ANALGESIC EFFECT OF ERECTOR SPINAE PLANE BLOCK IN LUMBAR SPINE SURGERY: A SYSTEMATIC REVIEW AND META-ANALYSIS OF RANDOMISED CONTROLLED TRIAL

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DISSERTATION SUBMITTED IN FULFILMENT OF THE REQUIREMENT FOR THE DEGREE OF MASTER ANAESTHESIOLOGY

FACULTY OF MEDICINE
UNIVERSITI MALAYA
KUALA LUMPUR

2024

ORIGINAL LITERARY WORK DECLARATION

Name of candidate: Lee Tzi Sen

Registration/Matric No: S2030959

Name of Degree: Master of Anesthesiology

Title of Project Paper/Research Report/Dissertation/Thesis ("this work")

Analgesic Effect of Erector Spinae Plane Block in Lumbar Spine Surgery:
A review and meta-analysis of randomised controlled trial Systematic

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Abstract

Introduction: The use of ESP block has gained popularity in multiple types of surgeries which include lumbar spine surgeries. It is a relatively new technique in lumbar spine surgery and its advantages includes analgesic effect and also reducing opioid consumption, hence promoting ERAS. The purpose of this meta-analysis is to evaluate the analgesic effect of ESP block in lumbar spine surgery.

Method: Randomized controlled trials of ESP block in lumbar spine surgery was searched in Pubmed and clinicaltrial,gov. Data was selected and was reviewed by two author which included a total of 7 RCTs.

Result: Meta-analysis suggested that there is a statistical significant difference in ESP block providing lower pain scores at rest at 0 hour (MD, -1.60; 95% CI, -2.74 to -0.46; I2 = 93%; P = 0.006) and 24 hours (MD, -0.54; 95% CI, -0.98 to -0.10; I2 = 70%; P = 0.02) postoperatively as compared to patients who do not receive ESP block. There is no statistically significant difference in postoperative pain scores between patients who receive and did not receive ESP block at 4 hours (MD, -0.97; 95% CI, -2.21 to 0.27; I2 = 94%; P = 0.13) and 12 hours (MD, -1.28; 95% CI, -2.54 to -0.03; I2 = 96%; P = 0.05). It also showed that patient with ESP block had lower 24-h opioid consumption (MD, -50.95; 95% CI, -68.09 to -33.80; I2= 100%; P < 0.00001) and significant reduction in incidence of PONV (RR, 0.39; 95% CI, 0.20 to 0.77; I2 = 55%; P =0.007).

Conclusion: Our meta-analysis found that ESP block proven to be effective in reducing post operatively pain score, post operative opioid consumption and PONV in lumbar spine surgery. However, due to high heterogeneity, further studies need to be carried out to determine the efficacy.

Abstrak

Pengenalan: Penggunaan blok ESP telah mendapat popularitи dalam pelbagai jenis pembedahan termasuk pembedahan tulang belakang lumbar. Ia adalah teknik yang agak baru dalam pembedahan tulang belakang lumbar dan kelebihannya termasuk kesan analgesik dan juga mengurangkan penggunaan opioid, justeru menggalakkan ERAS. Tujuan meta-analisis ini adalah untuk menilai kesan analgesik blok ESP dalam pembedahan tulang belakang lumbar.

Kaedah: Percubaan terkawal rawak blok ESP dalam pembedahan tulang belakang lumbar telah dicari di Pubmed dan clinicaltrial,gov. Data telah dipilih dan disemak oleh dua pengarang yang merangkumi sejumlah 7 RCT.

Keputusan: Meta-analisis mencadangkan bahawa terdapat perbezaan statistik yang signifikan dalam blok ESP yang memberikan skor kesakitan yang lebih rendah semasa rehat pada 0 jam (MD, -1.60; 95% CI, -2.74 hingga -0.46; I2 = 93%; P = 0.006) dan 24 jam (MD, -0.54; 95% CI, -0.98 hingga -0.10; I2 = 70%; P = 0.02) selepas pembedahan berbanding pesakit yang tidak menerima blok ESP. Tiada perbezaan yang signifikan secara statistik dalam skor kesakitan selepas pembedahan antara pesakit yang menerima dan tidak menerima blok ESP pada 4 jam (MD, -0.97; 95% CI, -2.21 hingga 0.27; I2 = 94%; P = 0.13) dan 12 jam (MD, -1.28; 95% CI, -2.54 hingga -0.03; I2 = 96%; P = 0.05). Ia juga menunjukkan bahawa pesakit dengan blok ESP mempunyai penggunaan opioid 24 jam yang lebih rendah (MD, -50.95; 95% CI, -68.09 hingga -33.80; I2= 100%; P <0.00001) dan pengurangan ketara dalam kejadian PONV (RR, 0.39; 95% CI, 0.20 hingga 0.77; I2 = 55%; P =0.007).

