Original Article

Impact of chest tube type on pain, drainage efficacy, and short-term treatment outcome following video-assisted thoracoscopic surgery lobectomy: a randomized controlled trial comparing coaxial silicone drains and standard polyvinyl chloride drains

Boris Greif[1], Janez Žgajnar[2], Tomaž Štupnik[1]

[1]Department of Thoracic Surgery, University Medical Centre Ljubljana, Medical Faculty of University of Ljubljana, Ljubljana, Slovenia; [2]Institute of Oncology, Medical Faculty of University of Ljubljana, Ljubljana, Slovenia

Contributions: (I) Conception and design: All authors; (II) Administrative support: B Greif; (III) Provision of study materials or patients: B Greif, T Štupnik; (IV) Collection and assembly of data: B Greif; (V) Data analysis and interpretation: All authors; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

Correspondence to: Boris Greif, MD. Assistant Professor, Department of Thoracic Surgery, University Medical Centre Ljubljana, Medical Faculty of University of Ljubljana, Zaloska Cesta 7, 1000 Ljubljana, Slovenia. Email: boris.greif@kclj.si.

Background: Chest drains are routinely used after video-assisted thoracoscopic surgery (VATS) lung resections to evacuate fluid and air from the pleural space. We compared the impact of coaxial silicone (SIL) drains *vs.* standard polyvinyl chloride (PVC) drains on postoperative pain, drainage efficacy, and short-term treatment outcome following VATS lobectomy.

Methods: The prospective randomized study included 80 patients who underwent VATS lobectomy for lung cancer between September 2020 and June 2023. Patients were randomized into two groups based on the type of chest drain used postoperatively: 40 in the experimental group (coaxial SIL drain Fr 24) and 40 in the control group (standard PVC drain Fr 24). The researchers collecting the data and the caregivers were not blinded to the group allocation. The primary objective was to evaluate pain over the initial 2 postoperative days by assessing analgesic consumption, respiratory muscle strength [measured as maximal inspiratory pressure (MIP) and maximal expiratory pressure (MEP)], and pain intensity using the visual analog scale (VAS). MIP, MEP, and VAS were measured both at rest and during physical activity.

Results: Sixty-nine patients were included in the final analysis: 35 in the experimental group and 34 in the control group. The groups were comparable in terms of drainage efficacy and short-term treatment outcome, but pain was significantly lower in the experimental group (coaxial SIL drain). Diclofenac consumption was significantly lower in the experimental group (P=0.004), with a trend toward lower consumption of other analgesics. All respiratory muscle strength measurements were higher in the experimental group, with significant differences in static MIP on the second postoperative day (P=0.046), both static (P=0.02) and dynamic (P=0.050) MEP on the first postoperative day, and static MEP on the second postoperative day (P=0.02). Static VAS (S-VAS) on the first postoperative day was statistically significantly lower in the experimental group (P=0.003). Dynamic VAS (D-VAS) was comparable between the groups.

Conclusions: This study confirmed the hypothesis that coaxial SIL drains, owing to their softer material, cause less pain while maintaining efficacy comparable to standard PVC drains.

Trial Registration: The study was registered at ClinicalTrial.gov (NCT06425601).

Keywords: Video-assisted thoracoscopic surgery (VATS); lobectomy; postoperative pain; chest tube; analgesia

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Introduction

Background

Semi-rigid and large bore (≥ Fr 24) polyvinyl chloride (PVC) drains are routinely used for the evacuation of fluid and air from the pleural space following video-assisted thoracoscopic surgery (VATS) lung resections. The rigidity and caliber of these drains are widely recognized as significant contributors to postoperative pain. Inadequate pain management can thereby compromise respiratory efficiency, coughing, and patient mobility, potentially precipitating respiratory complications like atelectasis and pneumonia (1-7). In VATS, postoperative pain has been commonly assessed through a combination of methods, including pain scales, analgesic consumption analysis, and functional evaluation tests (5,8-12).

Rationale and knowledge gap

In recent years, significant efforts have been made to minimize drain-related postoperative pain by modifying and improving the methods of chest drainage. Since one or two large bore drains (≥ Fr 24) are still commonly used to ensure effective drainage of air leaks, improvements have also been directed towards the materials used for the drains (1-4,7).

