour	2.20 ± 1.54	1.40 ± 0.94	0.108
Postoperative 24th hour	1.60 ± 1.18	1.05 ± 1.05	0.121

$^{\beta}$When VASr scores at 1st postoperative hour in Group C were compared with those in Group P.
^{a}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§*

TABLE 1. Demographic Data and Type and Duration Surgery

	Group K (n = 65)	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 (no. cases)	Lobectomy (48) Wedge resection (10) Pneumonectomy (3) Bilobectomy (2) Esophagectomy (2)	Lobectomy (51) Wedge resection (7) Pneumonectomy (5) Bilobectomy (2) Esophagectomy (3)
Duration of surgery (min)	272 (69)	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

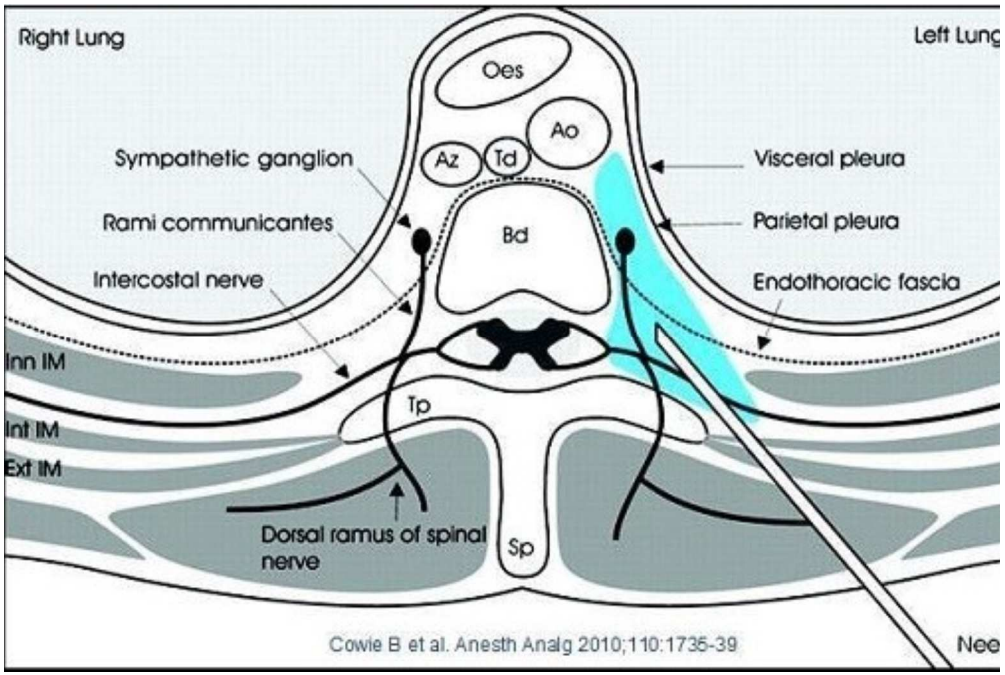
Data are proportions or median (range).

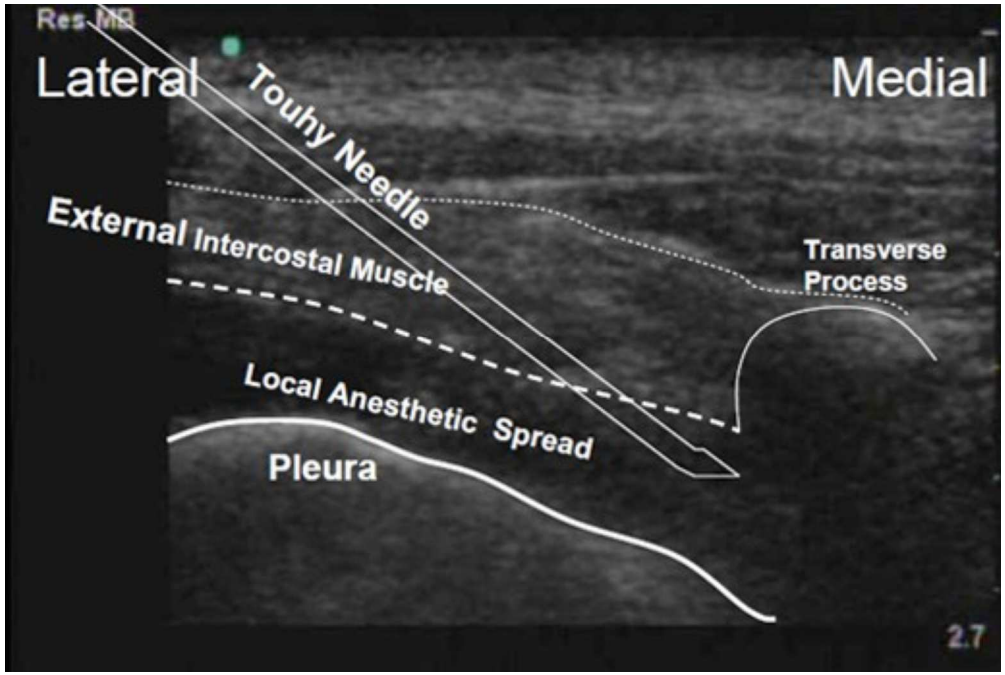
Group K indicates group with preemptive epidural ketamine; Group KF, group without preemptive epidural ketamine; VAS, visual analog scale.