Kesimpulan: Meta-analisis kami mendapati bahawa blok ESP terbukti berkesan dalam mengurangkan skor kesakitan selepas pembedahan, penggunaan opioid selepas pembedahan dan PONV dalam pembedahan tulang belakang lumbar. Walau bagaimanapun, disebabkan heterogeniti yang tinggi, kajian lanjut perlu dijalankan untuk menentukan keberkesanannya.

ACKNOWLEDGEMENT

I am deeply indebted to my supervisor, Dr Jeyaganesh Veerakumaran and Prof Dr Dharmendra Ganesan for his tirelessly guidance, invaluable patience, and feedback at every stage of this study. A special thanks to also to my co-author, Shee Loke Yuan for his enthusiastic guidance and support.

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LIST OF SYMBOLS AND ABBREVATIONS

ESP: Erector Spinae Plane

VAS: Visual Analog scale

NRS: Numeric rating scale

RCT: Randomized controlled trial

SAS: Sedation Agitation Scale

POD: Post operative delirium

PACU: Post Anesthesia care unit

PCA: Patient controlled analgesia

ERAS: Enhanced recovery after surgery

Chapter 1: Introduction

Spine surgery being one of the few surgeries that can caused high degree of postsurgical pain and pain is an important factor regarding the quality of perioperative care. However, so far there is yet to be real consensus regarding pain control in lumbar spine surgery.

As we know that, insufficient pain relief can cause perioperative and postoperative morbidity which further result in prolonged hospital stay. This will also have significant impact to both patient's mental and physical health. Moreover, prolonged hospital stay will also increase hospital expenses.

Erector spinae plane (ESP) block is a plane block where local anaesthetic is injected in a plane below the erector spinae muscle. Local anaesthetic that was introduced in ESP block was aimed to block the ventral and dorsal rami of the spinal nerves and to achieve a multi-dermatomal sensory block of the posterior, anterior, and lateral thoracic and abdominal walls. Therefore, it can provide lower extremity, abdominal and thoracic analgesia.[1] It was also said that erector spinae block able to reduce opioid use and use for pain relief in lumbar surgery.

With the addition of ESP block into the multimodal approach of pain management in for lumbar spine surgery perioperatively, it was foreseen to reduce perioperative and postoperative morbidity by giving better pain control.

CHAPTER 2: LITERATURE REVIEW

As the population grow older, the incidence of disc degeneration increases as it as directly correlated with increasing age. [2] This degenerative disc disease can cause great discomfort, pain and disability. [3] This leads to increasing number of cases of lumbar spine surgery especially in elderly age group. [4]

Lumbar spine surgery is one of the most painful procedures[5] and yet there is no real consensus for optimal pain management for perioperative lumbar spine surgery. Pain will have serious impact on recovery and length of stay in hospital.[6] Pain will also potentiate the development of postoperative chronic pain and increase the overall morbidity and mortality.[7]

Erector spinae plane block (ESPB) is a new block with potential application.[8] It has analgesia effect in in multiple surgical procedures including cervical, thoracic, cardiovascular, breast, open abdominal, laparoscopic, and spinal surgery.[9] The application of ESPB has markedly reduced the post operation analgesia requirement especially the opioid usage. This will result in less side effects of opioid experienced by the patient, subsequently improve the quality of care.

There are many studies which showed that ESPB had been successfully used in many surgeries, [10] [11] including spine surgery. [12] [13] [14]

According to H.Lin et al. 2022 study, there is a significant reduction of 55% in morphine consumption in first 24 hours post operation, improved Qor-15 and reduction in pain score.

Whereas in Zhang et al. 2020 study, it showed that bilateral ESPB can enhance recovery and reduce perioperative opioid consumption.

This showed the feasibility of incorporating ESPB into ERAS program.

ERAS is a multimodal approach for post operative patient aiming to improve outcomes of patient after surgery.[15] This includes multimodal analgesic method that would lead to a better outcome, short hospital stay, less adverse effect and costing savings. [16] ERAS also reduces use of opioid consumption post operatively.[17]

The use of opioid will lead to other adverse effect which will in turn leads to prolonged stay and recovery.[18]

However, there are controversy which showed that ESPB combined with the ERAS which includes multimodal analgesia showed limited benefit in major spine surgery. [19]

In Geoffrey Avis et al. 2022 study, ESPB did not showed significant reduction in morphine consumption in first 24 hours and had limited benefit in ERAS program.

Chapter 3 Methodology

3.1 Database Search

We search databases on Pubmed and clinicalTrial.gov. We included trial which are randomised controlled trial. Search terms that are being used including ‘’Erector spinae plane block in lumbar spine surgery’’. We aimed to compare analgesic effect of ESP block vs non-ESP block in adult patients who undergo lumbar spine surgeries.