Hence, there has been growing adoption of softer silicone (SIL) drains, purportedly offering reduced patient discomfort without compromising drainage efficacy compared to standard PVC drains. Previous studies have demonstrated the efficacy of SIL drains in fluid management and suggested potential pain reduction following diverse chest procedures, encompassing VATS and open surgeries (1-4,13,14). However, the benefit of SIL drains in reducing postoperative pain after VATS anatomical lung resections has not yet been clearly demonstrated, and postoperative pain remains a significant concern.

Objective

The objective of our prospective randomized study was to evaluate the impact of coaxial SIL drains on postoperative pain, drainage efficacy, short-term treatment outcome, and costs following VATS lobectomy, in comparison to standard PVC drains. We hypothesized that patients receiving a coaxial SIL drain would require less analgesia and demonstrate greater respiratory muscle strength. Furthermore, we anticipated that drainage efficacy and short-term treatment outcome would be comparable between the two groups. We present this article in accordance with the CONSORT reporting checklist (available at https://jtd.amegroups.com/article/view/10.21037/jtd-24-1489/rc).

Highlight box

Key findings

- Patients with coaxial silicone (SIL) drains demonstrated lower analgesic consumption and better-preserved respiratory muscle strength during the first 2 postoperative days.

What is known and what is new?

- Several studies have demonstrated the efficacy of SIL drains in fluid management and suggested potential pain reduction following video-assisted thoracoscopic surgery (VATS).
- This study demonstrated that coaxial SIL drains can reduce postoperative pain and improve patient comfort and recovery following VATS lobectomy.

What is the implication, and what should change now?

- Coaxial SIL drains may optimize chest drain materials to enhance patient comfort and recovery following VATS.

Methods

Study design and patients

This prospective randomized study enrolled patients who underwent VATS lobectomy for lung cancer at our institution between September 2020 and June 2023. Exclusion criteria were: age under 18 years, high risk of postoperative complications [American Society of Anesthesiologists (ASA) score >3, transfer factor for carbon monoxide (TLCO) or forced expiratory volume in 1 second (FEV1) ≤40%, cycloergometry with oxygen uptake VO_2 max <15 mL/kg/min], tumor invading the parietal pleura, extended lung resection (combined lung and chest wall/diaphragm resection or sleeve resection), prior surgery in the same hemithorax, chronic pain, chronic use of analgesics or sedatives, surgical revision, and inability to participate in the study.

Patients were randomized into two groups based on the chest drain type used postoperatively: the experimental group (SIL group) received a coaxial SIL drain Fr 24 (Redax Coaxial Drain, Redax S.p.A, Poggio Rusco, Mantova, Italy), while the control group (PVC group) received a standard PVC drain Fr 24 (Argyle, Covidien, Mansfield, MA, USA). The study included