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[1,2☯], Shuqing Jin[1,2☯], Xiaoyin Niu[2], Hao Ren[2], Shukun Fu[1], Quan Li[1,2*]

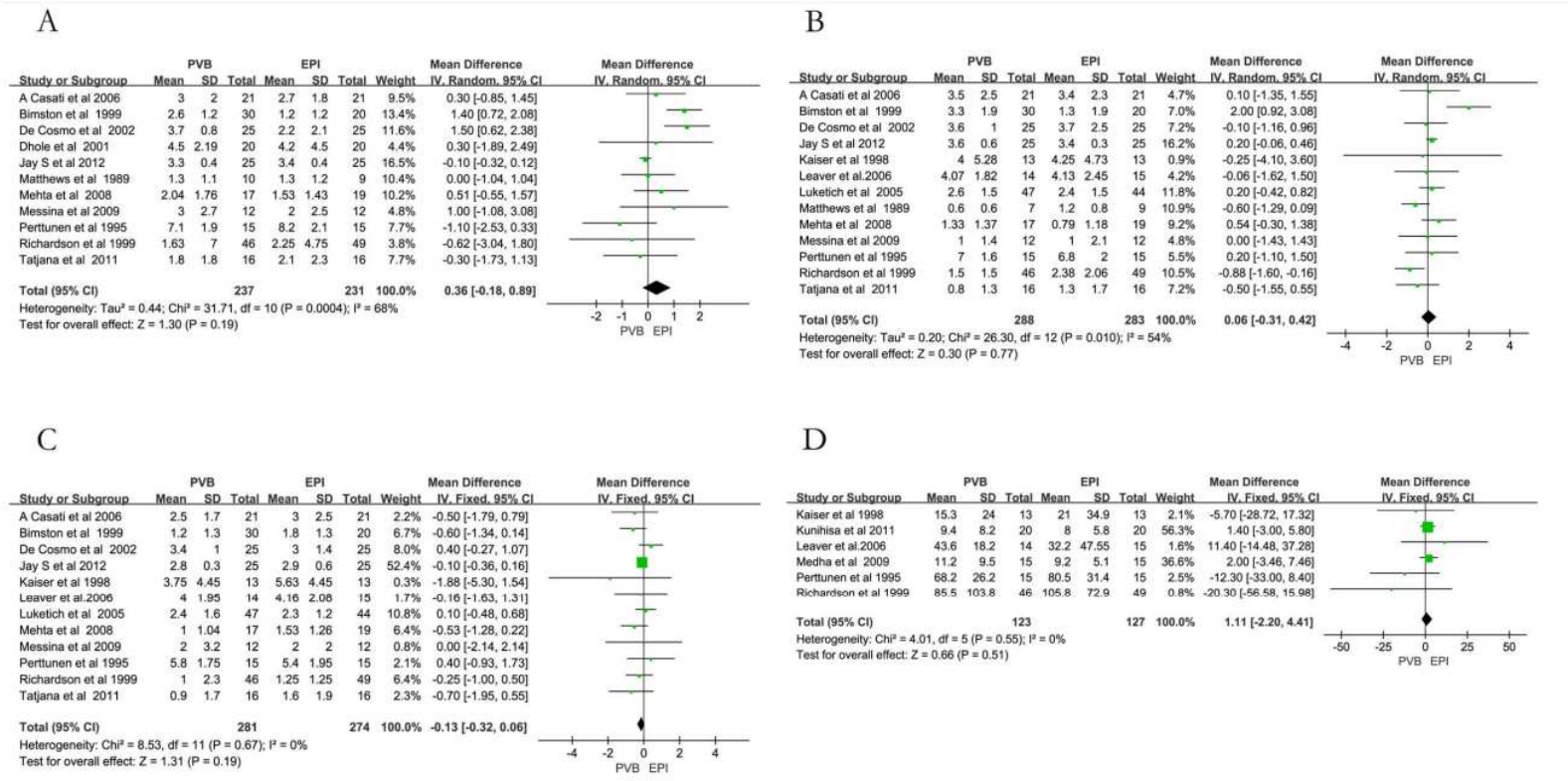


Figure 2. Meta-analyses of postoperative analgesic efficacy of PVB compared with that of EPI A) VAS scores 4–8 h; B) VAS scores 24 h; C) VAS scores 48 h; D) morphine consumption 24 h.