3.2 Screening

All accumulated studies where screened and decided which were eligible for inclusion separately by two authors.

3.3 Inclusion criteria

The inclusion criteria including,

1) Randomised control trial
2) Article published in English
3) Preoperative ESP block vs control group
4) Adult human patients
5) undergoing lumbar spine surgery

3.4 Data collection

Of all the random control studies that we had reviewed, 2 independent authors collected the data which included the author, year of study, type of operation, type and dosage of ESP block, adverse event due to ESP block, pain score (NRS or VAS).

3.5 Assurance of quality of study

Revised Cochrane risk of bias tools for randomized trial (Rob 2) as shown in table 2 were used to evaluate the quality of the study. 5 domains which are assessed including risk of randomisation process, deviation from the intended interventions, missing outcome data, measurement of outcomes and selection of reports.

4. Result

4.1 Study included

7 studies were included in this systemic review. All of them were RCT. A total of 602 patients were included. The follow up timing of all these studies ranged from post operative up to 3 months. All these studies utilised single injection ESP block on bilateral side with different dosage. All ESP blocks were done under ultrasound guidance.

Most used LA being ropivacaine or bupivacaine at various concentrations with frequent quantities of 20ml injected at bilateral side each. All the studies did not have any ESP block related complication and were able to reduce pain score as well as reduce opioid consumption.

Table 1: Search Flow Chart

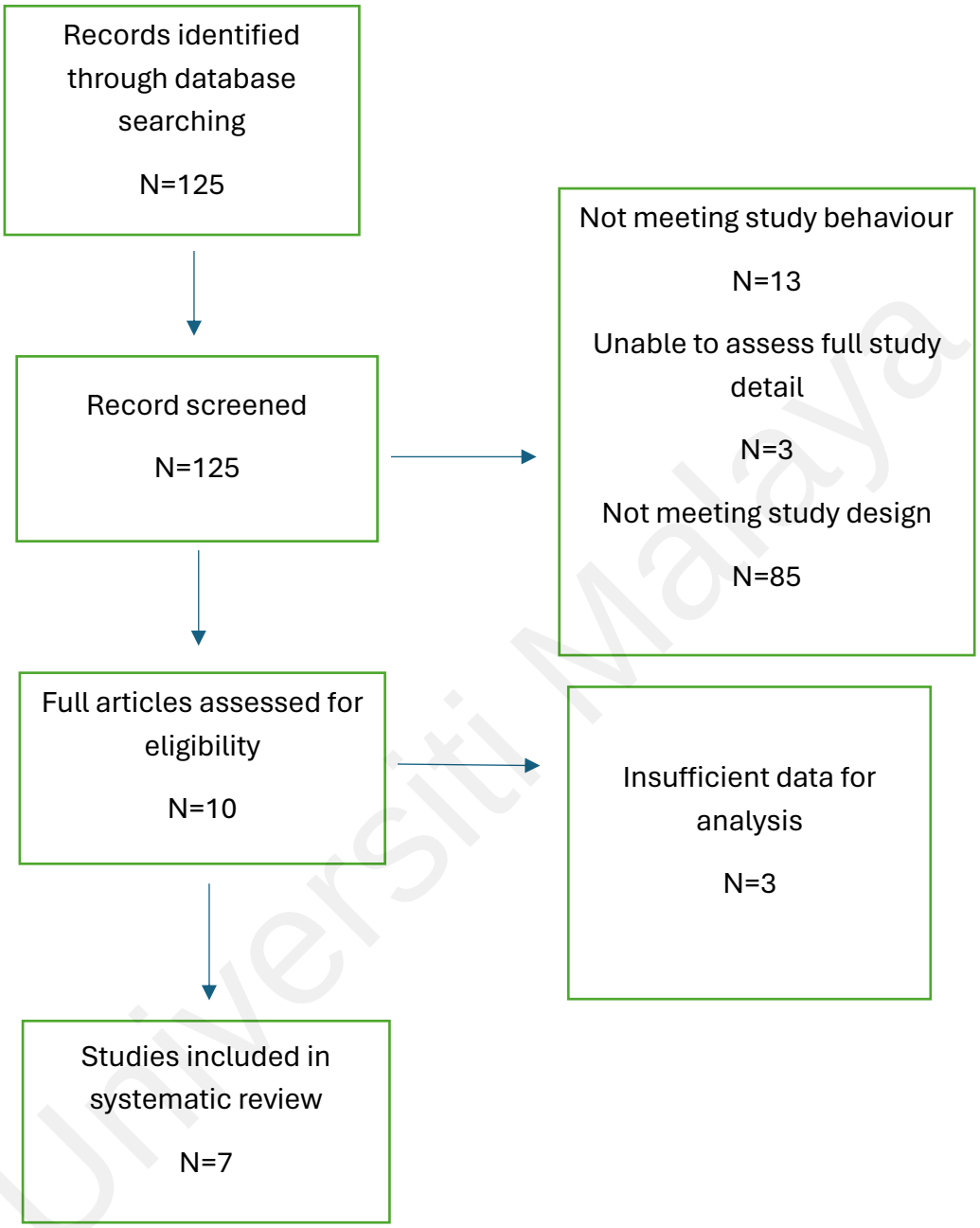


Table 2

Studies that were included in assessing analgesic effects of ESPB in lumbar spine surgeries.