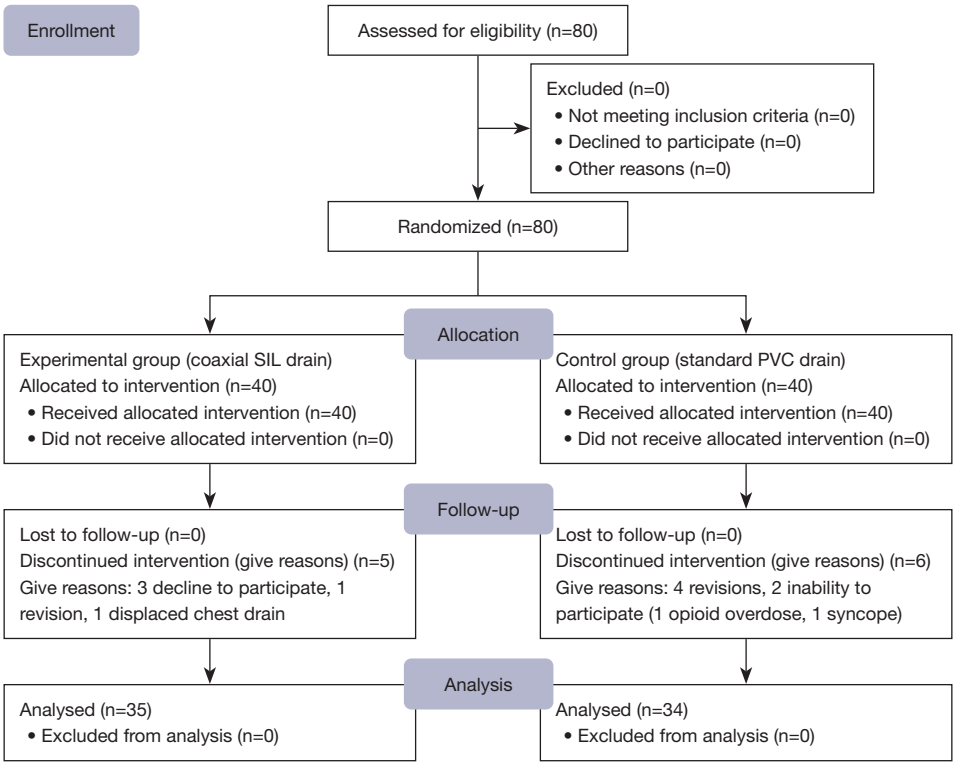

Figure 1 CONSORT 2010 flow diagram of patients enrolled in the study. SIL, silicone; PVC, polyvinyl chloride.

80 patients: 40 in the SIL group and 40 in the PVC group. Each group was treated concurrently, with no crossover between groups.

Simple randomization was used to allocate the patients in the two groups, by using a computerized numerical sequence. The principal investigator generated the random allocation sequence and was also responsible for enrolling participants in the study. Each allocation was communicated to the surgeon by the scrub nurse after opening a pre-sealed envelope at the conclusion of each procedure, following the intercostal block and just before inserting the chest drain. Randomization was performed following the CONSORT criteria and guidelines (15). The flow of patients in the study is shown in *Figure 1*.

Study protocol and treatment outcome

Each patient underwent a uniportal VATS lobectomy (16). At the conclusion of the procedure, all patients received an intercostal block using 0.5% levobupivacaine, targeting the intercostal space at the incision site, as well as one level above and one level below it. Subsequently, a chest drain was inserted through the anterior part of the incision into the pleural cavity, positioned anteriorly toward the thoracic apex.

All chest drains were connected to a digital drainage system (Medala, Thopaz, Germany) according to the following protocol: continuous suction of –10 cmH_2O on the day of surgery, continuous suction of –8 cmH_2O the day after surgery, and in the case of pneumothorax, the suction was increased to the minimum effective level. A chest X-ray was performed 4–6 hours after surgery, at each change of suction, and after drain removal. The drain was removed when the digital drainage system showed an air outflow of ≤20 mL/h for at least 8 hours, regardless of fluid outflow in the last 24 hours. The earliest the drain was removed was on the second postoperative day. All patients were evaluated in the outpatient clinic 4 weeks after discharge, including a follow-up chest X-ray.

Patients received a standard postoperative analgesia regimen following VATS lobectomy. On the day of surgery, they were administered the following parenteral analgesics: sodium diclofenac/orphenadrine citrate 75/30 mg every 12 hours and paracetamol 1 g every 6 hours. If analgesia was insufficient, piritramide 3–5 mg every 4 hours and metamizole 2.5 g every 12 hours were added. The day

after surgery, the regimen was switched to oral analgesics: tramadol/paracetamol 70/650 mg every 6 hours and diclofenac 75 mg twice daily, with metamizole 1.0 g every 6 hours as needed. The target VAS at rest was ≤3.

The primary objective of the study was to assess the impact of drain type on postoperative pain. Pain during the first 2 days after surgery was evaluated by assessing analgesic consumption, respiratory muscle strength [measured as maximal inspiratory pressure (MIP), and maximal expiratory pressure (MEP)], and pain intensity using the visual analogue scale (VAS). Analgesic consumption was recorded in milligrams for different drug groups: piritramide, paracetamol, diclofenac, metamizole, and tramadol. MIP and MEP were measured at rest (S-MIP, S-MEP) and during physical activity (D-MIP, D-MEP), specifically before and immediately after incentive spirometry. Pain was assessed using a 10-point VAS scale [0–10], with 0 indicating no pain and 10 indicating unbearable pain (17-19). Both static VAS (S-VAS) and dynamic VAS (D-VAS) were evaluated: S-VAS at 7 a.m., and D-VAS immediately after incentive spirometry at 10 a.m. S-VAS and D-VAS were obtained and recorded in the medical record by a nurse. Analgesic intake was also verified by telephone at the end of the first, second, and fourth weeks after drain removal.

