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ORIGINAL RESEARCH

Erector Spinae Block vs Paravertebral Block in Breast Cancer Surgery: A Systematic Review and Meta-analysis

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ABSTRACT

Background : The paravertebral block (PVB) is the gold standard for postoperative analgesia in breast surgery, but it easily causes pneumothorax. Erector spinae plane block (ESPB) is considered as alternative to PVB because its less invasive so relative safer. However, evidence in favor of these techniques is lacking.

Method :. A search of PubMed Central, Cochrane Library, Wiley Online Library, and ClinicalTrials.gov to identify the latest 20 years studies comparing ESPB and PVB in breast cancer surgery was conducted. Our endpoints were: intraoperative fentanyl consumption, total postoperative morphine, and time to first analgesic request.

Result : A total of 6 studies (394 patients) were included for this meta-analysis. The pooled analysis showed there is -3.03 (MD = -3.03: 95% CI: -7.47– 1.42) mean difference with insignificant overall effect (P = 0.18) for intraoperative fentanyl consumption on ESPB patient after breast cancer surgery compared against PVB procedure. There is an insignificant between ESPB and PVB regarding total postoperative morphine with 0.46 (MD = 0.46: 95% CI: -0.94 – 1.85) mean difference with insignificant overall effect (P =0.52). There is a significant difference between ESPB and PVB regarding time to first analgesic request with 0.23(MD = 0.23: 95% CI: 0.01– 0.44) risk ratio with statistically significant overall effect (P = 0.04). Both intraoperative fentanyl consumption and total postoperative morphine consumption showed heterogeneity. Meanwhile, time to the first analgesic request showed no heterogeneity.

Conclusion : PVB is superior to ESPB regarding time to first analgesic request, but ESPB can serve as an alternative to PVB with a similar analgesic effect.

Keywords: Breast cancer surgery; Erector Spinae Plane Block (ESPB); Mastectomy; Paravertebral Block (PVB); Radical mastectomy.

INTRODUCTION

Breast cancer is one of the most commonly reported malignancies in females, with a high proportion of affected patients undergoing breast surgery.[1,2] However, the post-operative pain of breast surgery is difficult to manage due to the complexity of the surgery and nerve innervation.[2] 30–50% of patients have reported moderate to severe acute pain, and 8–25% have persistent post-surgical pain.[3] Poorly controlled acute post-surgical pain is associated with impaired functional recovery, increased length of hospital stay, and delayed discharge from the post-anesthesia care unit — therefore resulting in significant health care needs and costs.[3,4]

Regional anesthesia technique that considered as the gold standard for managing breast surgical pain is Thoracic paravertebral block (PVB).[1,2,5] Although it is an effective technique for achieving adequate postoperative analgesia, it's an advanced technique with potential complications risks such as pleural penetrating and pneumothorax.[6]

Erector spinae plane block (ESPB) is a myofascial plane block that considered as alternative to PVB because its less invasiveness, ease of application, relatively safer and possible wider spreading of local anesthetics.[2,6] However, evidence in favor of these novel techniques is lacking.[1] Previous systematic reviews and meta-analysis reported the efficacy of ESPB[7,8], but trials of surgeries other than breast surgery were included in these meta-analyses. Furthermore, there are very few meta-analyses which compare ESPB and PVB. Therefore, we aim to conduct this meta-analysis to assess whether Erector Spinae Block is associated with improved outcomes (including intraoperative fentanyl consumption, total post operative morphine, and time to first analgesic request) compared with paravertebral block in breast cancer surgery.

METHOD

This meta-analysis was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. We searched the latest 20 years studies (published in 2002-2022) using PubMed Central, the Cochrane Library, Wiley Online Library, and ClinicalTrials.gov database. The search terms (text word) were "breast surgery", "mastectomy",

"Erector spinae", ESP, "Paravertebral Block", and PVB. Inclusion criteria for final selected studies were as follows: (1) language limited to English; (2) Randomized Controlled Trials comparing ESPB versus PVB as adjuvant anesthesia to general anesthesia in breast Surgery or mastectomy Surgery, include female ≥18 years with all type of breast tumor resection with or without concomitant axillary interventions; (3) Studies which reported at least one of the outcomes of our interest (endpoints). Our endpoints were: intraoperative fentanyl consumption, total postoperative morphine, and time to first analgesic request.