Year of publication and author	Sample size	Type of operation	ESP block	Outcome measure	Side effect of ESP block	Post operation follow up duration	Conclusion
Masoud NASHIBI et al. (2022)	40	One- or two-level lumbar laminectomy	Bilateral single shot ESPB under ultrasound guidance after anesthesia containing 20 cc of bupivacaine 0.25% on each side	Post-operative pain score, amount of meperidine used in 24 h, number of patients requiring meperidine as rescue analgesic	Nil	24 hours	ESPB is safe for pain reduction for lumbar spine surgery that reduces pain scores and opioid used patients. [20]
Masoud NASHIB et al. (2023)	70	Lumbar posterior spinal fusion of two or three levels with or without laminectomy or discectomy	20 cc of 0.25% bupivacaine was injected into each side under ultrasound guidance(1 or 2 levels cephalad to the surgical level)	Intraoperative amount of opioids and isoflurane, emergence timing, PONV, postoperative shivering, postoperative pain	Nil	Post-anesthesia care unit 1 hour after admission	ESPB reduces intraoperative hypnotic/ opioid use and emergence time in lumbar spine surgery and 1-h pain scores also reduced [21]
Aijia Zhang et al. (2023)	230	Posterior lumbar decompression or fusion surgery	20 mL 0.4% ropivacaine injected over each ESP at	NRS pain score after 12 hours of surgery, NRS pain score and use of	Nil	72 hours	Bilateral ultrasound-guided T12 ESPB is a effective regional anesthesia

			level t12 under ultrasound guidance	tramadol in 72 h postoperatively, intraoperative remifentanil use, hemodynamic, extubation timing, SAS score post extubation, incidence of POD and PONV, complications, time of ambulation , and length of hospital stay			for lumbar spine surgery and associated with faster recovery in elderly patients by giving appropriate postoperative analgesia. [22]
Swati Singh et al. (2019)	40	Lumbar spine surgery-elective (prolapsed lumbar intervertebral disk, lumbar stenosis, or laminectomy)	20 mL of 0.5% bupivacaine was injected over each side under ultrasound guidance at t10	Total morphine consumption during the first 24 hours, pain score at rest and patient satisfaction score	Nil	24 hours	US-guided ESP block reduces postoperative opioid requirement and improves patient satisfaction [23]
Yu longyu et al. (2020)	80	Elective posterior internal fixation for a single level lumbar fracture	30 mL of 0.25% bupivacaine at each side under ultrasound guidance	Numeric pain scale at rest and movement, postoperative sufentanil consumption , and total bolus presses and effective bolus presses of PCA at 6 , 12 , 24 , and 48 hours	Nil	3 months	Ultrasound-guided lumbar ESP block is good for postoperative analgesia in lumbar spine surgery and can lessen postoperative opioid usage and

				postoperativ ely The incidence of PONV during the first 24-48 hours, pruritus, and chronic postoperativ e pain; pethidine dose for rescue pain relief, and length of hospital stay			promote postoperati ve rehabilitati on. [24]
Li Junzhu (2021)	40	Lumbar fusion	0.375% ropivacai ne (20 mL) at each side under ultrasoun d guidance at level L2	Total oxycodone consumption , remifentanil consumption in surgery; the number of pain-relieving doses of sufentanil in the PACU, the resting and exercise pain scores, the consumption of oxycodone at various time periods, range of cold hypoesthesia after the block at 10, 20, and 30 minutes	Nil	48 hours	Ultrasound -guided lumbar ESPB reduces the amount of analgesics required during and after lumbar fusion and reduces the postoperati ve VAS pain score[25]
Vipin Kumar Goel et	102	Single level Transforami nal Lumbar	20 ml of 0.25% Bupivacai	Blood loss, length of surgery,	Nil	48 hours	Ultrasound -guided ESP block

al. (2021)		Inter-body Fusion surgery (elective)	ne on each side under ultrasound guidance at surgical level	opioid consumption, total muscle relaxants used, Numeric Pain Intensity, Modified observer's assessment of alertness and/or sedation score, the total opioids use at 24 hours up to 48 hours, total satisfaction score at 48 hours			for single-level lumbar fusion surgery is a good multimodal analgesia, reduced blood loss, total opioid usage and side effects, and postoperative pain with better patient satisfaction [26]

