

Serratus Anterior Block for Rib Fractures: A Systematic Review and Meta-analysis

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Abstract

Background: Effective analgesia is the mainstay of the management of traumatic rib fractures. Serratus anterior block is a newer regional anaesthesia technique used in traumatic rib fractures which may have a favourable safety profile compared to other regional techniques. There is currently a lack of evidence for serratus anterior block and its role in the improvement of mortality, pain, duration of stay and pulmonary complications in patients with traumatic rib fractures in comparison to other regional anaesthesia techniques.

Methods: Web of Science and PubMed were searched from inception until April 2022 for studies reporting on the use of a serratus anterior block compared to another therapy for the management of traumatic rib fractures. Primary outcomes were measures of analgesic efficacy. Secondary outcomes were the incidence of intervention related adverse events, hospital length of stay, intensive care unit length of stay and mortality.

Results: Seven studies with 649 patients were included. No significant difference was found between serratus anterior block and intravenous opiates in terms of resting pain scores and achievement of mild or no pain after the chosen intervention ($p > 0.05$). There was a statistically, but not clinically significant difference post block pain scores compared to other regional techniques (WMD = 0.63; 95% CI = 0.45 to 0.80; $p < 0.00001$). Significant differences were found in favour of blocks, specifically thoracic epidural and paravertebral blocks over serratus anterior block in terms of achieving mild or no pain after the block (OR = 0.54; 95% CI = 0.32 to 0.90; $I^2 = 0\%$; $p = 0.02$). No significant difference was found for any other outcomes.

Conclusions: Current literature comparing the serratus anterior block to alternative analgesic options is limited by the end points assessing block success. No data was available assessing the effect on pain during deep inspiration and coughing. This meta-analysis demonstrated similar analgesic efficacy to other regional anaesthesia techniques but a lower incidence of mild or no pain post block compared to traditional epidural or paravertebral techniques. Future studies need to be directed towards important outcomes such as dynamic pain scores and respiratory complication rates.

Keywords: Rib fractures, Serratus Anterior, Chest trauma

Introduction

Traumatic rib fractures (TRF) are common with a high risk of short- and long-term complications, especially in the elderly [1-4]. The baseline mortality rate is 10% for a patient admitted to hospital with rib fractures and up to 40% if the number of ribs fractured is greater than six [1]. Provision of effective analgesia is part of the mainstay of TRF management [5]. Ineffective analgesia in TRF

leads to low mobility, poor physiotherapy participation, inability to cough effectively, decreased secretion clearance and insufficient tidal volumes [5]. These factors contribute to development of acute respiratory distress syndrome (ARDS), chest infections, atelectasis, pulmonary embolism and overall increased morbidity and mortality [5]. Provision of effective analgesia using ultrasound-guided regional anaesthesia improves

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analgesic and non-analgesic outcomes, including improved inspiratory reserve volume and lower mortality rates [6, 7].

Serratus anterior block (SAB) is a newer regional anaesthesia technique used in TRF. SAB can be utilised for patients with coagulopathy, is easy to perform and can be used for catheter insertion for continuous local anaesthetic infusion [4]. Case series suggested SAB as a part of multimodal analgesia reduces opioid use, which has known adverse effects including respiratory depression, sedation, constipation, hyperalgesia, and physical dependence [8-10]. However, there is a lack of evidence for SAB and its role in improvement of mortality, pain, hospital length of stay (LOS) and pulmonary complications in patients with TRF in comparison to other regional anaesthesia techniques [4].

This review aims to assess the effectiveness and safety of the SAB to other analgesic techniques for reduction of incidence of mild pain, pain score at rest, oral morphine consumption, adverse events, length of stay and mortality rates in patients with TRF within 1 week after date of injury.

Methods

Search Methodology / Search Strategy

A systematic search of Web of Science and PubMed was performed using the search terms (1) "Rib Fractures" AND "Serratus Anterior" OR "Serratus Plane" (2) "Chest Trauma" AND "Serratus Anterior" OR "Serratus Plane". This search was performed from inception until April 2022. The reference lists and citations to eligible studies from the initial database search were then assessed to detect any additional studies for inclusion. A manual search of Google Scholar was also performed using the citations and reference lists of included studies. This systematic search was performed by two independent assessors.