Data extraction

The initial search yielded 458 studies, but only 6 studies included in the final analysis based on eligibility criteria. The flowchart of the study is shown in Figure-1. Information about the study and patient characteristics, intervention strategies, and clinical outcomes was systematically extracted.

Quality Assessment

Risk of bias for each study were evaluated by author using The Cochrane Collaboration's tool. The tool consists of seven points: random sequence generation, blinding of participants and personnel, blinding of outcome assessment, allocation concealment, selective reporting, incomplete outcome data, and other sources of bias. Randomized Trials with > 2 high-risk components were considered as having a moderate risk of bias, meanwhile randomized trials with > 4 high-risk components were considered as having a high risk of bias. **(Figure-2)**

Statistical Analyses

For each outcome, mean difference (MD) with a 95% confidence interval (CI) were calculated for continuous data. The heterogeneity was assessed using the Cochran's Q chi-square test and I^2 analysis method. The Q analysis show statistically significant heterogeneity if P-value < 0.05 and the I^2 values >50%. When there was insignificant heterogeneity, the data were pooled using a fixed-effects model, otherwise a random effect model was used. Publication bias was assessed graphically using a funnel plot. The data were processed utilizing Review Manager software (Version 5.4.1, the Cochrane Collaboration, 2020).

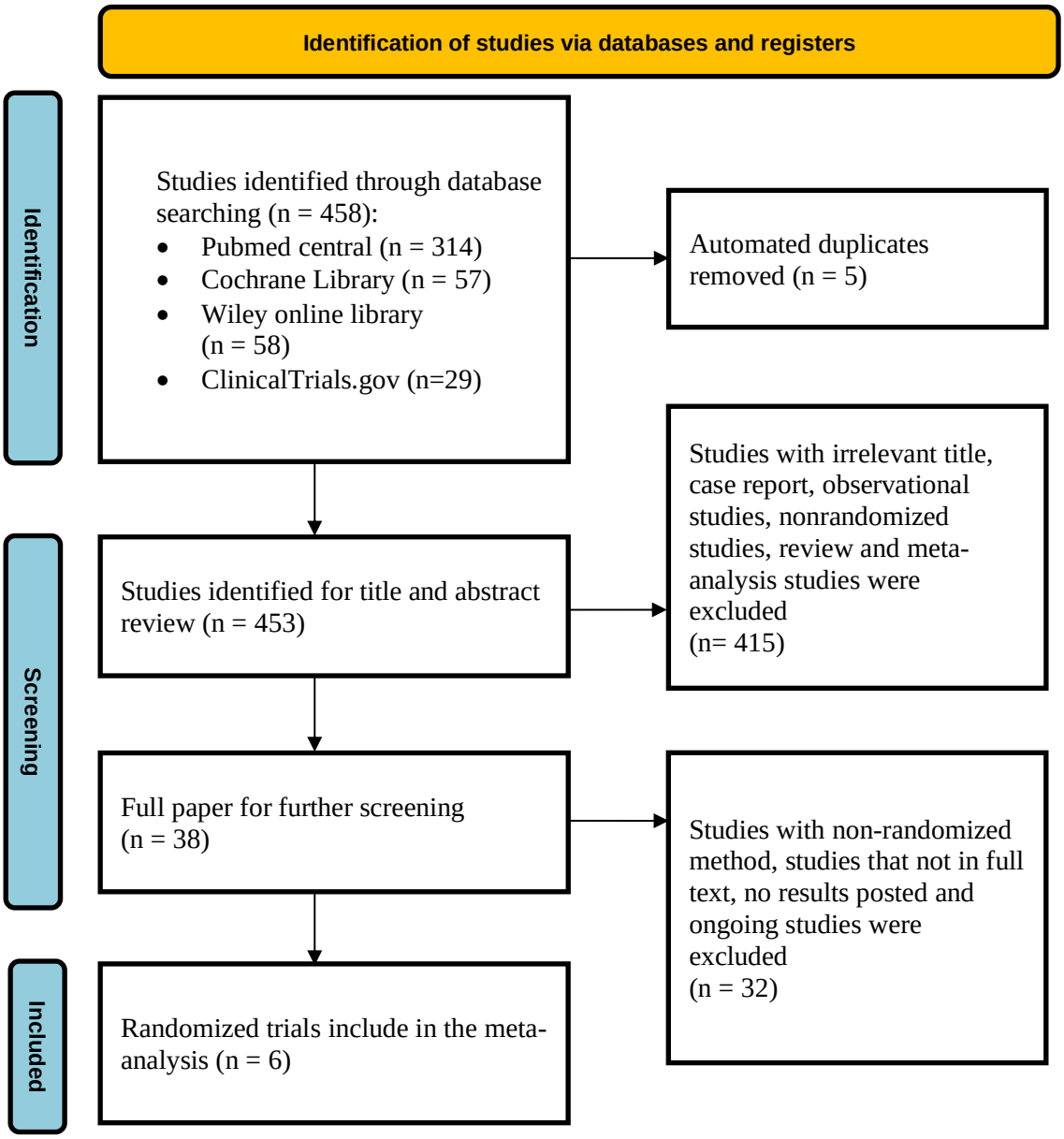

Figure-1. PRISMA Flowsheet.

Figure-2. Risk of bias summary

RESULT

Demographic characteristics of the included studies

We identified 458 studies from the keyword hits, after screening and eligibility assessment of those studies, 452 studies were excluded for various reasons, and we found 6 potentially relevant studies for the purpose of this systematic review and meta-analysis from 6 countries, including India, Egypt, Turkey, Thailand, China, and Japan. Out of six potentially relevant studies, all of them were randomized controlled trials. All of the included studies were double-blinded. Out of 394 participants included in this meta-analysis, There are 197 participants who undergo an erector spinae plane block and 197 participants who undergo a paravertebral block. Detailed information about demographic and study characteristic of included studies summarized in Table 1.

Outcome characteristics of the included studies