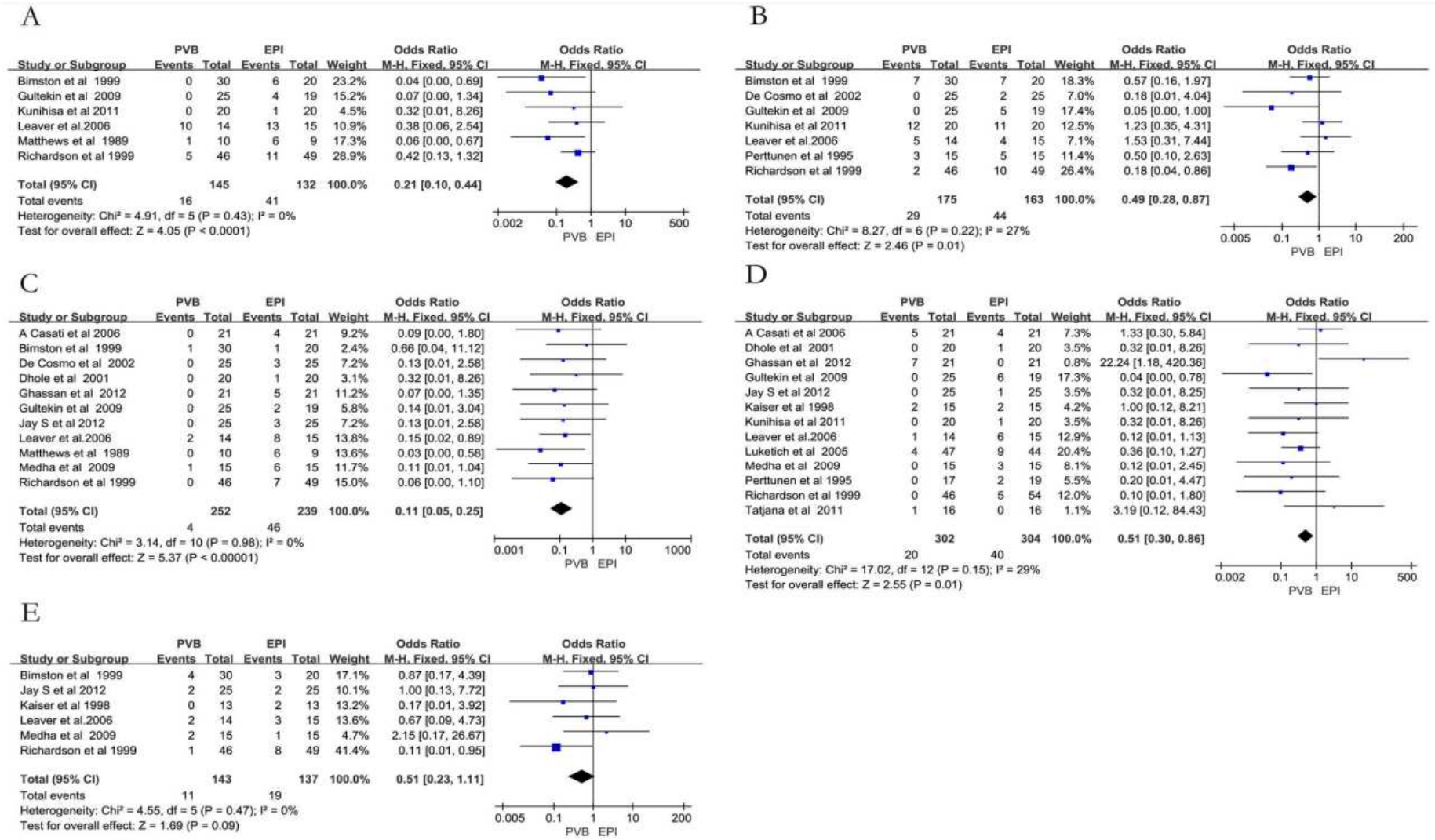
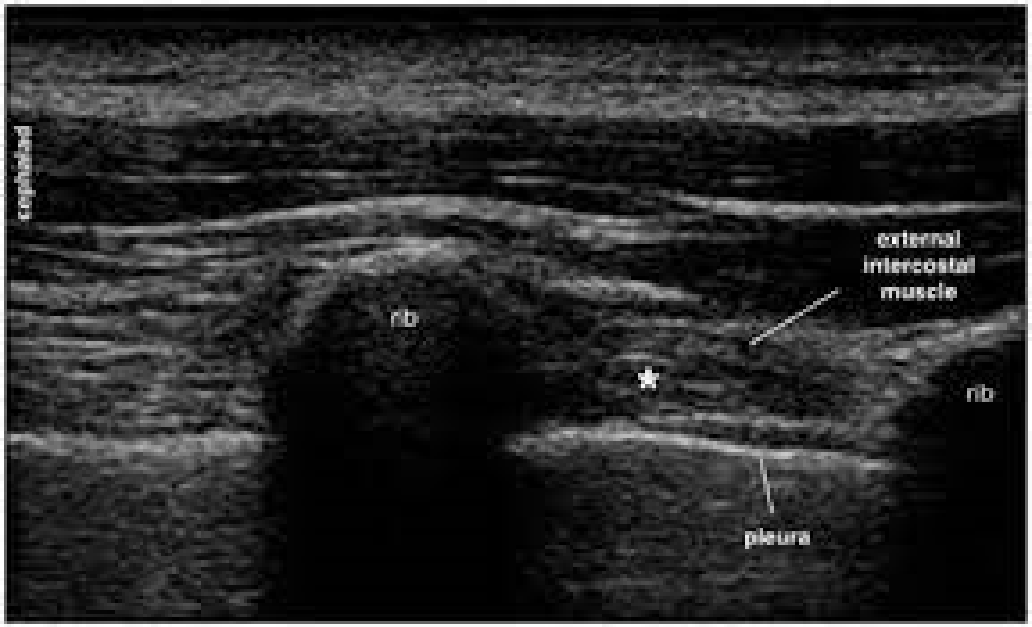