Table 3-Risk of bias assessment conducted using version 2 of the Cochrane risk-of-bias tool for randomized trials (RoB2)

Study	Domain 1: Risk of bias arising from the randomisation process	Domain 2.1: Risk of bias due to deviations from the intended interventions (effect of assignment to intervention)	Domain 2.2: Risk of bias due to deviations from the intended interventions (effect of adhering to intervention)	Domain 3: Missing outcome data	Domain 4: Risk of bias in measurement of the outcome	Domain 5: Risk of bias in selection of the reported result	Overall risk of bias
Goel et al., 2021	Low	Low	Low	Low	Some concerns	Low	Some concerns
Nashibi et al., 2022	Low	Low	Low	Low	Some concerns	Low	Some concerns
Nashibi et al., 2023	Low	Low	Low	Low	Some concerns	Low	Some concerns
Singh et al., 2019	Low	Low	Low	Low	Some concerns	Low	Some concerns
Yu et al., 2020	Low	Low	Low	Low	Some concerns	Low	Some concerns
Zhang et al., 2023	Low	Low	Low	Low	Some concerns	Low	Some concerns
Zhu et al., 2021	Low	Low	Low	Low	Some concerns	Low	Some concerns

4.2 Data Extraction and Analysis

Methods – Outcomes of Interest

The primary outcomes of interest for this study are the postoperative resting pain score at 0 hour, 4 hours, 12 hours and 24 hours. For studies providing median and interquartile range, the estimated mean is calculated according to Luo et al. (2018) [1] while the estimated standard deviation is calculated according to Wan et al. (2014) [2]. The secondary outcomes include 24-hour postoperative opioid consumption and incidence of post-operative nausea and vomiting.

Methods - Data Analysis

Statistical analysis was performed using Review Manager (v5.4). The DerSimonian and Laird random effects model was used to calculate risk ratio (RR) with 95% confidence intervals (CIs) for dichotomous data, while the mean difference (MD) with 95% CI were calculated for continuous variables. Heterogeneity was assessed statistically using the $\chi 2$ and I2 statistics. Heterogeneity is significant when the p value by $\chi 2$ test was <0.10, or the I2 statistic was $\geq 50\%$. An overall p value of <0.05 is considered statistically significant.

[1] D. Luo, X. Wan, J. Liu and T. Tong (2018), "Optimally estimating the sample mean from the sample size, median, mid-range and/or mid-quartile range", Statistical Methods in Medical Research, 27: 1785-1805.

[2] X. Wan, W. Wang, J. Liu and T. Tong (2014), "Estimating the sample mean and standard deviation from the sample size, median, range and/or interquartile range", BMC Medical Research Methodology, 14: 135.

4.3 Data Analysed and result

Postoperative Pain Scores

Six studies contained information regarding postoperative pain scores with the use of ESP block in patients as compared to control. Meta-analysis suggested that there is a statistical significant difference in ESP block providing lower pain scores at rest at 0 hour (MD, -1.60; 95% CI, -2.74 to -0.46; I2 = 93%; P = 0.006) [Figure 1] and 24 hours (MD, -0.54; 95% CI, -0.98 to -0.10; I2 = 70%; P = 0.02) [Figure 4] postoperatively as compared to patients who do not receive ESP block. There is no statistically significant difference in postoperative pain scores between patients who receive and did not receive ESP block at 4 hours (MD, -0.97; 95% CI, -2.21 to 0.27; I2 = 94%; P = 0.13) [Figure 2] and 12 hours (MD, -1.28; 95% CI, -2.54 to -0.03; I2 = 96%; P = 0.05) [Figure 3] respectively. Heterogeneity is significant across all outcome groups.

24-hour postoperative opioid consumption

Six studies provided opioid consumption data within the first 24 hours after surgery. Meta-analysis suggested that patients receiving ESP block have a statistically significant difference in having lower 24-h opioid consumption (MD, -50.95; 95% CI, -68.09 to -33.80; I2= 100%; P < 0.00001) when compared with the control group who did not receive the block [Figure 5].

Postoperative Side Effects of Nausea and Vomiting

Four studies investigated the impact of the ESP block on the incidence of postoperative nausea and vomiting (PONV) among patients. Meta-analysis revealed that ESP block have a statistically significant reduction in incidence of PONV (RR, 0.39; 95% CI, 0.20 to 0.77; I2 = 55%; P =0.007) when compared with the control group [Figure 6].