Total participants in 6 included studies are 394 participants consist of 197 participants with 197 participants undergo with erector spinae plane block and 197 participants undergo with paravertebral block. In this systematic review and meta-analysis, we assessed intraoperative fentanyl consumption, total postoperative morphine, and time to the first analgesic request. Detailed result of assessed outcome in this study summarized in Table 2.

Table 1. Demographic characteristic of erector spinae block against paravertebral block in breast cancer surgery (mastectomy or radical mastectomy) patients of the included studies

Studies	Location	Study Method	Binding	Study Period	Outcome	Inclusion Criteria	Participants (n)	
							ESPB	PVB
Agarwal S et al, 2021[1]	India	Prospective RCT	Double blinded	1 years	• Duration of analgesia (min) • Intraoperative fentanyl consumption (mcg) • Total dose of diclofenac (mg)	Female patients in the age group ranging 18-70 years, who underwent radical mastectomy	40	40
El-Ghamry et al, 2019[9]	Egypt	Prospective RCT	Double blinded	5 months	• Intraoperative fentanyl consumption (mcg) • Total postoperative morphine (mg) • Time to first analgesic request (h) • Nausea (%) • Vomiting (%) • Pneumothorax (%)	Female patients in the age group ranging 20-60 years, who underwent modified radical mastectomy	35	35
Elewa AM et al, 2022[5]	Egypt	Prospective RCT	Double blinded	9 months	• Total morphine consumption (mg) • For first required analgesia (h) • Intraoperative isoflurane (ml) • VAS at 1 h • VAS at 4 h • VAS at 8 h • VAS at 12 h • VAS at 24 h • PONV, N	Female patients in the age group ranging 20-60 years, who underwent modified radical mastectomy	30	30

Gurkan Y et al, 2019[6]	Turkey	Prospective RCT	Double blinded	5 months	• NRS at 1 h • NRS at 6 h • NRS at 12 h • NRS at 24 h • Morphine consumption (mg) • 1st h • 6th h • 12th h • 24th h	Female patients aged 18-65 years who were scheduled to go under elective unilateral breast surgery for breast cancer	25	25
Moustafa MA et al, 2019[10]	Egypt	Prospective RCT	Double blinded	10 months	• Time to first analgesic requirement (h) • Total morphine consumption (mg)	Female patients aged 40-65 years who were scheduled for modified radical mastectomy	45	45
Wittayapairoj A et al, 2022[11]	Thailand	Prospective RCT	Double blinded	7 months	• Intraoperative fentanyl consumption (mcg) • Total morphine consumption in 24 h (mg) • Number of patients requiring rescue morphine • Frequency of rescue morphine requirements (time)	Female patients aged 18-75 years who were scheduled for unilateral mastectomy	22	22
		197				197 197	197	
				Total			394	