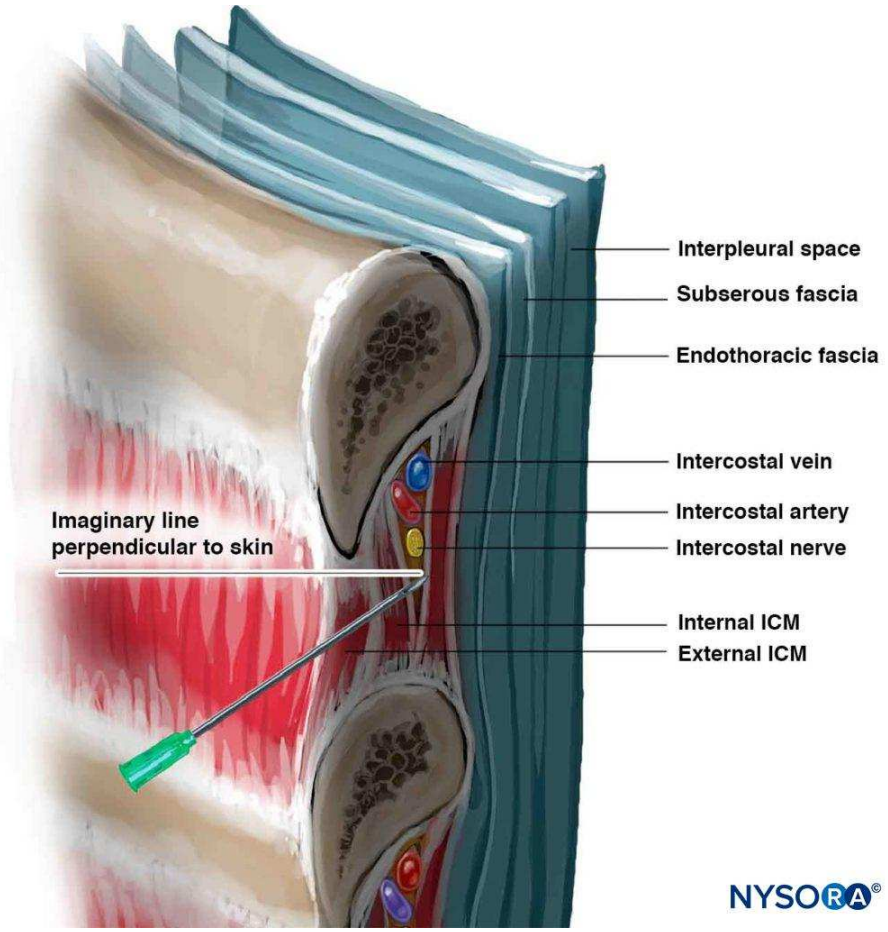


