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Breast

Regional Anesthesia and Postoperative Opioid Use in Autologous Breast Reconstruction: A Systematic Review and Meta-analysis

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Background: Nerve and fascial plane blocks are common components of early recovery after surgery protocols for autologous breast reconstruction, but there is mixed data regarding their efficacy. This study evaluated the association between regional anesthesia and postoperative opioid use, patient-reported pain, length of stay (LOS), and duration of surgery.

Methods: We conducted a systematic review of articles on regional anesthesia in autologous breast reconstruction and a dual extraction of outcomes. Data of interest included total, 24-hour, and 48-hour opioid use (intravenous [IV] morphine milligram equivalents [MMEs]), patient-reported pain, and length of surgery and stay. We performed meta-analyses with random effects models for mean difference (MD).

Results: We included 21 studies for analysis. Total opioid use was reduced among patients who received regional anesthesia (MD = −10.28 IV MMEs, ~3 oxycodone 5-mg equivalents, $P < 0.05$), as was opioid use at 24 (MD = −21.65 IV MMEs, $P < 0.05$) and 48 hours (MD = −24.42, $P < 0.05$). However, total opioid use was not significantly different when considering only data from randomized trials. There was no significant reduction in patient-reported pain at 48 hours (standardized MD = −0.28), nor was there a significant reduction in the length of surgery (MD = −0.26 h). Regional anesthesia was associated with an average 0.73-day reduced LOS.

Conclusions: Regional anesthesia was associated with a statistically but not clinically significant reduction in total postoperative opioid use and LOS following autologous breast reconstruction. Total opioid use was not significantly different when considering only randomized controlled trial data. *(Plast Reconstr Surg Glob Open 2025;13:e6694; doi: 10.1097/GOX.0000000000006694; Published online 15 April 2025.)*

INTRODUCTION

Pain after autologous breast reconstruction remains a significant barrier to recovery. Traditionally, postoperative pain has been managed with opioid analgesics, but concerns over opioid dependence and advances in multimodal early recovery after surgery (ERAS) protocols have reduced reliance on these medications.[1,2] These ERAS protocols, which include targeted interventions before, during, and after surgery, aim to improve surgical care, shorten hospital stays, and accelerate patient recovery, all while minimizing postoperative pain.[3–5]

Regional anesthesia is 1 component of multimodal pain management in ERAS protocols for autologous breast reconstruction.[6–8] Common examples of regional anesthesia include peripheral nerve blocks and fascial plane blocks, in which anesthetic is infiltrated around peripheral nerves or into the potential space between fascial layers.[9] Various nerve blocks and anesthetic agents have been proposed in ERAS protocols; however, ERAS protocols are often implemented with several simultaneous interventions (eg, fluid management and ambulation), making it difficult to determine the isolated effect of regional anesthesia.[10]

This study aims to evaluate the association between regional anesthesia and opioid use, focusing on the role

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of nerve blocks and fascial plane blocks in pain management after autologous breast reconstruction. The primary outcome was total opioid use, as well as interval opioid use at 24 and 48 hours postoperatively. Secondary outcomes included patient-reported pain, length of stay (LOS), and duration of surgery. We hypothesized that regional anesthesia implemented in isolation from other ERAS interventions would not be significantly associated with reduced opioid consumption following autologous breast reconstruction.

Takeaways

Question: How does regional anesthesia impact postoperative opioid use, patient-reported pain, length of stay, and duration of surgery for autologous breast reconstruction?

Findings: Total opioid use was reduced among patients who received regional anesthesia by ~3 oxycodone 5-mg equivalents. There was no significant reduction in patient-reported pain after 48 hours, nor was there a significant reduction in the length of surgery. Regional anesthesia was associated with an average 0.73-day reduced length of stay.

Meaning: Regional anesthesia may have a statistically but not clinically significant impact on total postoperative opioid use after autologous breast reconstruction.

METHODS

Systematic Review

We conducted a systematic review of PubMed, Embase, and Web of Science on May 4 and August 4, 2024, to identify articles on regional anesthesia in autologous breast reconstruction. (**See appendix, Supplemental Digital Content 1**, which displays the search strategy for systematic review, **http://links.lww.com/PRSGO/D960**.)

Briefly, we combined medical subject headings with title, abstract, and full-text keywords to identify studies. We included clinical trials, cohort studies, and case series involving 30 or more adult patients undergoing autologous reconstruction with an abdominal or gluteal-based soft tissue flap for breast reconstruction. To be eligible, experimental groups had to include patients receiving regional anesthesia in addition to treatment as usual (TAU), whereas control groups received only TAU (ie, without additional analgesics or sedatives not provided to the experimental arm). Regional anesthesia was defined as the injection or continuous infusion of an anesthetic agent into the proximity of an anatomical structure, such as a fascial plane or peripheral nerve, to promote analgesia. To be comprehensive, we included named nerve or fascial plane blocks, as well as the continuous instillation of local anesthetic into a wound. We excluded studies involving nonhuman subjects, children, nonautologous reconstructions, reconstruction using latissimus dorsi flaps, or procedures using only local, spinal, epidural, or general anesthesia. Head-to-head studies comparing different anesthetic agents without a negative control (ie, placebo) were also excluded. Additionally, we excluded reviews, case reports, case series with fewer than 30 participants, abstracts, conference proceedings, and editorials. The systematic review protocol was not registered.