Research question

Population: Patients with rib fractures

Intervention: SAB

Control: non-SAB anaesthesia techniques

Outcomes: The primary outcomes of interest were measures of analgesic efficacy. This included the (1) incidence of mild or no pain post intervention (2) numerical pain scores (0-10) post intervention (3) Time to rescue analgesia post intervention. The secondary outcomes of interest included the incidence of intervention related adverse events, hospital length of stay, intensive care unit (ICU) length of stay and mortality.

Study Inclusion and Exclusion Criteria / Eligibility Criteria

Eligible studies were required to report on the use of a

serratus anterior block compared to another therapy for the management of rib fractures. Any comparative study design was eligible for inclusion. Exclusion criteria included case studies, non-comparative cohort studies, animal studies and preclinical anatomical studies. Two reviewers independently assessed studies for inclusion.

Risk of Bias and Methodological Quality Assessment

Risk of bias for randomised controlled trials were assessed using the Cochrane Collaboration's tool for assessing risk of bias [11]. Non-randomised trials were assessed using the Risk of Bias in Non-randomised Studies-of Interventions (ROBINS-I) tool [12]. Studies were deemed to be of high quality if they were low risk in all domains of the risk of bias assessment.

Data extraction

Two review authors independently extracted data and resolved any discrepancy with a third reviewer. We entered data into an excel spreadsheet. This included the following information:

- General information of studies: authors, demographics of included subjects, study outcomes, study contexts
- Risk of bias assessments
- Study eligibility
- Outcomes as listed in the first section under "Methods"

Dealing with duplicate publications: When we yielded more than one publication of a study, we used the Endnote software to assist in identifying, comparing and removing duplicates.

Data synthesis – Statistical analysis

Statistical analysis was performed using the Cochrane Collaboration's RevMan 5.4 software (The Nordic Centre, Copenhagen, Denmark). Data was analysed in two subgroups. Serratus anterior block versus opioid therapy, or serratus anterior block versus other regional anaesthesia techniques. Dichotomous and continuous outcomes were analysed using random effects modelling and a p value of less than 0.05 was statistically significant. Dichotomous data was presented as odds ratios (OR) with a 95% confidence interval (95% CI). Continuous outcomes were presented as weighted mean difference (WMD) with 95% CI. The I² statistic was used to assess heterogeneity. An I² of greater than 50% was deemed to be significant.

Results/Findings

The initial database search yielded 95 publications after removal of duplicates (Figure 1). On abstract assessment 83 studies were excluded. A further five studies were excluded