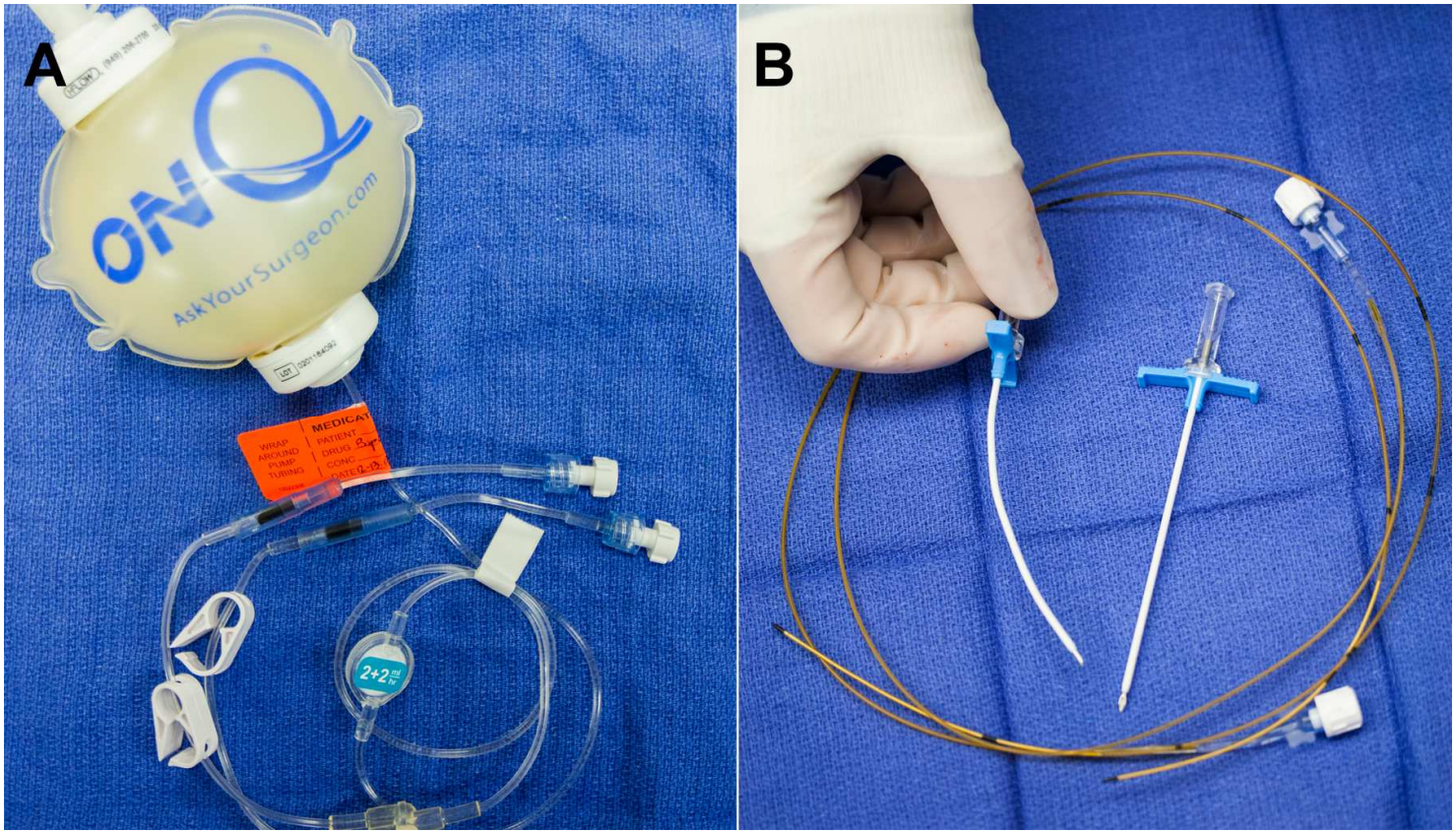
Figure 3. Meta-analyses of adverse side effect of PVB with that of EPI A) Urinary retention; B) nausea and vomiting; C) hypotension; D) rates of failed technique; E) pulmonary complications.