Two blinded reviewers (M.J.H. and K.J.Z.) conducted a dual screen of titles and abstracts and included those meeting the selection criteria. Conflicts between reviewers were resolved through discussion. Four blinded reviewers (M.J.H., K.J.Z., S.A., and A.J.C.) then performed a dual screening of full-text articles and included those that satisfied all selection criteria. Conflicts were resolved by a third reviewer who had not participated in the initial screening of the article.

Data Extraction

Three blinded reviewers (M.J.H., S.A., and I.A.S.) conducted a dual extraction of study data, including operative factors (eg, indication and flap type), anesthetic factors (eg, anesthetic agent and ultrasound guidance), and study outcomes. We collected data for the primary outcome, total opioid use, and opioid use at 24 and 48 hours using intravenous (IV) morphine milligram equivalents (MMEs). For studies reporting only oral morphine equivalents (OMEs), we converted OMEs to IV MMEs using standard conversion factors from the Centers for Disease Control.[11,12] We also gathered data on patient-reported pain using visual analog scales or numeric rating scales, LOS (in d), and length of operation (in h). Conflicts were resolved through discussion and reexamination of each article by 1 reviewer (M.J.H.).

Risk-of-bias Assessment

We conducted a risk-of-bias assessment using 1 of 2 instruments, depending on the study design. The Risk of Bias in Non-randomized Studies of Interventions tool was used to evaluate bias in cohort and case-control studies, and the revised Cochrane risk-of-bias tool for randomized trials was applied to randomized controlled trials (RCTs).[13,14] Two blinded reviewers (L.Z. and A.J.D.) independently assessed studies using the appropriate tool. Conflicts were resolved by a third reviewer (M.J.H.).

Meta-analysis

We used random effects models for mean difference (MD) to assess changes in opioid use, LOS, and length of operation associated with regional anesthesia. We used random effects models for standardized MD for pain, because both visual analog scale and numeric rating scale scores were reported. Meta-analyses were conducted only for outcomes with data from 3 or more studies or unique treatment arms. If 2 treatment arms from the same study were eligible, we treated them as separate studies with independent contributions to the model. When sufficient data were available, we performed stratified analyses by block location, block type, and ultrasound use. We also stratified by study design, with RCTs serving as a reference for sensitivity analyses. All meta-analyses were performed with patients who did not receive regional anesthesia as the relative control. Results from random effects models were presented

using forest plots with 95% confidence intervals (CIs) and prediction intervals. We assessed heterogeneity with the Cochran Q statistic, also reporting the I^2 value and P value. We used descriptive statistics to evaluate the proportion of patients by block location, block type, flap type, anesthetic agent, dose, and infusion rate. All analyses were performed using RStudio (Posit Software, Boston, MA) at the significance level of α equal to 0.05. Results were presented in compliance with the 2020 Preferred Reporting Items for Systematic Reviews and Meta-Analyses statement.[15]

RESULTS

Systematic Review

The systematic review identified 7051 studies. We removed 4182 duplicates and screened 2869 titles and abstracts, from which 77 studies advanced to full-text screening. The final sample contained 21 studies, including 5 RCTs[16–20] and 16 nonrandomized studies of interventions[21–36] (Fig. 1), and 1307 unique patients with data available for meta-analysis. Characteristics of included studies are outlined in Table 1, and summary characteristics are included in Table 2. Comparable studies that were ultimately excluded were those in which the isolated effect of regional anesthesia could not be ascertained,[7,37–46] as well as studies in which patients underwent breast reconstruction with latissimus dorsi flaps.[46–50]

Opioid Use

Total opioid use was significantly reduced for patients who received regional anesthesia in 5 of 13 studies (Fig. 2A).[21,22,33–35] Five of 8 studies reported significant reductions in opioid use at 24 hours (Fig. 2B),[18,19,28,29] and 5 of 6 studies reported significant reductions in opioid use between 24 and 48 hours (Fig. 2C).[28,29,34,36]

Random effects modeling revealed a significant association between regional anesthesia and reductions in total opioid use (Fig. 2A, MD = −10.28 IV MMEs, 95% CI [−16.52 to −4.05], $I^2 = 79.4\%$), opioid use at 24 hours postoperatively (Fig. 2B, MD = −21.65 IV MMEs, 95% CI [−35.33 to −7.97], $I^2 = 92.7\%$), and opioid use at 48 hours postoperatively (Fig. 2C, MD = −24.42, 95% CI [−35.14 to −13.69], $I^2 = 82.0\%$).

A subanalysis stratified by block type identified significant reductions in total postoperative opioid use among patients who received transverse abdominis plane (TAP) blocks (MD = −11.78 IV MMEs, 95% CI [−19.10 to −4.46], $I^2 = 62.1\%$) or rectus sheath blocks (MD = −24.80 IV MMEs, 95% CI [−42.13 to −7.47], $I^2 = 29.3\%$). (**See figure, Supplemental Digital Content 2**, which displays the MD in total postoperative opioid use [IV MMEs] for patients receiving TAP blocks [A] or rectus sheath blocks [B] in addition to TAU compared with patients who received TAU alone. MD in 24-hour postoperative opioid use for patients receiving TAP blocks [C] or rectus sheath blocks [D] in addition to TAU compared with patients who received TAU alone, **http://links.lww.com/PRSGO/D961**.)