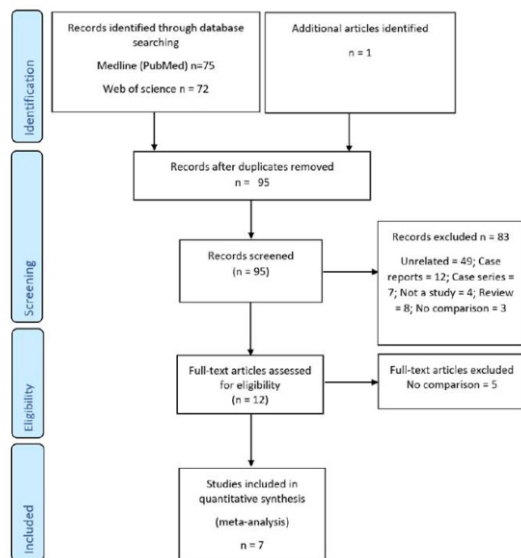


Fig. 1 PRISMA flow diagram of literature search

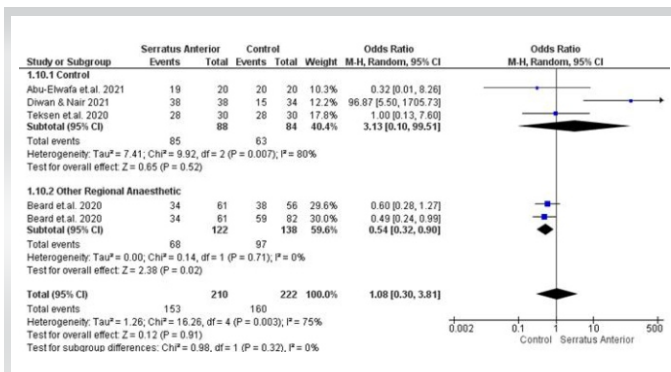


Figure 3: Odds Ratio: SAB versus control

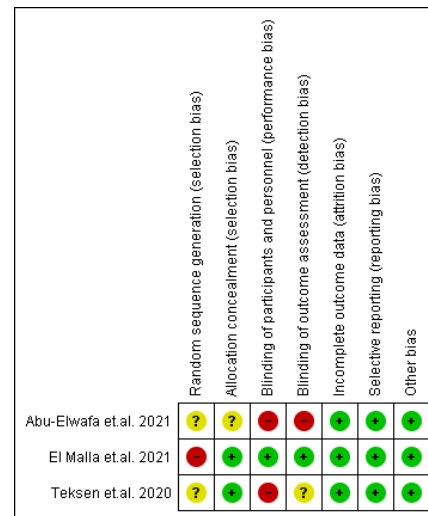


Figure 2a: Risk of bias summary for RCTs

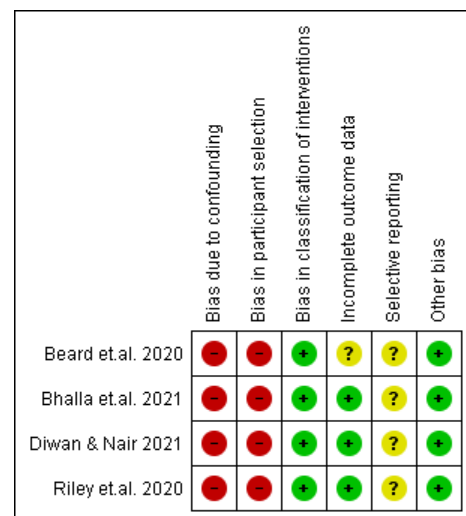


Figure 2b: Risk of bias summary non-randomised studies

Table 1: Study Characteristics. a. Age range of all subjects; b. Mean age of all subjects; c. Mean age of SAB group; d. Mean age of epidural and paravertebral block (EPVB) group; e. Mean BMI of SAB group; f. Mean BMI of EPVB group; g. Age range of fentanyl group; h. Age range of SAB group; i. Mean age of erector spinae block (ESB) group; j. Mean BMI of ESB group; k. Mean age of control group; l. Mean weight of control group; m. Mean weight of SAB group; n. RCT= randomized controlled trial; o. PCS= prospective cohort study; p. RCS= retrospective cohort study; q. NRS= numerical rating scale; r. VRS= 4-point Likert Verbal Rating Scale, where 0= no pain, 1= mild pain, 2= moderate pain and 3= severe pain; s. VAS= visual analogue scale.

Study, type	Number of patients	Age (years)	Mean weight (kg) or BMI	Intervention; SAB type	Setting	Pain scale; Mild pain definition	Outcomes
Abu-Elwafa [13], RCT ⁿ	40	>15 ^a	Not documented	SAB vs IV morphine loading dose and infusion; superficial	Patients with lateral and/or anterior 3 – 6 rib fractures	VAS ^s ; VAS 1 – 3	1. Incidence of mild or no pain post intervention 2. Pain score (NRS) q post intervention 3. Adverse events
Beard [14], PCS ^o	354	61.3 ^b	Not documented	SAB catheters vs thoracic epidural (TEA) catheters vs paravertebral (PA) catheters; unspecified	Patients with multiple TRF	VRS ^s ; VRS 1	1. Incidence of mild or no pain post intervention; pain score VRSr 2. Adverse events 3. Hospital length of stay 4. Intensive Care Unit length of stay
Bhalla [15], RCS ^p	39	57.9 ± 21.1 ^c ; 57.5 ± 16.4 ^d	27.1 ± 5.1 ^e ; 29.4 ± 7.1 ^f	SAB vs EPVB; deep	SAB or EPVB performed for pain due to multiple TRFs in ICU	NRS ^q ; NRS 1 – 3	1. 24 hour pre and post opioid reduction 2. Hospital length of stay 3. Intensive Care Unit length of stay 4. All-cause mortality
Diwan [16], RCS	72	28 – 65 ^g ; 32 – 74 ^h	Not documented	SAB vs IV fentanyl bolus with or without infusion; deep	SAB vs fentanyl administered for patients with multiple rib fractures	VAS ^s ; VAS 1 – 3	1. Incidence of mild or no pain post intervention; pain score VASs 2. Opioid consumption post intervention
El Malla [19], RCT	50	35.8 ± 11.56 ⁱ ; 34.4 ± 12.35 ^c	25.43 ± 0.59 ^j ; 25.98 ± 0.56 ^e	ESB vs SAB; superficial	Patients with ASA I or II aged between 18 – 60, admitted to ICU with fractured ribs within the first day of trauma	NRS ^q ; NRS 1 – 3	1. Opioid consumption post intervention 2. Pain score post intervention 3. Adverse events
Riley [17], RCS	34	66 ⁱ ; 65.54 ^c	Not documented	ESB vs SAB; unspecified	Patients with rib fractures	Nil; nil	1. 24-hour pre and post opioid reduction 2. Opioid consumption post intervention 3. Hospital length of stay 4. Intensive Care Unit length of stay 5. All-cause mortality 6. Adverse events
Teksen [18], RCT	60	50.7 ± 18.8 ^g ; 42.4 ± 15.8 ^h	76.5 ± 12.6 ^m ; 76.2 ± 12.7 ⁱ	SAB vs control; superficial	Patients with rib fractures	NRS ^q ; NRS 1 – 3	1. Incidence of mild or no pain post intervention 2. Pain score NRS post intervention 3. Opioid consumption post intervention