Table 4-Table for data analysis on post operative pain score at 0,4,12,24 hours

Title of Study	Total Participants		Pain Score at 0 hour				Pain Score at 4 hours				Pain Score at 12 hours				Pain Score at 24 hours			
	Intervention	Control	Intervention		Control		Intervention		Control		Intervention		Control		Intervention		Control	
			Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Goel et al., 2021	51	50	1.52	1.03	4.08	1.78	1.9	0.92	2.14	0.83	1.78	0.81	2.1	0.78	1.09	0.64	1.46	0.68
Nashibi et al., 2022	20	20	1.65	1.14	3.65	1.63	2.2	1.15	3.65	1.27	1.75	0.79	2.75	0.97	1.5	0.76	2.6	1.05
Nashibi et al., 2023	35	30																
Singh et al., 2019	20	20	2.3598	2.3935	3.6403	0.7978	2.3598	2.3935	2	1.5957	2	1.5957	2	1.5957	2	1.5957	2	1.5957
Yu et al., 2020	40	40									0	0	1.3549	0.7689	1	1.5379	1	1.5379
Zhang et al., 2023	108	105	0.1067	0.3959	0.7037	1.5034	1	1.5034	3.3518	2.2542	2	1.5034	3	1.5028	1.8241	1.1275	2	1.5028
Zhu et al., 2021	20	20									3.3037	1.117	7.3927	2.234	5.0814	1.9547	6.8741	1.9547

Table 5- Table for data analysis on 24 hours post operative opioid consumption and PONV

Title of Study	Total Participants			Mean Opioid Consumption				PONV				
	Intervention	Control		Intervention		Control		Intervention		Control		
				Number	Total	Number	Total	Number	Total	Number	Total	
Goel et al., 2021	51	50	Fentanyl (mcg)	100.98	15.15	158	23.38					
Nashibi et al., 2022	20	20	Meperidine (mg)	22.5	32.34	57.5	45.95	3	20	6	20	Number
Nashibi et al., 2023	35	30	Fentanyl (ug)	14.29	21.25	73.33	65.96	0.34	0.68	0.6	0.81	Score
Singh et al., 2019	20	20	Morphine (mg)	1.4	1.5	7.2	2	0	20	2	20	Number
Yu et al., 2020	40	40	Pethidine (mg)	96.25	13.68	245	13.13	7	40	33	40	Number
Zhang et al., 2023	108	105						23	108	38	108	Number
Zhu et al., 2021	20	20	Remifentanil (mg)	0.69	0.03	0.85	0.04					