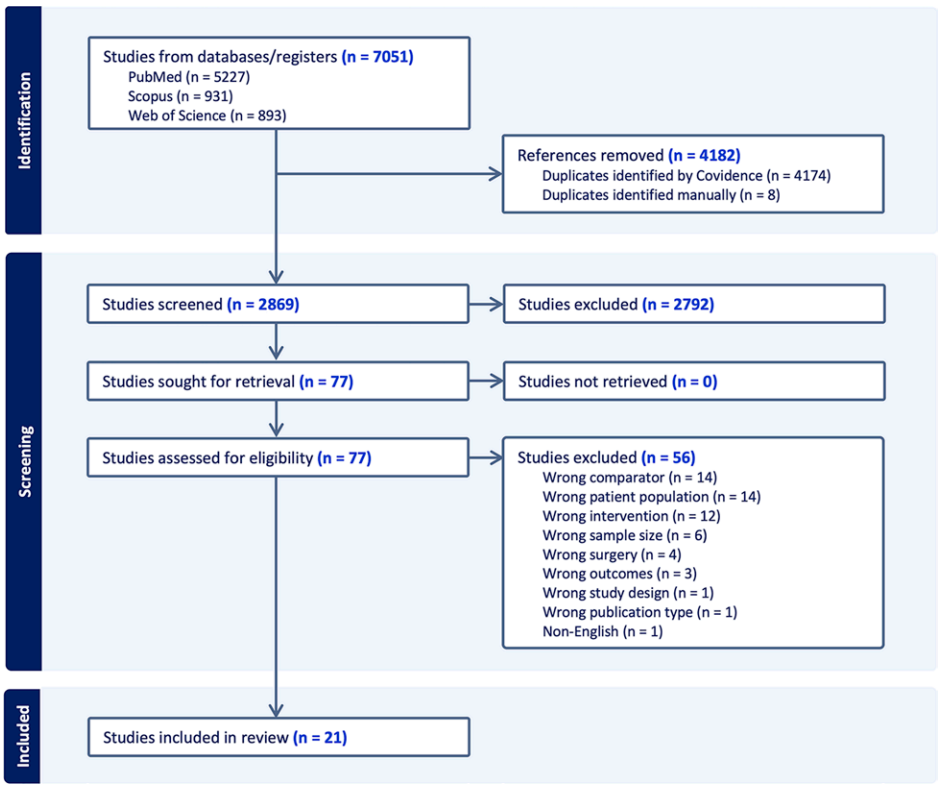

Fig. 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses flow diagram depicting screening and selection of eligible articles.

Table 1. Characteristics of Included Studies (N = 21)

Study	Design	Sample Size		Flap	Laterality	Block	Anesthetic	Dose	Rate/Schedule	Route	Reported Outcomes			
		Exp.	Cont.								Opioids	Pain	OR Time	LOS
Atwez et al[22]	Retrospective cohort	10	30	DIEP, MS-TRAM	Both	TAP	Liposomal bupivacaine 1.30%	266 mg	—	Single injection	●		●	
Boehmler et al[23]	Hybrid*	40	40	DIEP	Both	Rectus sheath	Bupivacaine 0.25%	—	4 mL/h	Continuous infusion	●			●
Chattopadhyay et al[24]	Retrospective cohort	181	3910	TRAM, DIEP, SIEA, GAP	Both	TAP	—	—	—	—				
Dagtekin et al[16]	RCT	8	8	TRAM	—	Superficial to rectus fascia	Ropivacaine 0.20%	20 mg per catheter	10 mL/h per catheter	Continuous infusion	●	●		
Gatherwright et al[25]	Hybrid*	8	6	DIEP	Unilateral	TAP	Liposomal bupivacaine 1.30% Bupivacaine 0.25%	266 mg 50 mg	— —	Single injection	○	○		○
		8	6	DIEP	Unilateral	TAP	Bupivacaine 0.25%	2 mg/kg	—	Single injection	○	○		○
		5	6	DIEP	Unilateral	TAP	Bupivacaine 0.25%	—	4 mL/h	Continuous infusion	○			○
Haddock et al[21]	Retrospective cohort	80	69	DIEP	Bilateral	TAP	Liposomal bupivacaine	—	—	Single injection	●		●	●
Heller et al[17]	RCT	23	25	MS-TRAM	Unilateral	Rectus sheath	Bupivacaine 0.375%	37.5 mg per catheter	2 mL/h	Continuous infusion	●	○		○
Hivelin et al[26]	Prospective cohort	15	15	DIEP	Unilateral	TAP	Ropivacaine 0.50%	1.5 mg/kg	—	Single injection	●	○		●
Hunter et al[27]	Retrospective cohort	40	40	TRAM, DIEP	Both	TAP	Ropivacaine 1.0% Bupivacaine 0.13%	150–200 mg —	6–10 mL/h —	Continuous infusion	●	●		
Jablonka et al[28]	Retrospective cohort	48	40	DIEP, MS-TRAM, SIEA	Both	TAP	Bupivacaine 0.25%	75 mg	2 mL/h	Continuous infusion	●			●
		40	40	DIEP, MS-TRAM, SIEA	Both	TAP	Liposomal bupivacaine 1.3% Bupivacaine 0.25%	260 mg 75 mg	— —	Single injection	●			●
Losken et al[29]	Retrospective cohort	15	19	TRAM	Both	Rectus sheath	Bupivacaine	—	4 mL/h	Continuous infusion	●			○
Odom et al[30]	Retrospective cohort	47	104	Mostly DIEP	Both	Paravertebral	Bupivacaine 0.50%	75–100 mg per side	—	Single injection	●		●	
Oh et al[20]	RCT	48	43	DIEP, MS-TRAM	Both	TAP	Bupivacaine 0.25%	0.2 mL/kg	Q8H	Serial injection		●	●	
Parikh et al[31]	Prospective cohort	39	39	DIEP, MS-TRAM	Both	Paravertebral	Bupivacaine 0.50%	75 mg per side	—	Single injection		○		
Park et al[32]	Retrospective cohort	33	22	DIEP	Both	Superficial to rectus fascia	Ropivacaine 0.50%	—	8 mL/h	Continuous infusion	●			
Salibian et al[33]	Retrospective cohort	50	64	DIEP, MS-TRAM, SIEA	Both	TAP	Liposomal bupivacaine 1.3%	260 mg	—	Single injection	●	●	○	●
Tan and Farrow[34]	Retrospective cohort	16	16	TRAM	Both	Rectus sheath	Ropivacaine 0.75% Ropivacaine 0.38%	37.5 mg	5 mL/h	Continuous infusion	●			●
Utvoll et al[18]	RCT	20	20	DIEP	—	Superficial to rectus fascia	Bupivacaine 0.25%	25 mg	Q3H	Serial injection	●	●	●	
Wheble et al[35]	Retrospective cohort	12	15	DIEP, SIEA	Both	TAP	Chirocaine 0.25%	150 mg	—	Single injection	●			●
Zhong et al[36]	Prospective cohort	36	63	DIEP, MS-TRAM	Both	TAP	Bupivacaine 0.25%	25 mg	Q12H	Serial injection	●	○	○	
Zhong et al[19]	RCT	49	44	DIEP, MS-TRAM	Both	TAP	Bupivacaine 0.25%	0.2 mL/kg	Q8H	Serial injection	●			