MIP and MEP measurements were conducted with patients in a seated position using a portable device (GIO Digital Pressure Gauge, GaleMed, Wujie, Yilan). Our selected respiratory therapy involved incentive spirometry, also performed while seated. We utilized a 4,000 mL incentive spirometer (Coach 2 Incentive Spirometer 4000, Smiths Medical ASD Inc., Minneapolis, MN, USA). Detailed instructions on the procedures for measuring MIP and MEP, as well as of incentive spirometry, were provided to each patient.

The secondary objective of the study was to assess the efficacy of chest drainage, short-term treatment outcome, and costs based on the type of drain used. The efficacy of chest drainage was evaluated using the following variables: duration of drainage, rate of pneumothorax and pleural effusion observed on chest X-ray on the day of surgery and after drain removal, rate of clinically evident subcutaneous emphysema, rate of prolonged airleak (>5 days), and rate of intervention (thoracentesis or chest drainage) after drain removal. Short-term treatment outcome was assessed using the following variables: length of hospital stay, respiratory complication rate (atelectasis and pneumonia), and readmission rate within the first month after drain removal. Cost-efficacy analysis between the two groups was conducted by examining the economic impact of chest tube usage, analgesic consumption, and length of hospital stay.

Statistical analysis

Sample size was calculated to detect a difference of 18% in additional analgesic use, specifically metamizole. Additionally, it was expected that the experimental group would exhibit higher respiratory muscle strength. The calculation of sample size incorporated findings from relevant literature (2,5) and accounted for a projected 12.5% attrition rate due to non-compliance with the study protocol.

Data analysis was performed using the R programming language (version 4.1.2; R Core Team, Vienna, Austria) within the RStudio software environment (version 2021.9.1.372; RStudio Team, Boston, MA, USA). Data are described as mean ± standard deviation, median [interquartile range (IQR)], and number (%) as appropriate. Continuous variables were compared using the *t*-test for normally distributed data with equal variance, Welch's *t*-test for normally distributed data with unequal variance, and the Mann-Whitney *U* test for non-normally distributed data. Categorical variables were compared using the Chi-squared test and Fischer's exact test. The differences in means and proportions between the two groups, along with the corresponding 95% confidence intervals (CIs) for the *t*-test, were reported. All statistical tests were two-tailed with a significance level of 0.05.

Ethical statement

The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). This study was approved by the National Medical Ethics Committee Komisija Republike Slovenije za medicinsko etiko (approval number 0120-445/2019/8), and registered at ClinicalTrial.gov (NCT06425601) prior to the study participant enrollment. Written informed consent was achieved from all study participants before their study participation.

Results

General data of the study participants

In accordance with the inclusion criteria, 80 patients who underwent VATS lobectomy for lung cancer between

September 2020 and June 2023 were recruited and randomized for the study. Following allocation to the intervention, 11 (13.75%) patients were excluded from the final analysis. Reasons for discontinuation were as follows: 5 surgical revisions, 3 refusals to participate, 2 inabilities to participate, and 1 drain dislocation on the first day after surgery. Consequently, 69 patients were included in the final analysis: 35 in the SIL group and 34 in the PVC group (*Figure 1*). The two groups were comparable in terms of demographic, clinicopathological, and surgical characteristics, as presented in *Table 1*, except that more upper lobectomies were performed in the SIL group (P=0.050).

Pain

All pain assessment results are summarized in *Table 2*. The evaluation of analgesic consumption revealed a statistically significant reduction in diclofenac use in the SIL group (293.6 *vs.* 333.1 mg, P=0.004), while no significant differences were observed for other analgesics. The difference in metamizole consumption was 15.3%, favoring the SIL group (2,521.4 *vs.* 2,977.9 mg, P=0.74). There was no significant difference in the proportion of patients continuing analgesic use at 1, 2, and 4 weeks after drain removal, with a trend towards reduced analgesic consumption observed in the SIL group at each follow-up interval. One patient in the SIL group did not respond to the telephone follow-up.

In the analysis of respiratory muscle strength, all measurements were better in the SIL group. Specifically, statistically significant increases were observed in static MIP on the second postoperative day (74.1 *vs.* 64.2 cmH_2O, P=0.046), both static [86.7 *vs.* 69.5 cmH_2O; mean difference −17.2 (95% CI: −31.6 to −2.9); P=0.02] and dynamic MEP on the first postoperative day (82.8 *vs.* 67.2 cmH_2O, P=0.050), and static MEP on the second postoperative day [93.8 *vs.* 77.1 cmH_2O; mean difference −16.8 (95% CI: −31.2 to −2.3); P=0.02].