Figure 1 Post operative pain score at 0 hour

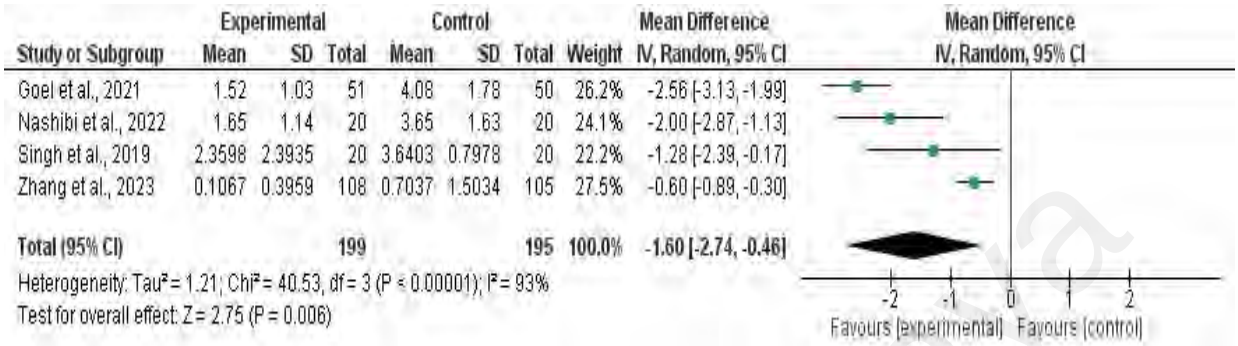


Figure 2 Post operative pain score at 4 hour

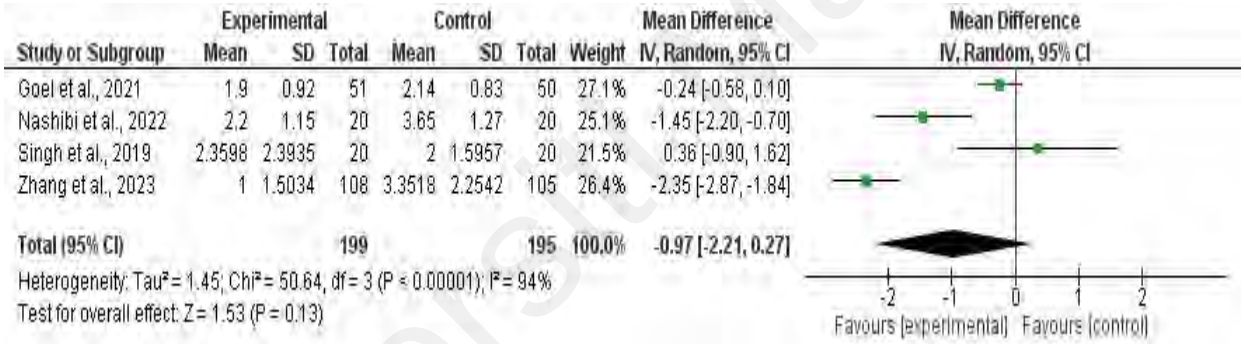


Figure 3 Post operative pain score at 12 hour

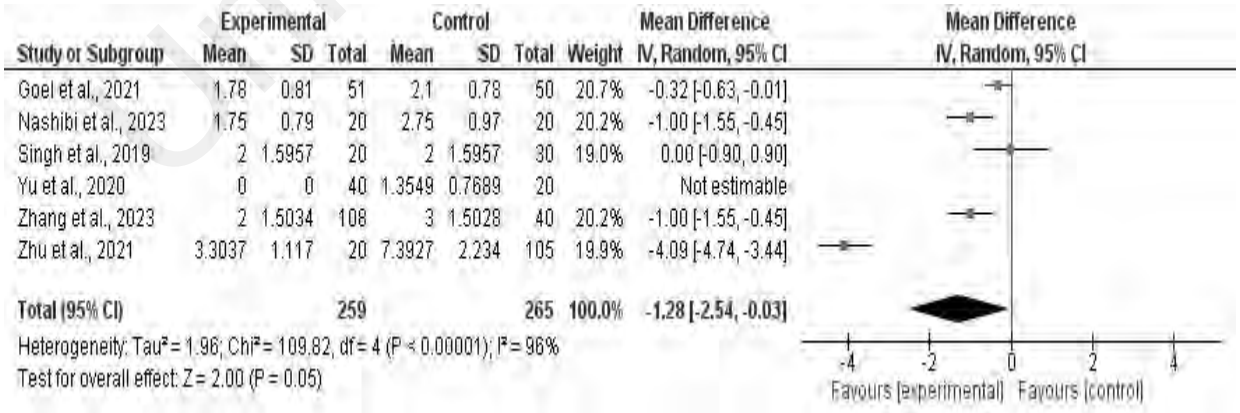


Figure 4 Post operative pain score at 24 hour

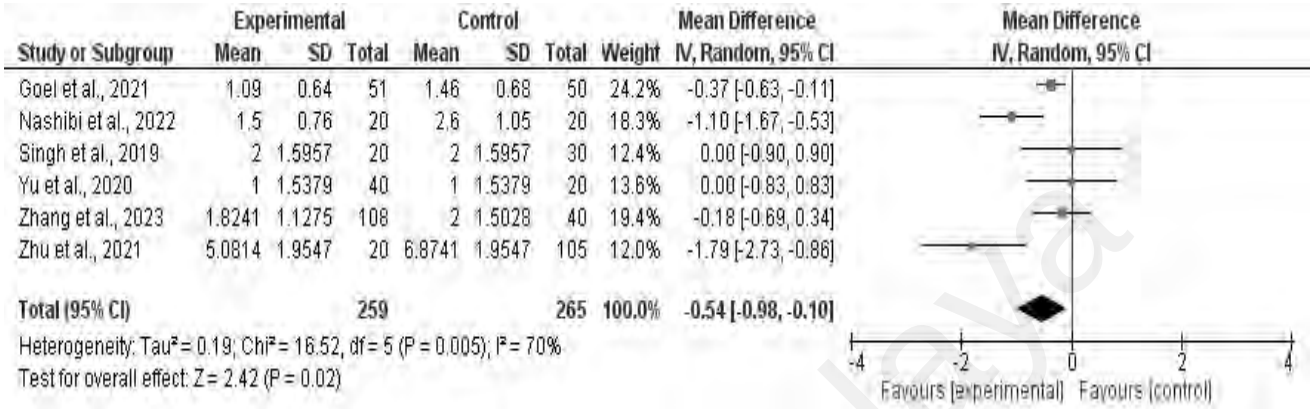


Figure 5- Mean opioid consumption

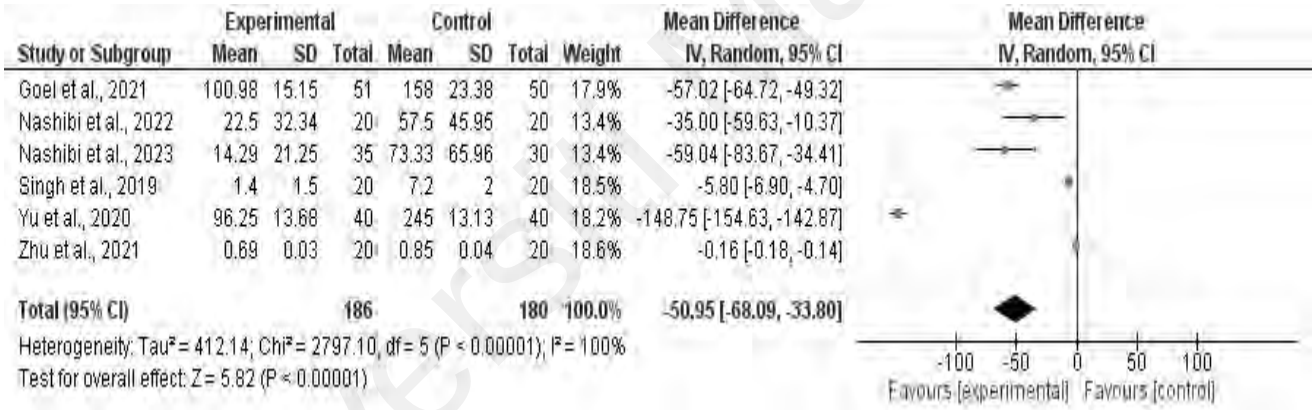
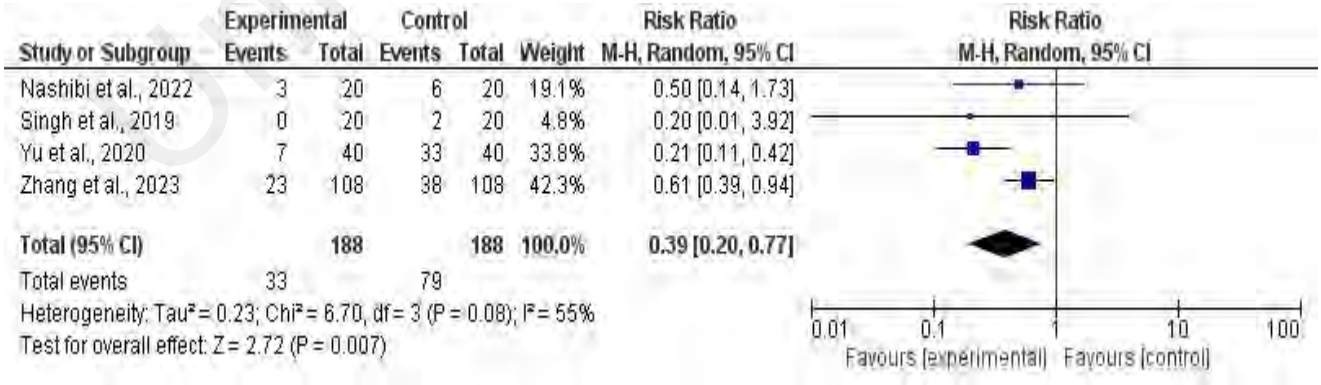


Figure 6- Post operative nausea and vomiting



Discussion

Lumbar spine surgery has been increasing in trend in view of aging of the population. Being one of the most painful surgeries, yet no real consensus for pain management in lumbar spine surgery has been developed. ESP block had been recently introduced in multiple types of surgeries including lumbar spine surgery as method to help in pain control and minimise opioid usage.

In our meta-analysis which included 7 RCTs, ESP block was found to be useful in lumbar spine surgery. On patients receiving ESP block, it was found out that they had significant less pain score at 0 hours and 24 hours post operatively. Moreover, this meta-analysis also revealed that ESP block in lumbar spine surgery had significantly reduced 24 hours opioid consumption and PONV post operatively. No patient was found to develop complications from ESP block in all 7 RCTs.

However, there are several limitations were found in this study. Pain score in ESP block and non-ESP block patients show no statistically significant difference in postoperative pain score at 4 and 12 hours respectively. This might be attributed to high heterogeneity across all outcomes. However, due to the limited number of studies, meta-regression could not be performed to assess the impact of these potential confounders.

First, heterogeneity was found in type of surgery performed. Different types of lumbar spine surgery might affect the degree of pain. Potential confounders such as duration of surgery, intraoperative complications and length of incision were not included in majority of studies for further analysis.

Secondly, different local anaesthetic agents used could contribute to potential confounders, including different type of medication, volume, concentration and the site of injection. Among included studies in this meta-analysis, the type of local anaesthesia used include ropivacaine

and bupivacaine with concentration ranging from 0.25% to 0.5% and the location of injection was either at the lumbar or lower thoracic level.

Thirdly, the type of post-operative opioid rescue given differs among studies, including meperidine, oxycodone, pethidine, morphine and sufentanil. Although belonging to the same class of drugs, there are differing duration of action (short/long) and time of onset which can cause difference in pain score perceived.

Conclusion

In conclusion, this meta-analysis suggests that the ESP block significantly improved postoperative pain score, results in reduced opioid consumption and postoperative nausea vomiting. Future randomised controlled trials with controlled confounding factors mentioned above should be carried out to provide a more comprehensive overview for further analysis.

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