*Prospective cohort study with historical patients serving as an external control arm.

DIEP, deep inferior epigastric perforator; GAP, gluteal artery perforator; MS, muscle sparing; OR, operating room; SIEA, superficial inferior epigastric artery; TAP, transverse abdominis plane; TRAM, transverse rectus abdominis myocutaneous. ●, reported outcome with sufficient data for inclusion in meta-analysis. ○, reported outcome but insufficient data for inclusion in meta-analysis.

Table 2. Compiled Characteristics of Included Treatment Arms (N = 24)*

Characteristic	n (%)
Block type	
TAP	15 (63)
Rectus sheath	4 (17)
Superficial to rectus sheath	3 (13)
Paravertebral	2 (8.3)
Route of administration	
Single injection	10 (42)
Continuous infusion†	9 (38)
Removed POD 2	5 (56)
Removed POD 3	3 (33)
Not reported	1 (11)
Serial bolus	4 (17)
Not reported‡	1 (4.2)
Physician placing block	
Surgeon	20 (83)
Anesthesiologist	3 (13)
Not reported	1 (4)
Ultrasound guidance	
Yes	12 (50)
No	11 (46)
Not reported	1 (4)
Anesthetic	
Bupivacaine	12 (50)
Ropivacaine	5 (21)
Liposomal bupivacaine	5 (21)
Chirocaine	1 (4)
Not reported	1 (4)
Setting	
Intraoperative	18 (75)
Preoperative	3 (13)
Not reported	3 (13)

POD, postoperative day
*Sample count includes unique treatment arms from Gatherwright et al[25] and Jablonka et al.[28]
†Continuous infusion catheters removed between POD2 and POD4 in Hunter et al.[27] This study is counted under POD3.
‡Route of administration not standardized in Chattopadhyay et al.[24]

Opioid use in the first 24 hours postoperatively was also significantly lower in these groups (tap block: **Supplemental Digital Content 2**, **http://links.lww.com/PRSGO/D961**, MD = −25.73 IV MMEs, 95% CI [−50.58 to −0.87], I^2 = 95.2%; rectus sheath block: **Supplemental Digital Content 2**, **http://links.lww.com/PRSGO/D961**, MD = −21.47 IV MMEs, 95% CI [−41.76 to −1.19], I^2 = 85.6%). There were insufficient data to evaluate associations between opioid use and other named blocks.

Another subanalysis stratified by administration method found significant reductions in total postoperative opioid use among patients who received either a single injection (MD = −14.33 IV MMEs, 95% CI [−27.51 to −1.16], I^2 = 92.3%) or continuous infusion (MD = −9.85 IV MMEs, 95% CI [−19.46 to −0.24], I^2 = 53.9%) of anesthetic. (**See figure, Supplemental Digital Content 3**, which displays the MD in total postoperative opioid use [IV MMEs] for patients receiving regional anesthesia via a single injection [A] or continuous infusion [B] in addition to TAU compared with patients who received TAU alone. Total postoperative opioid use for patients receiving regional anesthesia without and with ultrasound in addition to TAU [C and D, respectively] is compared with patients who received TAU alone, **http://links.lww.com/PRSGO/D962**.) Total opioid consumption was also significantly reduced among patients who received regional anesthesia without ultrasound guidance (**Supplemental Digital Content 3**, **http://links.lww.com/PRSGO/D962**, MD = −9.04 IV MMEs, 95% CI [−15.85 to −2.24], I^2 = 52.6%) but not those who received regional anesthesia with ultrasound (**Supplemental Digital Content 3**, **http://links.lww.com/PRSGO/D962**, MD = −12.54 IV MMEs, 95% CI [−27.27 to 2.19], I^2 = 92.9%).