Intercostal nerve block

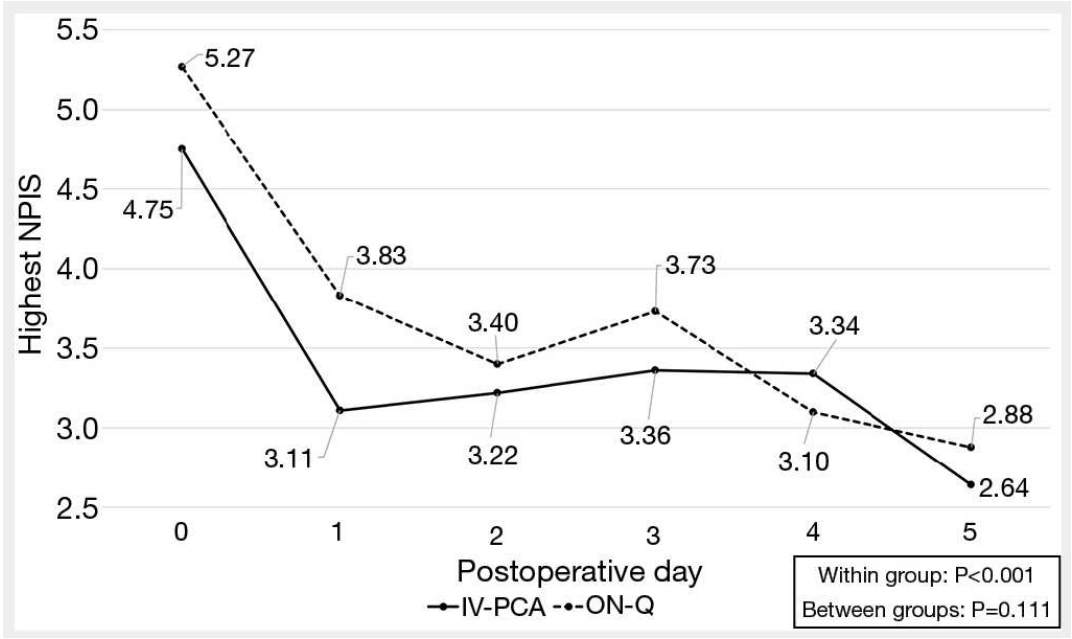




Continuous local anesthetic agent infusion



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



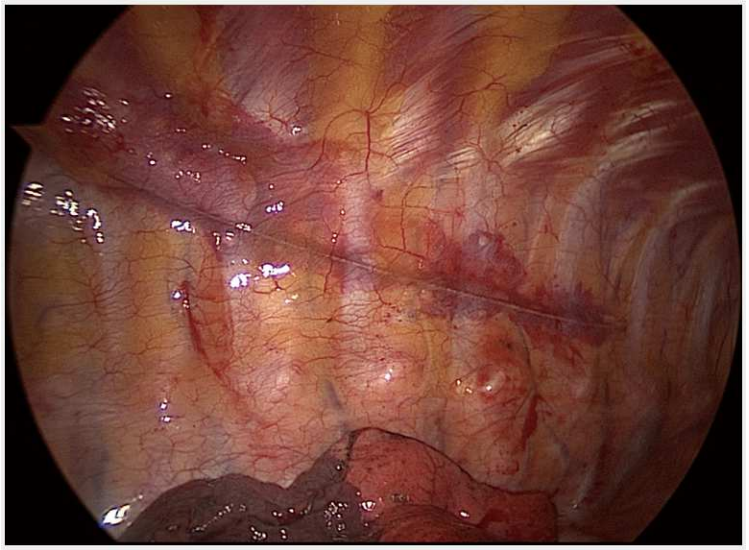