RCT: Randomized Controlled Trial, NRS/VAS: numerical rating scale/visual analogue scale, PONV: post-operative nausea and vomitting

Table 2. Outcome of erector spinae block against paravertebral block in breast cancer surgery (mastectomy or radical mastectomy) patients of the included studies

Studies	ESPB				PVB		
	Intraoperative fentanyl consumption (mcg)	Total postoperative morphine (mg)	Time to first analgesic request (h)	Groups (n)	Intraoperative fentanyl consumption (mcg)	Total postoperative morphine (mg)	Time to first analgesic request (h)
Agarwal S et al, 2021[1]	35 ± 16.83	-	-	1. GA + ESPB (40) 2. GA + PVB (40)	36.6 ± 12.58	-	-
El-Ghamry et al, 2019[9]	135.9 ± 14.5	26.7 ± 2.1	6.58± 0.60	1. GA + ESPB (35) 2. GA + PVB (35)	141.2 ± 11.9	27.3 ± 2.9	6.35 ± 0.42
Elewa AM et al, 2022[5]	-	4.9 ± 1.2	7.9 ± 1.2	1.GA + ESPB (30) 2.GA + PVB (30)	-	5.8 ± 1.3	7.5 ± 0.9
Gurkan Y et al, 2019[6]	-	5.6 ± 3.43	-	1. GA + ESPB (25) 2. GA + PVB (25)	-	5.64 ± 4.15	-
Moustafa MA et al, 2019[10]	-	6.17 ± 2.08	11.04± 1.9	1. GA + ESPB (45) 2. GA + PVB (45)	-	6.22 ± 2.09	11.22 ± 1.95
Wittayapairoj A et al, 2022[11]	177.3 ± 51.7	8.6 ± 3.8	-	1. GA + ESPB (22) 2. GA + PVB (22)	158.0 ± 49.0 2.63 ± 49.0	3.5 ± 3.3	-

*mean ± Standard Deviation (SD). ESPB: erector spinae plane block, GA: general anesthesia, PVB: paravertebral block

Intraoperative Fentanyl Consumption Outcome of Erector Spinae Plane Block vs. Paravertebral Block in Patients Undergoing Breast Cancer Surgery (Mastectomy or Radical Mastectomy)

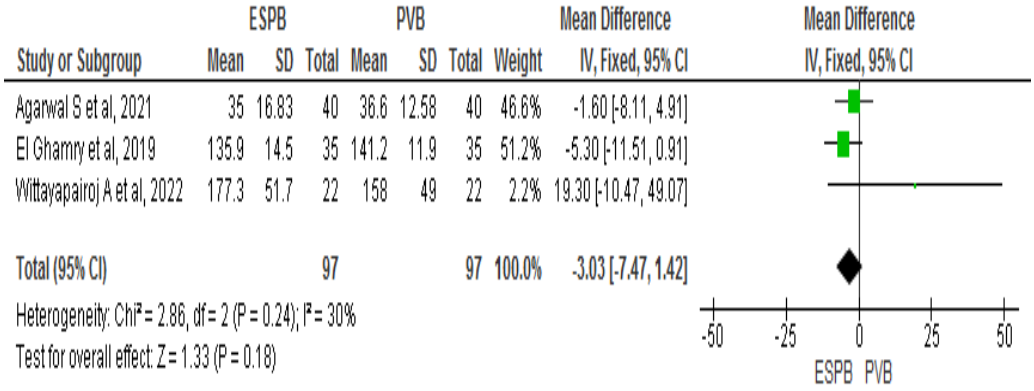

Figure 3. The forest plot of intraoperative fentanyl consumption on erector spinae block plane patient after breast cancer surgery compared against paravertebral block procedure

In the meta-analysis forest plot presented in figure 3 showed heterogeneity model analysis (I^2 = 30%; X^2 = 2.86; P = 0.24). Based on the heterogeneity analytical result data compiled from three studies included were statistically heterogeneous, so on fixed-effect analysis we conducted a summary effect measure to evaluate risk ratio of intraoperative fentanyl consumption on erector spinae block plane patient after breast cancer surgery compared against paravertebral block procedure. The analytical results showed there is -3.03 (MD = -7.47: 95% CI: -7.47 – 1.42; P = 0.18) mean difference with statistically insignificant overall effect (P = 0.18) for intraoperative fentanyl consumption. This result

showed there is no significant mean difference of intraoperative fentanyl consumption on erector spinae block plane patient after breast cancer surgery compared against paravertebral block procedure. To exclude publication bias risk, funnel plot assessment was performed. Based on the visual inspection of the funnel plot shown in figure 4, there is asymmetry plotting of three studies included on the funnel plot. Based on this, we can assume the result of the analysis have a risk of publication bias.