Finally, a subanalysis stratified by an anesthetic agent identified significant reductions in total postoperative opioid use among patients who underwent blocks with liposomal bupivacaine (MD = −14.40 IV MMEs, 95% CI [−19.69 to −9.11], I^2 = 10.8%), but not with other long-acting local anesthetic agents (MD = −14.07 IV MMEs, 95% CI [−36.33 to 8.19], I^2 = 83.2%). (**See figure, Supplemental Digital Content 4**, which displays the MD in total postoperative opioid use [IV MMEs] for patients receiving regional anesthesia with liposomal bupivacaine [A] or another long-acting local anesthetic [B] in addition to TAU compared with patients who received TAU alone, **http://links.lww.com/PRSGO/D963**.)

Patient-reported Pain

Three studies reported patient-reported pain at 48 hours postoperatively.[16,20,27] Random effects modeling of 3 studies showed no significant reduction in patient-reported pain at 48 hours postoperatively among patients who received regional anesthesia (Fig. 3, standardized MD = −0.28, 95% CI [−0.65 to 0.09], I^2 = 31.5%). There were insufficient data to perform analyses for 24, 72, 96, or 120 hours postoperatively.

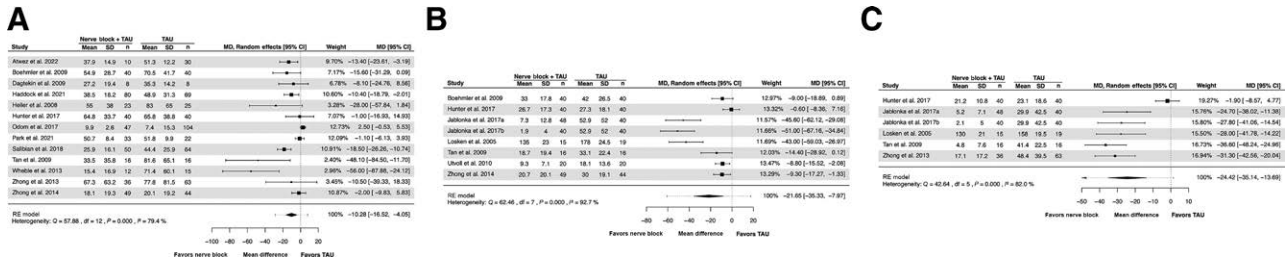

Fig. 2. MD in total (A), 24-hour (B), and 48-hour (C) postoperative opioid requirement (IV MME) between patients who received regional anesthesia in addition to TAU compared with patients who received TAU alone. RE, random effects.

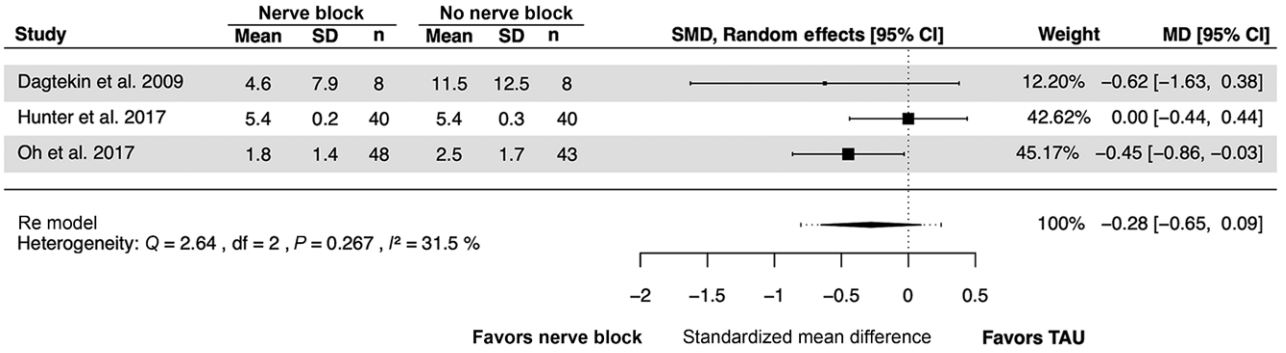

Fig. 3. Standardized MD in patient-reported pain at 48 hours postoperatively between patients who received regional anesthesia in addition to TAU compared with patients who received TAU alone. RE, random effects.