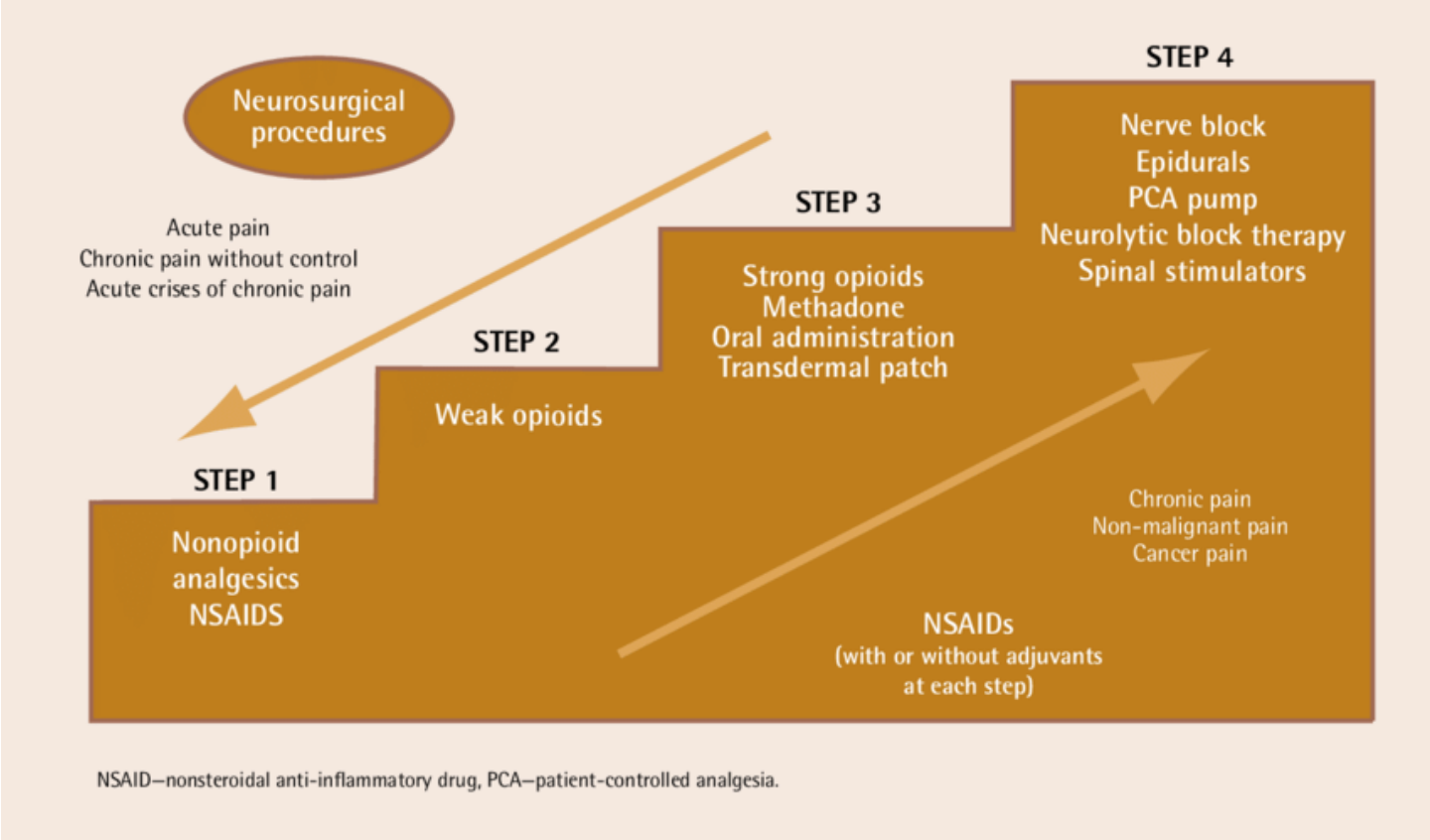


Table 2 Side effects and cause of early discontinuation

Events	IV-PCA (n=36)	ON-Q (n=30)	P
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®) 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