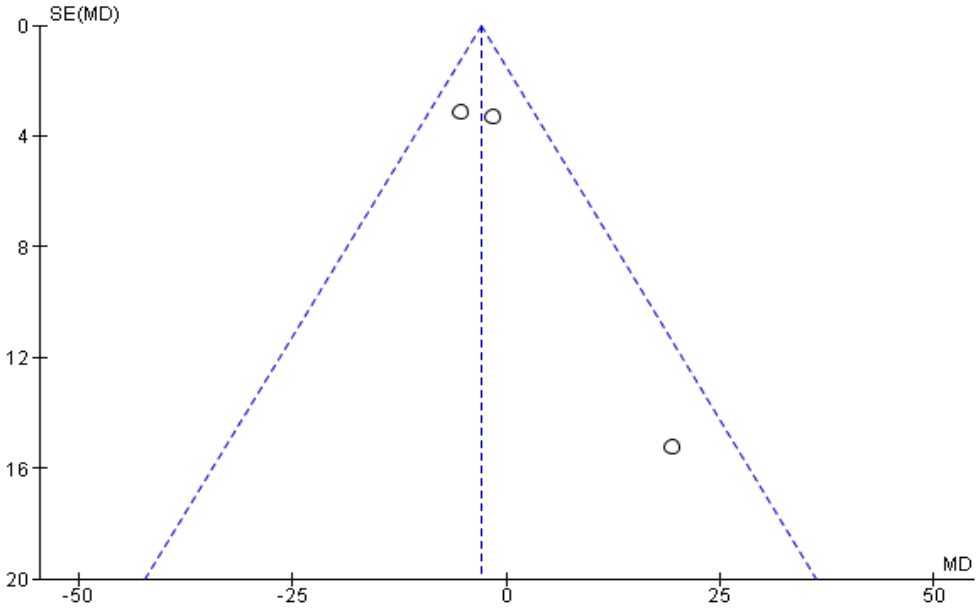

Figure 4. The funnel plot of intraoperative fentanyl consumption on erector spinae block plane patient after breast cancer surgery compared against paravertebral block procedure

Total Postoperative Morphine Outcome of Erector Spinae Plane Block Against Paravertebral Block in Breast Cancer Surgery (Mastectomy Or Radical Mastectomy) Patients

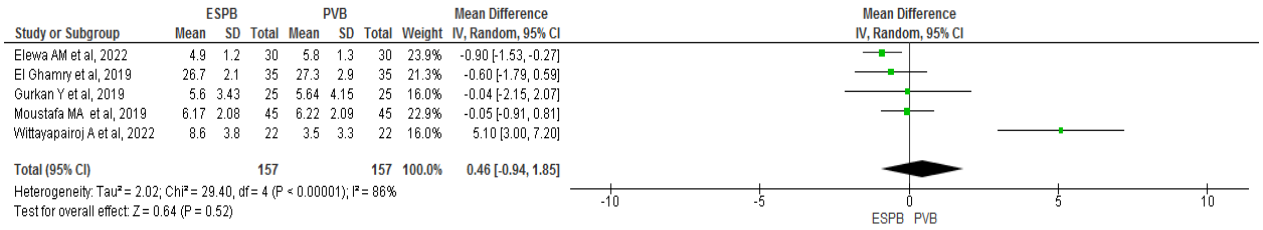

Figure 5. The forest plot of total postoperative morphine on erector spinae block plane patient after breast cancer surgery compared against paravertebral block procedure

In the meta-analysis forest plot presented in figure 5 showed heterogeneity model analysis (I^2 = 86%; X^2 = 29.40; P < 0.00001). Based on the heterogeneity analytical result data compiled from five studies included were statistically heterogeneous, so on random-effect analysis we conducted a summary effect measure to evaluate total postoperative morphine on erector spinae block plane patient after breast cancer surgery compared against paravertebral block procedure. The

analytical results showed there is 0.46 (MD = 0.46: 95% CI: -0.94 – 1.85) mean difference with statistically insignificant overall effect (P = 0.52) for total postoperative morphine. This result showed there is statistically no significant difference in total postoperative morphine between patients undergoing erector spinae block after breast cancer surgery and those undergoing paravertebral block.