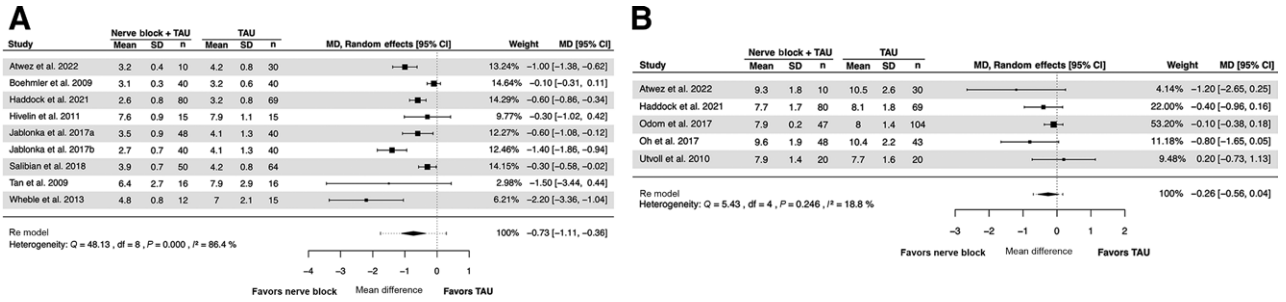

Fig. 4. MD in LOS (d) (A) and length of surgery (h) (B) between patients who received regional anesthesia in addition to TAU compared with patients who received TAU alone. RE, random effects.

Length of Stay

Six of 9 studies found significant reductions in hospitalization duration for patients receiving regional anesthesia.[21,22,28,33,35] Random effects modeling revealed a significant reduction in LOS among patients who received regional anesthesia (Fig. 4A, MD = −0.73 d, 95% CI [−1.11 to −0.36], I^2 = 86.4%). A subanalysis stratified by administration method identified significant reductions in LOS among patients who received blocks via single injection (MD = −0.86 d, 95% CI [−1.33 to −0.40], I^2 = 86.5%), but not with continuous infusion (MD = −0.38 d, 95% CI [−0.88 to 0.12], I^2 = 62.0%). (**See figure, Supplemental Digital Content 5**, which displays the MD in LOS [d] between patients receiving regional anesthesia in addition to TAU compared with patients who received TAU alone, stratified by those who received anesthetic by single injection [A], continuous infusion [B], TAP block [C], with ultrasound guidance [D], or without ultrasound guidance [E], **http://links.lww.com/PRSGO/D964**.) Another subanalysis found a significant reduction in LOS among patients who received TAP blocks when compared with patients who received no regional anesthesia (**Supplemental Digital Content 5**, **http://links.lww.com/PRSGO/D964**, MD = −0.81 d, 95% CI [−1.19 to −0.43], I^2 = 82.1%). LOS was significantly reduced among patients who received regional anesthesia regardless of whether ultrasound was used for anesthetic administration (**Supplemental Digital Content 5**, **http://links.lww.com/PRSGO/D964**, MD = −0.79 versus MD = −0.73 d for patients with and without ultrasound, respectively).

Length of Operation

None of the 5 studies reporting operative duration reported any significant differences in the length of surgery between patients with and without regional anesthesia.[18,20–22,30] Random effects modeling also demonstrated no significant differences in length of surgery when considering all studies (Fig. 4B, MD = −0.26 h, 95% CI [−0.56 to 0.04], I^2 = 18.8%). However, a subanalysis stratified by block type identified a significant reduction in length of surgery among patients who received TAP blocks (MD = −0.59 h, 95% CI [−1.03 to −0.14], I^2 = 0.0%). (**See figure, Supplemental Digital Content 6**, which displays the MD in operative duration (h) between patients who received regional anesthesia via TAP block in addition to TAU with patients who received TAU alone, **http://links.lww.com/PRSGO/D965**.)

Sensitivity Analysis From Randomized Trials

Three RCTs reported sufficient data for a meta-analysis of total opioid use. Random effects modeling showed no significant difference in total opioid use for patients receiving regional anesthesia (Fig. 5, MD = −5.69 IV MMEs, 95% CI [−14.69 to 3.31], I^2 = 18.5%). There were insufficient data from RCTs to perform meta-analyses for any other outcome.

Risk-of-bias Assessment

Sixteen nonrandomized studies of interventions (eg, cohort studies, case-control studies) were assessed using the Risk of Bias in Non-randomized Studies of Interventions

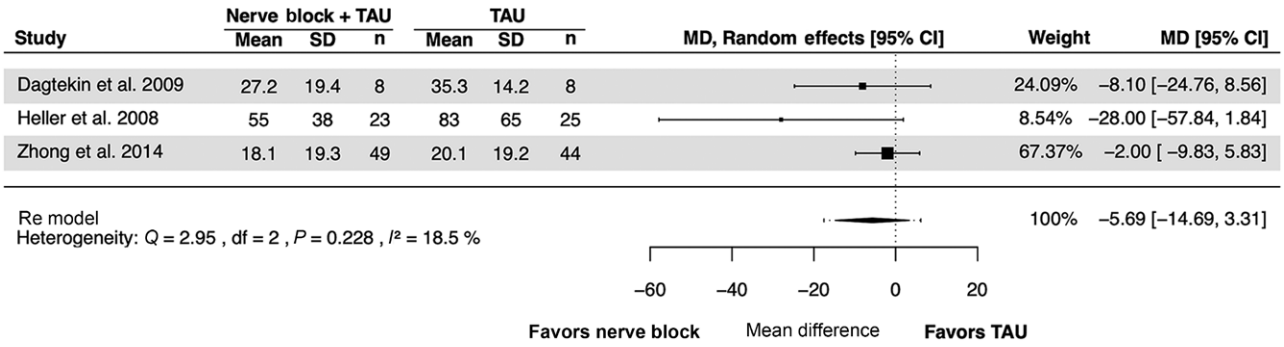

Fig. 5. MD in total postoperative opioid requirement (IV MME) among RCTs comparing patients who received regional anesthesia in addition to TAU with patients who received TAU alone. RE, random effects.

