International Journal of Medicine
pISSN 1468-3814 | eISSN 2667-7008
https://theinternationalmedicine.com/

Original Research Article DOI: 10.61336/im/26-2-55

Effect of Tramadol or Clonidine as an Adjuvant to Local Anaesthetics in Supraclavicular Brachial Plexus Block for Upper Extremity Surgery: A Prospective Randomized Comparative Study

Dr Shazia Banoo [1], Dr Shivata Sharma [2], *Dr. Guddi Devi [3]

[1] *Senior Resident, Department of Anesthesia and critical care, Government Medical College DODA, Jammu and Kashmir , India.*

[2] *Senior resident, Department of Anesthesia and critical care, Government Medical College DODA, Jammu and Kashmir , India.*

[3] *Senior resident, Department of Anesthesia and critical care, Government Medical College DODA, Jammu and Kashmir , India.*

Correspondence:
Dr. Guddi Devi

Received: January 06, 2026
Revised: January 27, 2026
Accepted: February 11, 2026
Published: February 20, 2026

Abstract

Background: Supraclavicular brachial plexus block is a commonly employed regional anaesthesia technique for upper extremity surgeries. The use of adjuvants along with local anaesthetics has been shown to enhance block characteristics and prolong postoperative analgesia. Tramadol and clonidine are frequently used adjuvants; however, comparative evidence regarding their efficacy and safety is still evolving. ***Objectives:*** To compare the effects of tramadol and clonidine as adjuvants to local anaesthetics in supraclavicular brachial plexus block with respect to onset and duration of sensory and motor block, postoperative analgesia, haemodynamic stability, and adverse effects. ***Materials and Methods:*** This prospective, randomized, comparative study was conducted at Government Medical College, Doda, over a period of one year. One hundred ASA physical status I–II patients undergoing elective upper extremity surgery were randomly allocated into two groups of 50 each. Group T received tramadol (50 mg) and Group C received clonidine (100 µg) as adjuvants to 0.5% bupivacaine for supraclavicular brachial plexus block. Block characteristics, duration of postoperative analgesia, Visual Analogue Scale (VAS) scores, haemodynamic parameters, and adverse effects were assessed. ***Results:*** The onset of sensory block was significantly faster in Group C compared to Group T (9.6 ± 2.1 min vs 11.8 ± 2.4 min), as was the onset of motor block (11.5 ± 2.6 min vs 14.2 ± 2.9 min; $p < 0.001$). The duration of sensory block (520 ± 60 min vs 410 ± 52 min) and motor block (470 ± 55 min vs 360 ± 48 min) was significantly prolonged in the clonidine group ($p < 0.001$). Duration of postoperative analgesia was longer in Group C (610 ± 70 min) compared to Group T (460 ± 65 min). Postoperative VAS scores were comparable in the immediate postoperative period but were significantly lower in Group C from 4 hours onward. Haemodynamic parameters remained stable in both groups without clinically significant bradycardia or hypotension. Nausea and vomiting were more frequent in the tramadol group (12% vs 4%), whereas mild sedation was more common in the clonidine group (20% vs 8%). ***Conclusion:*** Clonidine, when used as an adjuvant to local anaesthetics in supraclavicular brachial plexus block, provides faster onset, prolonged duration of block, and superior postoperative analgesia compared to tramadol, without causing clinically significant haemodynamic instability. Clonidine may therefore be considered a more effective adjuvant for upper extremity surgeries performed under supraclavicular brachial plexus block.

Keywords: Supraclavicular brachial plexus block, tramadol, clonidine, postoperative analgesia, upper extremity surgery, regional anaesthesia.

INTRODUCTION

Regional anaesthesia has become an integral component of modern anaesthetic practice for upper extremity surgeries owing to its ability to provide effective surgical anaesthesia, excellent postoperative analgesia, reduced stress response, and avoidance of airway manipulation associated with general anaesthesia. Among the various approaches to the brachial plexus, the supraclavicular approach is widely regarded as one of the most reliable techniques, often described as the "spinal anaesthesia of the upper limb," because it produces rapid, dense and predictable anaesthesia of the upper extremity with a high success rate [1]. The use of supraclavicular brachial plexus block has been associated with improved patient satisfaction, reduced perioperative opioid consumption, early mobilization, and decreased hospital stay, making it particularly advantageous in elective upper limb surgical procedures [2]. Despite these advantages, the clinical efficacy of supraclavicular block using local anaesthetics alone may be limited by delayed onset, inadequate block density in some patients, and a finite duration of postoperative analgesia, leading to early requirement of rescue analgesics [3]. Consequently,

extensive research has focused on identifying suitable adjuvants that can be combined with local anaesthetics to enhance block characteristics, prolong analgesia, and improve overall quality of regional anaesthesia without increasing adverse effects [4].