On the first postoperative day, S-VAS was significantly lower in the SIL group (2.4 *vs.* 3.1, P=0.003), whereas there was no difference between the groups in S-VAS on the second postoperative day or in either D-VAS measurement.

Treatment outcome, drainage efficacy, and cost-efficacy

The average duration of chest drainage was comparable between the groups (SIL group 5.0 *vs.* PVC group 4.3 days, P=0.99), with the median being exactly the same (2 days). There was no difference in the mean length of hospital stay (SIL group 4.7 *vs.* PVC group 4.1 days, P=0.88), while the median was lower in the SIL group (2 *vs.* 3 days). The respiratory complication rate and readmission rate were similar between the groups (*Table 3*). Variables determining drainage efficacy were comparable between the groups and are summarized in *Table 4*. In comparing complications by lobectomy site, patients undergoing upper lobectomy (including middle lobectomy) experienced more drainage-related issues, such as subcutaneous emphysema and prolonged air leak, than those undergoing lower lobectomy (18 *vs.* 3 patients; P=0.052). The cost difference between the groups was 201.7€ (P=0.057) and was in favor of PVC group (*Table 5*).

Discussion

Key findings

This is the first prospective, randomized, controlled trial comparing coaxial SIL drains with standard PVC drains following VATS lobectomy. Our results demonstrate that SIL drains provide comparable drainage efficacy while significantly reducing postoperative pain. These findings are encouraging and represent a meaningful advancement in optimizing chest drainage following VATS anatomical lung resections, based on scientific evidence.

Comparison with similar researches

Traditionally, the management of chest drains in thoracic surgery has been guided more by surgeons' experience and personal preferences rather than an evidence-based approach (20-22). Additionally, postoperative pain following VATS procedures remains a significant issue, as its underlying mechanisms and treatments have not been thoroughly studied. The chest drain is a major cause of pain and other complications, often determining the length of hospitalization. Consequently, the negative effects of a chest drain can persist throughout the hospital stay and impact treatment outcome (2,5,20,22-24).

To reduce drain-related postoperative pain and complications, SIL drains have become increasingly popular. They are considered less painful for patients compared to standard drains while still providing effective pleural space drainage after surgery. Numerous studies on various lung resections and other thoracic procedures, using both open

Table 1 Demographic, clinicopathological, and surgical characteristics of the patients

Characteristics	PVC group (n=34)	SIL group (n=35)	P value
Age (years)	65.6±9.4	66.8±9.4	0.51
Sex			>0.99
Male	14 (41.2)	15 (42.9)	
Female	20 (58.8)	20 (57.1)	
Height (cm)	168.2±10.2	169.6±9.0	0.54
Weight (kg)	72.4±14.9	75.5±23.4	0.75
BMI (kg/m^2)	25.5±4.1	26.0±6.2	0.84
ASA			>0.99
2	10 (29.4)	10 (28.6)	
3	24 (70.6)	25 (71.4)	
Smoking			0.67
Non-smoker	10 (29.4)	11 (31.4)	
Ex-smoker	9 (26.5)	12 (34.3)	
Smoker	15 (44.1)	12 (34.3)	
Comorbidity	28 (82.4)	30 (85.7)	0.96
Cardiovascular disease	21 (61.8)	20 (57.1)	0.88
COPD	7 (20.6)	13 (37.1)	0.21
FEV1%	93.7±19.7	91.4±20	0.64
TLCO	79.7±18.2	84.1±22.3	0.37
Lobectomy			0.05*
Upper	15 (44.1)	25 (71.4)	
Lower	16 (47.1)	7 (20.0)	
Middle	3 (8.8)	3 (8.6)	
Operation time (min)	107.9±33.7	117.2±41.4	0.34
Tumor diameter (mm)	28.3±16.8	28.1±12.2	0.55
Lymph node number	10.7±3.9	9.8±4.2	0.37
TNM stage			0.19
IA	12 (35.3)	15 (42.9)	
IB	6 (17.6)	8 (22.9)	
IIA	2 (5.9)	1 (2.9)	
IIB	9 (26.5)	2 (5.7)	
IIIA	3 (8.8)	8 (22.9)	
IIIB	1 (2.9)	1 (2.9)	
IVA	1 (2.9)	0	
Pneumostat use	2 (5.9)	1 (2.9)	0.61

Data are presented as mean ± standard deviation or number (%). *, P≤0.05. PVC, polyvinyl chloride; SIL, silicone; BMI, body mass index; ASA, American Society of Anesthesiologists; COPD, chronic obstructive pulmonary disease; FEV1%, forced expiratory volume in 1 second %; TLCO, transfer factor for carbon monoxide; TNM, tumor-node-metastasis.