on full-text assessment. Seven studies with 649 patients were included in the present meta-analysis (Table 1) [13-19]. Of these, there were three randomised controlled trials (RCTs) (n=150) [13, 18, 19] and four non-randomised studies (n=499) [14, 15, 16, 17]. None of the included studies met the criteria of a high-quality study (Figure 2).

Primary Outcomes

Incidence of Mild Pain at Rest:

This outcome was reported in four studies [13, 14, 16, 18]. Compared to intravenous opioids, there was no significant difference in the incidence of mild pain post block or on initiation of intravenous analgesia (OR= 3.13; 95% CI= 0.10 to 99.51; I2= 80%; p= 0.52; Figure 3). There was however a significantly lower odds of achieving mild pain post block with serratus anterior block compared to either paravertebral or thoracic epidural (OR= 0.54; 95% CI= 0.32 to 0.90; I2= 0%; p= 0.02; Figure 3).

Pain Scores at Rest:

Three studies assessed the effect on resting pain scores [13, 18, 19]. Compared to opioid infusion, there was no significant difference in resting pain scores (WMD= -1.29; 95%CI= -2.71 to 0.13; I2= 97%; p= 0.07). One study comparing serratus anterior block to another regional anaesthetic technique demonstrated a clinically insignificant but statistically significant difference in pain scores (WMD= 0.63; 95% CI= 0.45 to 0.80; p<0.00001). Pain scores during deep breathing or coughing were unable to be assessed.

Oral Morphine Equivalent Consumption:

Oral morphine equivalent consumption in the 24 hours post block or initiation of intravenous opioid therapy was assessed by four studies [16-19]. With significant heterogeneity (I2= 100%), there was no significant difference compared to intravenous opioid therapy (WMD= -67.04 mg; 95% CI= -178.75 mg to 44.68 mg; p= 0.24). Similarly, compared to other regional anaesthesia techniques, there was no significant difference (WMD= -15.52 mg; 95% CI= -75.18 mg to 44.14 mg; I2= 78%; p= 0.61). Additionally, two studies measure the change in opioid consumption in the 24 hours post block compared to the 24 hours pre block [15, 17]. There was no significant difference between serratus anterior block and other regional anaesthetic techniques (WMD= -9.85 mg; 95% CI= -51.79 mg to 32.09 mg; I2= 57%; p= 0.65).

Secondary Outcomes

Adverse events:

Therapy related adverse events were assessed by three studies [13, 17, 19]. Overall, there was no significant difference

(OR=1.01; 95% CI= 0.03 to 29.39; I2= 58%; p= 1.00).

Length of stay:

Hospital length of stay was assessed by three studies comparing serratus anterior block to other regional anaesthetic techniques [14, 15, 17]. There was no significant difference demonstrated (WMD= 2.85 days; 95% CI= -1.09 days to 6.79 days; I2= 50%; p= 0.16)

ICU length of stay was also assessed by three studies comparing serratus anterior block to other regional anaesthetic techniques [14, 15, 17]. Similarly, there was no difference demonstrated (WMD= -0.09 days; 95% CI= -3.51 days to 3.34 days; I2= 87%; p= 0.96).