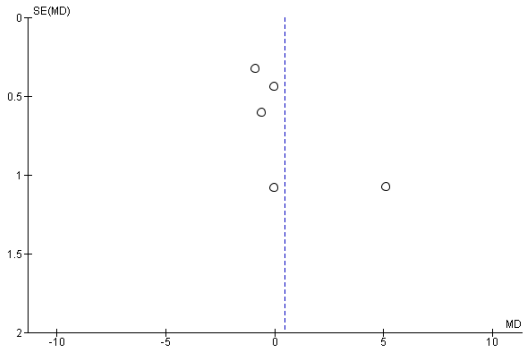

Figure 6. The funnel plot of total postoperative morphine on erector spinae block plane patient after breast cancer surgery compared against paravertebral block procedure

To exclude publication bias risk, funnel plot assessment was performed. Based on the visual inspection of the funnel plot shown in figure 6, there is asymmetry plotting of five studies included on the funnel plot. Based on this, we can assume the result of the analysis have a risk of publication bias.

Time to First Analgesic Request Outcome of Erector Spinae block plane vs. Paravertebral Block in Patients Undergoing Breast Cancer Surgery (Mastectomy or Radical Mastectomy)

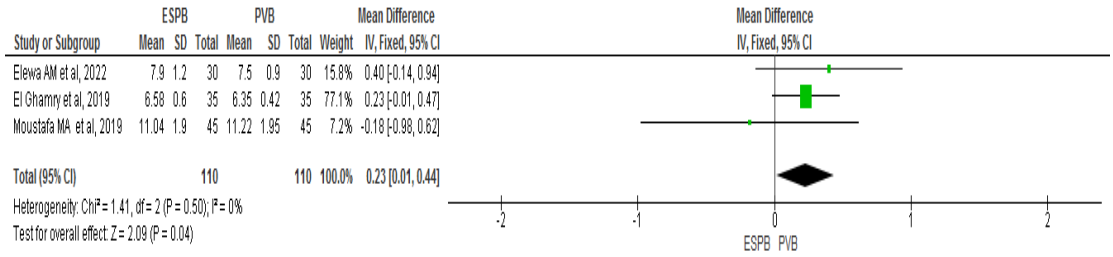

Figure 7. The forest plot of time to first analgesic request on erector spinae block plane patient after breast cancer surgery compared against paravertebral block procedure

In the meta-analysis forest plot presented in figure 7 showed heterogeneity model analysis (I^2 = 0%; X^2 = 1.41; P = 0.50). Based on the heterogeneity analytical result data compiled from three studies included were statistically no heterogeneous, so on fixed-effect analysis we conducted a summary effect measure to evaluate mean difference of time to first analgesic request on erector spinae block plane patient after breast cancer surgery compared against paravertebral block procedure. The analytical results showed there is 0.23 (MD = 0.23: 95% CI: 0.01 – 0.44) mean difference with statistically significant overall effect (P = 0.04) for time to first analgesic request. This result showed there is significant effect of time to first analgesic request on erector spinae blocks plane patient after breast cancer surgery compared against paravertebral block procedure.

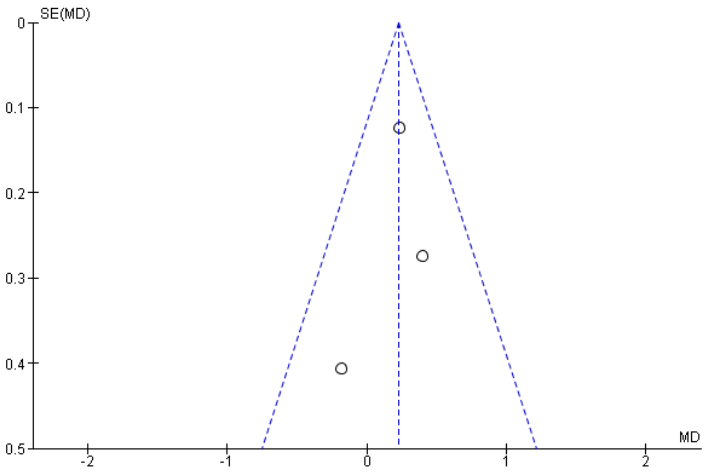

Figure 8. The funnel plot of time to first analgesic request on erector spinae block plane patient after breast cancer surgery compared against paravertebral block procedure