Table 2 Pain analysis

Pain assessment parameters	PVC group (n=34)	SIL group (n=35)	P value	Difference (95% CI)
Analgesic use (mg)				
Metamizole	2,977.9±2,544.6	2,521.4±1,722.9	0.74	
Paracetamol	4,765.4±1,001.9	4,644.3±1,022.8	0.62	121.2 (–365.1 to 607.4)
Diclofenac	333.1±87	293.6±84	0.004*	
Piritramide	11±6.7	11.4±4.7	0.44	
Tramadol	173.2±76.1	186.4±95.2	0.45	
Muscle strength (cmH_2O)				
sMIP1	61.4±33.3	64±22.2	0.24	
dMIP1	66.8±38.7	71.4±28	0.34	
sMIP2	64.2±34.1	74.1±28.2	0.046*	
dMIP2	66.2±35	75.5±29.6	0.10	
sMEP1	69.5±26.1	86.7±33.3	0.02*	–17.2 (–31.6 to –2.9)
dMEP1	67.2±21.9	82.8±31.6	0.05*	
sMEP2	77.1±27.3	93.8±32.8	0.02*	–16.8 (–31.2 to –2.3)
dMEP2	78.4±29.6	91.7±32.5	0.08	–13.3 (–28.2 to 1.6)
VAS				
sVAS1	3.1±1	2.4±0.8	0.003*	
sVAS2	2.7±0.9	2.6±0.9	0.96	
dVAS1	4.9±1.7	5.3±1.9	0.32	
dVAS2	4.1±1.3	3.9±1.6	0.37	
Analgesic intake after drain removal	n=34	n=34[†]		
Week 1	33 (97.1)	31 (91.2)	0.61	
Week 2	23 (67.6)	17 (50.0)	0.22	
Week 4	11 (32.4)	7 (20.6)	0.41	

Data are presented as mean ± standard deviation or number (%). [†], 1 patient did not respond to the telephone follow-up. *, P≤0.05. PVC, polyvinyl chloride; SIL, silicone; CI, confidence interval; MIP, maximal inspiratory pressure; s, static; d, dynamic; 1, first postoperative day; 2, second postoperative day; MEP, maximal expiratory pressure; VAS, visual analogue scale.

Table 3 Treatment outcome

Outcomes	PVC group (n=34)	SIL group (n=35)	P value
Duration of drainage (days)	4.3±4.2/2 [2–4.8]	5.0±6.0/2 [2–5.5]	0.99
Length of hospital stay (days)	4.1±3.0/3 [2–5.8]	4.7±4.6/2 [2–5.5]	0.88
Respiratory complications	5 (14.7)	4 (11.4)	0.73
All complications	12 (35.3)	12 (34.3)	>0.99
Readmission	4 (11.8)	4 (11.4)	>0.99

Data are presented as mean ± standard deviation/median [IQR] or number (%). PVC, polyvinyl chloride; SIL, silicone; IQR, interquartile range.

Table 4 Drainage efficacy

Drainage efficacy parameters	PVC group (n=34)	SIL group (n=35)	P value
Pneumothorax POD 0	3 (8.8)	2 (5.7)	0.67
Pleural effusion POD 0	2 (5.9)	0	0.24
Subcutaneous emphysema	2 (5.9)	4 (11.4)	0.67
Empty space after drain removal	3 (8.8)	6 (17.1)	0.48
Residual effusion after drain removal	3 (8.8)	1 (2.9)	0.36
Prolonged air leak	7 (20.6)	8 (22.9)	>0.99
Redrainage after chest tube removal	1 (2.9)	3 (8.6)	0.61
Thoracentesis after chest tube removal	3 (8.8)	0	0.11

Data are presented as number (%). PVC, polyvinyl chloride; SIL, silicone; POD, postoperative day.