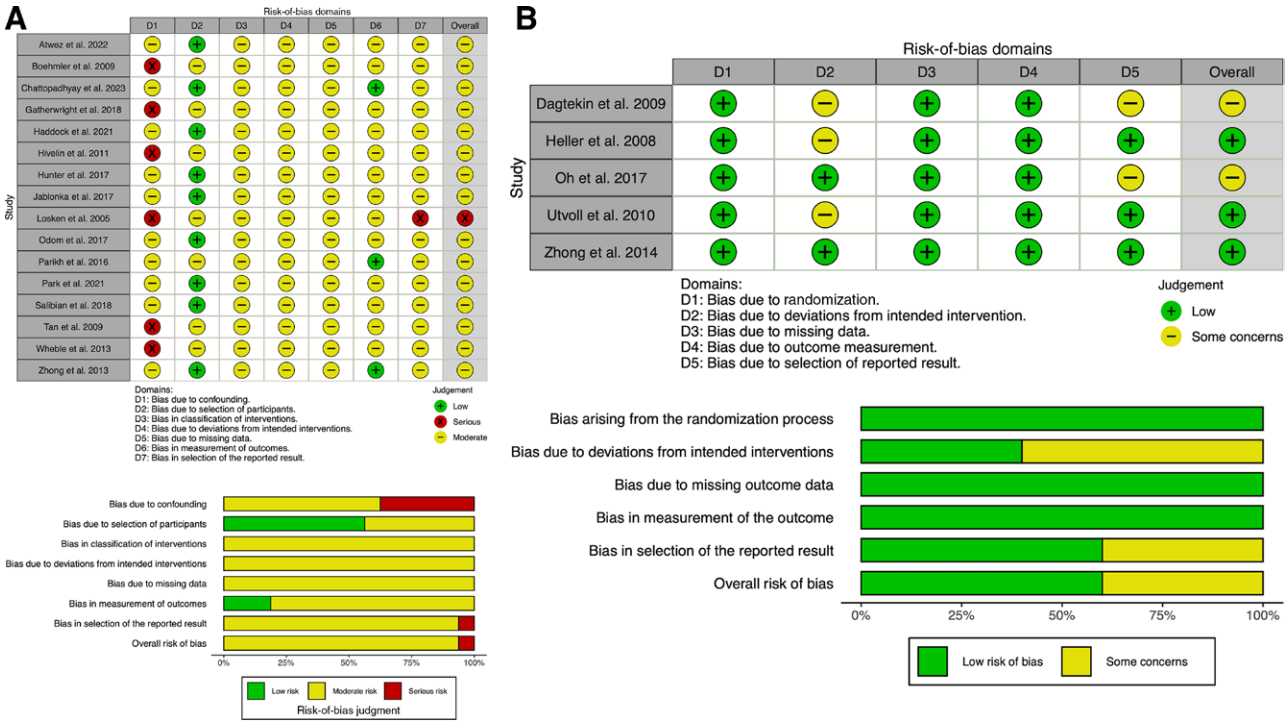

Fig. 6. Risk-of-bias assessment outcomes for nonrandomized studies (A) and RCTs (B).

tool, and 5 RCTs were assessed with the revised Cochrane risk-of-bias tool for randomized trials instrument. The greatest risk of bias among these studies was due to confounding, with 6 studies at serious risk.[23,25,26,29,34,35] One study was deemed to have an overall serious risk of bias, but none were classified as critical risk or excluded from analysis (Fig. 6A).[29] Two RCTs were assessed as having some concerns of bias,[16,20] and 3 were assessed as having low risk of bias.[17–19] All RCTs were included in the analysis (Fig. 6B).

DISCUSSION

In this systematic review and meta-analysis of opioid use following autologous breast reconstruction, we identified statistically but not necessarily clinically significant associations between the use of regional anesthesia and reduced postoperative opioid use. On average, patients who received regional anesthesia used 21.7 fewer IV MMEs after 24 hours (~6 oxycodone 5-mg equivalents) and 24.4 fewer IV MMEs between 24 and 48 hours postoperatively (~7 oxycodone 5-mg equivalents) compared with those who did not receive regional anesthesia. Total opioid use was also reduced among patients who received regional anesthesia, but only by approximately 3 oxycodone 5-mg equivalents and only for patients who received liposomal bupivacaine. Other long-acting local anesthetics such as bupivacaine and ropivacaine were not significantly associated with reduced total opioid use in a subanalysis stratified by anesthetic agent. Regional anesthesia was also associated with an average 0.73-day reduction in LOS ($P < 0.05$) without prolonging the duration of surgery.