To exclude publication bias risk, funnel plot assessment was performed. Based on the visual inspection of the funnel plot shown in figure 8, there is asymmetry plotting of three studies included on the funnel plot. Based on this, we can assume the result of the analysis have a risk of publication bias.

Discussion

Thoracic Epidural Anesthesia (TEA) has gradually been replaced by other techniques in recent years due to the risks and limitations of TEA, including the restricted inclusion of patients using anticoagulants and the high rates of respiratory depression,

hypotension, and postoperative urinary retention associated with TEA. It has been progressively replaced with other techniques, such as ultrasonic guided PVB and ESPB.[8]

Paravertebral blockage (PVB) is multi-purpose and can be applied unilaterally or bilaterally. In contrast to a thoracic epidural, the PVB technique can be used to prevent contralateral sympathectomy, thus reducing hypotension and leading to better preservation of blood pressure. Thoracic PVB provides post-thoracotomy pain relief similar to thoracic epidural analgesia (TEA) with inferior side effects supported by medium quality evidence.[12] Erector spinae plane (ESP) block is a new nerve blockage technique offered for the first time by Forero et al. in 2016.[13] This is commonly performed by depositing drugs on the fascial plane beneath the erector spinae muscles at the apex of the transverse process of the spine to reduce pneumothorax and significant neurovascular injury. A number of studies have also reported that ESPB has an effective role in postoperative analgesia for thoracic and thoracic surgery, showing that it can be easily performed with high occlusion rates.[8]

Our meta-analysis result showed there is statistically no significant mean difference of intraoperative fentanyl consumption on erector spinae block plane patient after breast cancer surgery compared against paravertebral block procedure (MD = -3.03; 95% CI: -7.47 – 1.42; P = 0.18). This is in line with a retrospective cohort study by Aoyama et al. that mentions intraoperative fentanyl consumption for ESPB being lower than PVB. There is statistically no significant difference between both ESPB and PVB groups (p = 0.76) regarding intraoperative fentanyl consumption, according to Aoyama et al.[14]

Previous meta-analysis by Xiong et al. revealed that there is no statistically significant mean difference in total postoperative morphine between the erector spinae plane block procedure and the paravertebral block plane procedure on patients after breast cancer surgery (MD = -1.08; 95% CI: -2.76 – 0.51; P=0.18). This in line with our meta-analysis result showed there is statistically no significant mean difference of total postoperative morphine on erector spinae block plane patient after breast cancer surgery compared against paravertebral block procedure (MD = 0.46; 95% CI: -0.94 –

1.85; P = 0.52). This result that more morphine consumption at 24 hours by 0.46 mg after surgery for ESPB compared to PVB.[8]

This meta-analysis also found that there is statistically significant mean difference of time to first analgesic request on erector spinae block plane patient after breast cancer surgery compared against paravertebral block procedur (MD = 0.23; 95% CI: 0.01 – 0.44; P = 0.04). However, according to the researcher, the difference is not significant enough when applied in clinical practice because the difference in effect size (mean difference) is only 0.23. The possibility of this occurring is due to bias in sample selection, one of which is a withdrawal bias, in which participants withdraw from the study.

There are several limitations to our meta-analysis and systematic review. First, the included research that describes our research is limited because there is very little research on this particular issue that can be accessed for free, which may weaken the conclusion. Second, most of the literature is composed of small sample sizes, with the largest included experimental group is 45 patients. Third, this study was limited to ESPB and restricted the inclusion of studies of other novel fascial plane blocks.

CONCLUSION

There was a statistically insignificant overall effect for intraoperative fentanyl consumption and total postoperative morphine, which showed heterogeneity. Meanwhile, there was statistical significance regarding the time to the first analgesic request, and it showed no heterogeneity.

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