Table 5 Cost-efficacy analysis

Cost parameters	PVC group (n=34)	SIL group (n=35)	P value
Chest tube cost	6.5	27.3	–
Analgesics cost	17.7±4.2	17.9±4.0	–
Hospital cost per day	289	289	–
Total cost	1,214.2±870.5	1,415.9±1,328.4	0.057

Data are presented as mean ± standard deviation or number. Costs are indicated in euro. Total cost = hospital daily cost × mean length of hospital stay + analgesics cost + chest tube cost. PVC, polyvinyl chloride; SIL, silicone.

and VATS technique, have demonstrated the comparable efficacy of SIL drains (1-4,7,13,14,25). However, the impact of chest drain type on pain after VATS anatomical lung resections remains poorly investigated.

In 2017, Rena *et al.* (1) conducted a retrospective study comparing the efficacy of a specially designed coaxial SIL drains (Redax® Coaxial Drain) comprising an external fluted part for fluid removal and an internal coaxial part for air removal, against standard chest drains following lung lobectomy. The findings indicated that SIL drains are similarly effective and induce less postoperative pain. However, limitations of the study include its retrospective design, reliance solely on the VAS for assessing postoperative pain, and the inclusion of patients undergoing either open surgery or VATS surgery. Similarly, in 2016, Li *et al.* (2) conducted a randomized prospective study affirming the reliability of SIL drains and suggesting they may mitigate patient discomfort. Nevertheless, this study is also constrained by including diverse surgical procedures (VATS lobectomy and VATS wedge resection) and varied diagnoses (lung cancer, pneumothorax, and other benign conditions). Moreover, pain intensity was evaluated exclusively via VAS during resting conditions after a 12-hour period without analgesic administration. Consequently, uncertainties persist regarding the impact of SIL drains on postoperative pain following VATS anatomical lung resections.

Explanations of findings

Our randomized study demonstrated a favorable outcome in terms of postoperative pain for coaxial SIL drains, suggesting that SIL drains are less painful compared to standard PVC drains. Although our hypothesis regarding a statistically significant difference in metamizole consumption (anticipated 18% reduction) was not met (P=0.74), its consumption in the SIL group was clearly lower and close to the hypothesis (mean difference of 456.51 mg or 15.3%). Additionally, the analysis showed a statistically significant lower consumption of diclofenac, while there was no difference between the groups for other analgesics. The observed difference in metamizole consumption might be attributed to the significant difference in diclofenac consumption, supporting the hypothesis that patients with SIL drains require fewer analgesics and

experience less pain.

Regarding respiratory muscle strength measurements, the groups were entirely comparable in terms of gender and anthropometric characteristics [weight, height, and body mass index (BMI) classification], which significantly influence respiratory muscle strength measurements (26). As hypothesized, patients in the SIL group exhibited greater respiratory muscle strength in all measurements, with a statistically significant difference observed in four out of eight variables. The results of analgesic consumption and respiratory muscle strength should be interpreted together. Typically, lower analgesic consumption might compromise MIP and MEP outcomes if pain management is inadequate. Our study showed concurrently lower analgesic consumption and better-preserved respiratory muscle strength in the SIL group, and higher analgesic consumption and poorer-preserved respiratory muscle strength in the PVC group.

The VAS analysis, except for a statistically significant difference in S-VAS on the first postoperative day in favor of the SIL group, showed comparable results between the groups. The S-VAS on both days of measurement was consistent with the target S-VAS ≤3, with a slight deviation on the first postoperative day in the PVC group (mean =3.06). While the VAS is a simple and widely used method for assessing postoperative pain (17,27), its limitations—such as subjectivity and measuring pain intensity rather than its quality—must be acknowledged (10,28).

Implications and actions needed

An important aspect of our study is that we focused primarily on objective methods for result interpretation, such as assessing analgesic consumption (10) and measuring respiratory muscle strength, thereby enhancing the quality of pain analysis. The VAS assessment primarily served as a control for the adequacy of analgesic therapy (target S-VAS ≤3), which was achieved. We believe that postoperative pain at rest should be well-managed (S-VAS ≤3) in all patients with no significant difference in S-VAS scores across patients. However, differences in analgesic consumption may arise due to the varying doses required to achieve the target S-VAS. In our study, no significant differences in D-VAS were observed between groups. This outcome may be attributable to the sample size, suggesting that future studies with larger cohorts are needed to more accurately evaluate potential differences in dynamic pain response.