Mortality:

Mortality was assessed by three studies comparing serratus anterior block to other regional anaesthetic techniques [14, 15, 17]. There was no significant difference between techniques (OR= 0.91; 95% CI= 0.41 to 2.01; I2= 0%; p= 0.81).

Discussion

This systematic review evaluated the efficacy of the SAB compared to intravenous opioid therapy and other regional anaesthesia techniques. Our systematic search identified seven low quality studies consisting of 649 patients. The results of this review were heterogenous for most outcome measures and we were unable to assess the effect on dynamic pain scores and respiratory complications. No significant difference was found in the analgesic or non-analgesic outcomes in patients with TRF when SAB is compared to intravenous opioids and other regional anaesthesia techniques. The non-analgesic outcomes include adverse events, length of stay and mortality rates.

Compared with intravenous opiates, SAB achieved a similar reduction in resting pain scores and incidence of mild or no pain intervention. This review is limited by the low quality of included studies, with heterogeneous results and heterogeneous study designs. However, each study within the analysis individually demonstrated SAB to be an effective opioid sparing technique [13-19]. One consistent result with low heterogeneity was that SAB has significantly lower odds of leading to mild or no pain compared to paravertebral blocks (PVB) or thoracic epidural (TE). However, this needs to be balanced against the additional risks associated with the PVB/TE and technical skills required for their safe administration compared with SAB. SAB has several advantages over PVB/TE particularly in the unwell trauma patient with multiple injuries. Owing to these advantages, SAB has the potential to have widespread uptake by care

providers from a range of different specialties as has occurred with other fascial plane blocks. SAB can be performed with patients in the supine position. This is particularly beneficial in trauma patients as other concurrent injuries may prevent them from sitting or rolling laterally to perform either paravertebral block or thoracic epidural. In addition, it is appropriate for patients who are coagulopathic or who have associated head injuries or spinal trauma where epidural and paravertebral blocks are contraindicated. The use of PVB/TE is also complicated in sedated or obtunded patients as it limits the ability to identify early neurological sequelae of PVB/TE. Pooled analysis in this study did not identify any significant difference in therapy-related adverse outcomes between the different regional anaesthesia techniques. However, it is important to note that the providers delivering these different regional techniques likely do not represent the skill set of the average care provider and that higher rates of complications with novice operators could be expected. Safe provision of TE relies on the service having familiarity with the monitoring and observations required to allow for early detection of complications.

A major limitation of the meta-analysis was that there was insufficient RCTs included. Including observational studies is known to have low internal validity and could bias the summary effect of a meta-analysis [20]. However, due to the limited number of RCTs, the decision was made to include non-RCTs to summarize the current available evidence as much as possible.

Another limitation was that the measures of analgesic efficacy utilised in the included studies lacked clinical relevance. Pain scores at rest were measured in most trials but not pain during deep breathing, coughing or movement. Studies also focused on achieving mild or no pain post-intervention at rest. However, the clinical significance of these measures is questionable as rib fractures tend to cause little pain at rest with shallow breathing [1, 2]. The lack of clinically significant difference of pain scores at rest seen between the different interventions is therefore not unexpected. A more clinically important measure is pain scores during activities such as deep breathing, coughing and mobilising. Pain during these movements is likely to increase time spent in bed and reduce ability to participate in physiotherapy and other measures that reduce TRF related complications including pneumonia. Future randomised prospective clinical trials should incorporate such measures in their protocols to increase the clinical utility of their results.

Previously it has been proposed that SAB use as part of multimodal analgesia in TRF is opiate sparing when compared to intravenous opiates alone. Opiate sparing analgesia has theoretical advantages as the use of opiate analgesia is

associated with adverse effects including respiratory depression, sedation, constipation, hyperalgesia and physical dependence [8-10]. Each study alone showed a significant reduction in opioid use with SAB combined multimodal analgesia compared with intravenous opiates alone. However, when pooled analysis was performed the difference in opiate use between the groups was no longer significant. This may be in part due to a range of different opioid agents being used in each study. Future large prospective randomised trials are needed that standardise the intravenous opiate arm to a single agent to ensure that the differences are not partially accounted for by opiate selection. Furthermore, a study that is sufficiently powered to draw conclusions about the relative opiate sparing of SAB compared with PVB/TE would help to further guide clinicians on the best choice of analgesia for TRF.