Evidence on the efficacy of regional anesthesia for reducing opioid consumption and improving pain management has been mixed.[9,21,27,51,52] A systematic review and meta-analysis by Abdou et al[53] reported a significant reduction in LOS and opioid use for patients who received TAP blocks for autologous breast reconstruction. They did not report a meta-analysis for opioid use due to heterogeneity, but they noted that opioid use was significantly reduced in 8 of 9 of their included studies.[53] A separate review by Chi et al[54] supplemented these findings with a meta-analysis showing significant reductions in opioid use for patients who received TAP blocks. Nevertheless, RCTs by Heller et al,[17] Dagtekin et al,[16] and Zhong et al[19] all reported no significant difference in total opioid consumption in patients who received regional anesthesia. Our results suggest that regional anesthesia effectively reduces opioid use by as much as 36 mg of oral oxycodone in the early postoperative period. However, the effect size of regional anesthesia was attenuated to approximately 15 mg of oral oxycodone by the time of discharge. Although still significantly less than nonregional anesthesia controls, this discrepancy between early and late opioid use may be attributed to the diminishing effect of single injection anesthetics (eg, liposomal bupivacaine) after 72 hours and the tendency of studies to remove continuous anesthetic catheters by postoperative day 3.[16,17,23,25,28,29,32,34,55] This hypothesis is supported by studies from the operative management of fractures, which have demonstrated a "rebound effect" among patients who receive regional anesthesia.[56–61] These patients use the same, or significantly fewer, quantities of opioids compared with nonblock patients in the early postoperative period (<72 h) but significantly more opioids at or after discharge.[56–61]

The most used block in the studies we reviewed was the TAP block, where anesthetic is infiltrated into the fascial plane between the internal oblique and transversus abdominis muscle (TRAM).[62] This block is commonly used to anesthetize donor sites for abdominal flap harvest and can be performed as a single injection with liposomal bupivacaine.[63] Alternative TAP block approaches involve indwelling infusion catheters that continuously deliver anesthetic.[63] Our study found no significant difference in opioid use reduction between TAP blocks performed with single injections and those with continuous infusion; however, single injection blocks were associated with a shorter LOS. Single injection techniques are also likely more comfortable and safer for patients, as they eliminate the need for retained infusion catheters and reduce the number of tethering points (eg, lines and drains) postoperatively.[64,65]

The technique used to administer blocks also varied considerably across studies. Ultrasonography is a valuable tool for identifying tissue planes and ensuring proper anesthetic placement; however, not all studies used ultrasound.[66] Single injection techniques without ultrasound relied on tactile recognition of tissue planes during block placement, which may be challenging for providers who are new to this technique. In contrast, infusion catheters were typically placed under direct visualization in the operating room. There is insufficient evidence to suggest that 1 method is superior to the others, but this variability may account for the heterogeneity observed across outcomes in this meta-analysis.

Our sensitivity analysis using only data from RCTs suggests that confounding may influence the effect of regional anesthesia reported in some nonrandomized studies. For example, reductions in total opioid use were not significant in random effects models using data from 3 RCTs. Heller et al[17] demonstrated that continuous infusion of bupivacaine into the abdominal site following free TRAM breast reconstruction offered no significant reduction in total opioid use. Dagtekin et al[16] substantiated these findings in a trial of patients receiving continuous wound instillation with ropivacaine 0.2%. More recently, Zhong et al[19] demonstrated significant reductions in opioid use at 24 hours but no significant difference in total opioid use among patients receiving TAP blocks with bupivacaine for muscle-sparing TRAM or deep inferior epigastric perforator flap breast reconstruction.[60,61] Our meta-analysis from these and other RCTs found no reduction in total opioid use, and the magnitude of the MD was smaller than that observed when including nonrandomized studies (5.69 versus 10.28 IV MMEs).

This study has limitations. First, research on the outcomes of interest may have been published or may be in preparation, which could potentially alter the results of this meta-analysis. To account for this, we conducted a systematic review at 2 time points to include literature published within the 3-month interval between the primary and secondary searches. Second, significant heterogeneity was observed across outcomes related to opioid use, indicating possible methodological or contextual differences among the studies. As noted, a wide variety of techniques, medications, and modalities for regional anesthesia exist, with no consensus on a singular best practice. To address this uncertainty, we used random effects models and provided prediction intervals to better contextualize our findings. Third, we encountered missing data in some articles. Although we contacted corresponding authors to obtain this information, our success was variable. Finally, we used reported MMEs when available but had to calculate MMEs for studies that did not report opioid use in this unit of measure (eg, studies that reported OMEs). Although conversion factors might have varied across studies, this discrepancy should not significantly impact our measurement of MDs.

CONCLUSIONS

In this systematic review and meta-analysis, we identified a statistically but not necessarily clinically significant reduction in total postoperative opioid use among patients who received regional anesthesia for autologous breast reconstruction (~3 oxycodone 5-mg equivalents). This reduction was not statistically significant when considering only data from RCTs (~2 oxycodone 5-mg equivalents). Receipt of regional anesthesia was also associated with a 0.73-day reduction in LOS but was not linked to longer operative times. Regional anesthesia may not substantially impact total postoperative opioid use, but it offers a nonnarcotic analgesic option to patients who prefer to avoid opioid medications. RCTs with rigorous

administration protocols (eg, route of administration, anesthetic, and dose) on commonly used nerve and fascial plane blocks are needed to better clarify the best use of this intervention within ERAS protocols.

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DISCLOSURE

The authors have no financial interest to declare in relation to the content of this article.

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