Our study did not investigate the potential impact of chest tube material on chronic pain. Given that chronic pain following VATS can significantly affect patient outcomes (29-32), examining the role of various chest drain materials in this context could yield valuable clinical insights. Further research is therefore warranted to explore this important aspect of postoperative care, with the potential to improve long-term patient quality of life. The conducted study also showed comparable drainage efficacy and short-term treatment outcome between the groups. To detect potential differences in respiratory complications, a larger patient sample would be required. It would also be valuable to analyze pain in patients with longer drainage durations, although these cases are rare. A study on the impact of omitting chest drainage after lung resections on maintaining physical capacity (12) showed benefits of omitting the drain only on the first postoperative day, with no difference noted after a week compared to the state with a chest drain. Nonetheless, there is a belief that early preservation of lung function and physical capacity can prevent complications such as pneumonia and atelectasis. The slightly longer mean hospital stay (SIL 4.7 *vs.* PVC 4.1 days, P=0.88) and mean chest drainage duration (SIL 5.0 *vs.* PVC 4.3 days, P=0.99) in the SIL group, may be attributed to the higher proportion of upper lobectomies performed in this group. Nonetheless, both groups showed comparable rates of drainage-related complications, including prolonged air leak and subcutaneous emphysema. This suggests that coaxial SIL drains were effective for managing air leaks, irrespective of the lobectomy site.

Postoperative pain and other outcome variables may have been influenced by factors beyond the type of drain, particularly intraoperative factors. However, we can assert that the groups were very homogeneous and comparable in terms of demographic, clinicopathological, and intraoperative characteristics, likely minimizing their impact on the comparison between the groups.

In summary, based on our results, coaxial SIL drains were associated with less pain compared to PVC drains. However, this benefit was small, with limited clinical significance beyond the statistical P values. Importantly, the observed pain reduction did not translate into improvement of hospital stay duration, chest tube duration, or complication rates. The study has certain limitations. Firstly, it is not blinded, as the researchers collecting the data and the caregivers were aware of the group allocation. Secondly, the level of pain during the initial hours post-surgery, and consequently the use of parenteral analgesia, might have been affected by the execution of the intercostal

block. Although this procedure was standardized, variations in execution between different groups could exist. Furthermore, the accuracy of respiratory muscle strength measurements may be compromised by factors such as the patient's comprehension, mood, and cooperation (26,33), especially in the presence of pain. Moreover, other factors, such as intraoperative variables, could have influenced pain levels, as previously mentioned. The study was conducted with chest tubes connected to continuous suction management. However, many thoracic surgeons prefer using water seal management in case of air leak, which may be a limitation when employing coaxial SIL drains. Nevertheless, some studies (1,34) have demonstrated that coaxial drains with water seal management provide effective chest drainage, with no significant difference in complications, such as postoperative pneumothorax or clinically significant subcutaneous emphysema, compared to standard chest tubes. The number of patients (13.75%) excluded from the final analysis slightly exceeded 12.5% of the maximum expected attrition, which likely had a minor impact on the potential differences between the groups. Future research involving randomized, blinded studies on the impact of chest drain materials on postoperative pain and recovery is imperative to support and expand upon our findings.

Conclusions

Patients with coaxial SIL drains required fewer analgesics and exhibited enhanced respiratory muscle strength postoperatively. Although measuring and analyzing pain is challenging, our study indicates that coaxial SIL drains are less painful compared to PVC drains. Given these promising outcomes, further research should investigate optimizing chest drain materials to improve patient comfort and recovery following VATS.

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Footnote

Reporting Checklist: The authors have completed the CONSORT reporting checklist. Available at https://jtd.amegroups.com/article/view/10.21037/jtd-24-1489/rc

Trial Protocol: Available at https://jtd.amegroups.com/article/view/10.21037/jtd-24-1489/tp

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Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). This study was approved by the National Medical Ethics Committee Komisija Republike Slovenije za medicinsko etiko (approval number 0120-445/2019/8), and registered at ClinicalTrial.gov (NCT06425601) prior to the study participant enrollment. Written informed consent was achieved from all study participants before their study participation.

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