Several of the trials included in the review performed tests of respiratory function pre and post provision of regional anaesthesia. Unfortunately, there was significant variation between each study's chosen measures of respiratory function. These included but were not limited to peak flow, performance on measures, incentive spirometry and formal spirometry. Within the individual studies, SAB was reported to improve respiratory function to a similar extent to other regional anaesthesia techniques. It was not possible to pool these measures for meta-analysis as the different methods for measuring improvement of respiratory function could not be transformed into a single reliable measure. Similarly, there was no significant difference found in ICU LOS or hospital LOS when SAB was compared to other regional anaesthesia techniques. As discussed earlier, these results are likely the function of similar analgesia outcomes between the different regional anaesthesia techniques.

These results showed that SAB could be an alternative to other regional anaesthesia techniques, especially given the advantages of SAB including being easy to perform, can be used in coagulopathy and reduction of opioid use. SAB was reported to be associated with lower odds of achieving mild pain when compared to TE and PVB [14], however pain with activity may be better with TE or PVB, as further inferiority of the analgesic effect of SAB may be masked by the method used to measure pain scores in these studies. The current evidence does not support the use of SAB over opioid therapy alone. SAB may also offer the same respiratory benefits, which is the key to preventing pneumonia and respiratory failure. The regional anaesthesia technique to use likely depends on the location of rib fractures, types of rib fractures, confidence of the practitioner and patient factors. The findings of this review have the potential to impact clinical practice, as the results improve the process of

weighing benefits and risks associated with SAB and other analgesic techniques when providing care for patients with TRF, although it is acknowledged that the information gaps mentioned above will be better addressed with further high-quality research studies.

Conclusion

Current literature comparing the serratus anterior block to alternative analgesic options is limited by the end points assessing block success. No data was available assessing the effect on pain during deep inspiration and coughing. This meta-analysis demonstrated similar analgesic efficacy to other regional anaesthesia techniques but a lower incidence of mild or no pain post block compared to traditional epidural or paravertebral techniques. Future studies need to be directed towards important outcomes such as dynamic pain scores and respiratory complication rates.

References

1. Fligel, B.T.; Luchette, F.A.; Reed, R.L.; Esposito, T.J.; Davis, K.A.; Santaniello, J.M.; Gamelli, R.L. Half-a-dozen ribs: the breakpoint for mortality. *Surgery*. 2005 Oct;138(4):717-723; discussion 723-715.
2. Griffiths, R.; Surendra Kumar, D. Major trauma in older people: implications for anaesthesia and intensive care medicine. *Anaesthesia*. 2017 Nov;72(11):1302-1305.
3. Barry, R.; Thompson, E. Outcomes after rib fractures in geriatric blunt trauma patients. *Am J Surg*. 2018 Jun;215(6):1020-1023.
4. El-Boghdadly, K.; Wiles, M.D. Regional anaesthesia for rib fractures: too many choices, too little evidence. *Anaesthesia*. 2019 May;74(5):564-568.
5. Kim, M.; Moore, J.E. Chest Trauma: Current Recommendations for Rib Fractures, Pneumothorax, and Other Injuries. *Curr Anesthesiol Rep*. 2020;10(1):61-68.
6. Womack, J.; Pearson, J.D.; Walker, I.A.; Stephens, N.M.; Goodman, B.A. Safety, complications and clinical outcome after ultrasound-guided paravertebral catheter insertion for rib fracture analgesia: a single-centre retrospective observational study. *Anaesthesia*. 2019 May;74(5):594-601.
7. Adhikary, S.D.; Liu, W.M.; Fuller, E.; Cruz-Eng, H.; Chin, K.J. The effect of erector spinae plane block on respiratory and analgesic outcomes in multiple rib fractures: a retrospective cohort study. *Anaesthesia*. 2019 May;74(5):585-593.
8. Benyamin, R.; Trescot, A.M.; Datta, S.; Buenaventura, R.; Adlaka, R.; Sehgal, N.; Glaser, S.E.; Vallejo, R. Opioid complications and side effects. *Pain Physician*. 2008 Mar;11(2 Suppl):S105-120.
9. Kunhabdulla, N.P.; Agarwal, A.; Gaur, A.; Gautam, S.K.; Gupta, R.; Agarwal, A. Serratus anterior plane block for multiple rib fractures. *Pain Physician*. 2014 Sep-Oct;17(5):E651-653.
10. Rose, P.; Ramlogan, R.; Sullivan, T.; Lui, A. Serratus anterior plane blocks provide opioid-sparing analgesia in patients with isolated posterior rib fractures: a case series. *Can J Anaesth*. 2019 Oct;66(10):1263-1264.
11. Higgins, J.P.; Altman, D.G.; Gotzsche, P.C.; Juni, P.; Moher, D.; Oxman, A.D.; Savovic, J.; Schulz, K.F.; Weeks, L.; Sterne, J.A.; Cochrane Bias Methods, G.; Cochrane Statistical Methods, G. The Cochrane Collaboration's tool for assessing risk of bias in randomised trials. *BMJ*. 2011 Oct 18;343:d5928.
12. Sterne, J.A.; Hernan, M.A.; Reeves, B.C.; Savovic, J.; Berkman, N.D.; Viswanathan, M.; Henry, D.; Altman, D.G.; Ansari, M.T.; Boutron, I.; Carpenter, J.R.; Chan, A.W.; Churchill, R.; Deeks, J.J.; Hrobjartsson, A.; Kirkham, J.; Juni, P.; Loke, Y.K.; Pigott, T.D.; Ramsay, C.R.; Regidor, D.; Rothstein, H.R.; Sandhu, L.; Santaguida, P.L.; Schunemann, H.J.; Shea, B.; Shrier, I.; Tugwell, P.; Turner, L.; Valentine, J.C.; Waddington, H.; Waters, E.; Wells, G.A.; Whiting, P.F.; Higgins, J.P. ROBINS-I: a tool for assessing risk of bias in non-randomised studies of interventions. *BMJ*. 2016 Oct 12;355:i4919.
13. Abu-Elwafa, W.A.E.-G.; Ragab, I.A.; Abdelrahman, A.H.; Mahmoud, W.A. Comparative Study between Efficacy of Serratus Anterior Muscle Block as A Regional Analgesia Technique and I.V Morphine Infusion in Patient with Fracture Ribs. *The Egyptian Journal of Hospital Medicine*. 2021 Jan;82(2):348-353.
14. Beard, L.; Hillermann, C.; Beard, E.; Millerchip, S.; Sachdeva, R.; Gao Smith, F.; Veenith, T. Multicenter longitudinal cross-sectional study comparing effectiveness of serratus anterior plane, paravertebral and thoracic epidural for the analgesia of multiple rib fractures. *Reg Anesth Pain Med*. 2020 May;45(5):351-356.
15. Bhalla, P.I.; Solomon, S.; Zhang, R.; Witt, C.E.; Dagal, A.; Joffe, A.M. Comparison of serratus anterior plane block with epidural and paravertebral block in critically ill trauma patients with multiple rib fractures. *Trauma Surg Acute Care Open*. 2021;6(1):e000621.
16. Diwan, S.; Nair, A. A retrospective study comparing analgesic efficacy of ultrasound-guided serratus anterior plane block versus intravenous fentanyl infusion in patients with multiple rib fractures. *J Anaesthesiol Clin Pharmacol*. 2021 Jul-Sep;37(3):411-415.
17. Riley, B.; Malla, U.; Snels, N.; Mitchell, A.; Abi-Fares, C.; Basson, W.; Anstey, C.; White, L. Erector spinae and serratus anterior blocks for the management of rib fractures: A retrospective exploratory matched study. *Am J Emerg Med*. 2020 Aug;38(8):1689-1691.
18. Teksen, S.; Oksuz, G.; Oksuz, H.; Sayan, M.; Arslan, M.; Urfalioglu, A.; Gisi, G.; Bilal, B. Analgesic efficacy of the serratus anterior plane block in rib fractures pain: A randomized controlled trial. *Am J Emerg Med*. 2021 Mar;41:16-20.
19. El Malla, D.A.; Helal, R.; Zidan, T.A.M.; El Mourad, M.B. The Effect of Erector Spinae Block versus Serratus Plane Block on Pain Scores and Diaphragmatic Excursion in Multiple Rib Fractures.
20. Metelli S, Chaimani A. Challenges in meta-analyses with observational studies. *Evidence Based Mental Health*. 2020;23(2):83-87.

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given his/her consent for his/her images and other clinical information to be reported in the Journal. The patient understands that his/her name and initials will not be published, and due efforts will be made to conceal his/her identity, but anonymity cannot be guaranteed.

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