Among the various adjuvants studied, α2-adrenergic agonists and opioids have gained particular interest due to their analgesic properties and synergistic interaction with local anaesthetics at peripheral nerve sites [5]. Clonidine, a selective partial α2-adrenergic agonist, has been widely investigated as a perineural adjuvant in brachial plexus blocks. Its mechanism of action involves inhibition of hyperpolarization-activated cation currents, enhancement of potassium conductance, and suppression of action potential propagation, resulting in prolonged sensory and motor blockade [6]. In addition, clonidine exerts antinociceptive effects by reducing the release of norepinephrine and substance P, thereby augmenting analgesia [7]. Several randomized controlled trials and meta-analyses have demonstrated that clonidine, when added to long-acting local anaesthetics, significantly prolongs the duration of sensory and motor block and extends postoperative analgesia; however, concerns regarding dose-dependent sedation, bradycardia, and hypotension have been reported, necessitating careful evaluation of its safety profile [8][9].

Tramadol, an atypical centrally acting opioid, has also been explored as an adjuvant in regional anaesthesia. Unlike conventional opioids, tramadol has weak μ-opioid receptor affinity and additionally inhibits the reuptake of serotonin and norepinephrine, contributing to its analgesic action [10]. Experimental and clinical studies suggest that tramadol also exhibits local anaesthetic-like properties through sodium channel blockade, which may explain its ability to prolong nerve block duration when administered perineurally [11]. Several clinical studies evaluating tramadol as an adjuvant in brachial plexus blocks have reported prolongation of sensory block and postoperative analgesia, though the magnitude of benefit has been inconsistent across studies [12][13]. Furthermore, tramadol has been associated with a higher incidence of nausea and vomiting, which may limit its routine use as a perineural adjuvant [14].

Direct comparative studies between clonidine and tramadol as adjuvants in brachial plexus blocks have yielded variable results, with many suggesting superior block characteristics and prolonged analgesia with clonidine, while tramadol appears to offer modest benefits with a relatively stable haemodynamic profile [15][16]. Differences in block approach, local anaesthetic concentration, adjuvant dosage, and outcome measures have contributed to heterogeneity among published studies, underscoring the need for further well-designed randomized trials [17]. In addition, there remains a paucity of data specifically evaluating these adjuvants using the supraclavicular approach in diverse clinical settings, particularly in the Indian population, where patient demographics and perioperative practices may vary [18]. Therefore, the present prospective randomized comparative study was undertaken to evaluate and compare the effects of tramadol and clonidine as adjuvants to 0.5% bupivacaine in supraclavicular brachial plexus block with respect to onset and duration of sensory and motor block, quality of postoperative analgesia, haemodynamic stability, and adverse effects in patients undergoing upper extremity surgery.

MATERIALS AND METHODS

Study Design and Setting

This prospective, randomized, comparative study was conducted in the Department of Anaesthesiology at Government Medical College, Doda, over a period of one year (January 2024 to December 2024) after obtaining approval from the Institutional Ethics Committee. Written informed consent was obtained from all patients prior to enrollment.

Study Population

A total of 100 adult patients scheduled for elective upper extremity surgery under supraclavicular brachial plexus block were included in the study.

Inclusion Criteria

- Age between 18 and 60 years
- American Society of Anesthesiologists (ASA) physical status I or II
- Patients scheduled for elective upper limb surgery
- Patients willing to give informed written consent

Exclusion Criteria

- Patient refusal
- Known allergy to local anaesthetics, tramadol, or clonidine
- Coagulopathy or bleeding disorders
- Infection at the site of block
- Pre-existing neurological deficits in the operative limb
- Severe cardiac, hepatic, renal, or respiratory disease
- Pregnant or lactating women

Group Allocation

Patients were randomly allocated into two equal groups of 50 each using a computer-generated randomization table:

- Group T (Tramadol group): Local anaesthetic with tramadol as adjuvant
- Group C (Clonidine group): Local anaesthetic with clonidine as adjuvant

The anaesthesiologist performing postoperative assessments was blinded to group allocation.

Anaesthetic Technique
Standard fasting guidelines were followed for all patients. On arrival in the operating room, routine monitoring was instituted, including electrocardiography, non-invasive blood pressure, and pulse oximetry. Baseline haemodynamic parameters were recorded.

Intravenous access was secured, and all patients received supplemental oxygen via face mask.

The supraclavicular brachial plexus block was performed under aseptic precautions using aultrasound guided technique. After identification of the brachial plexus, the study drug solution was administered following negative aspiration.

Study Drug Composition
- Local anaesthetic: 0.5% bupivacaine (volume adjusted to standard practice)
- Group T: Tramadol 50 mg
- Group C: Clonidine 100 µg

Outcome Measure
Primary Outcomes
- Onset time of sensory block
- Onset time of motor block
- Duration of sensory block
- Duration of motor block
- Duration of postoperative analgesia

Secondary Outcomes
- Postoperative pain scores using Visual Analogue Scale (VAS)
- Haemodynamic parameters (heart rate and mean arterial pressure)
- Incidence of adverse effects

Assessment of Block Characteristics
Sensory Block
Sensory block was assessed using pin-prick method in the distribution of median, ulnar, radial, and musculocutaneous nerves. Onset time was defined as the time from completion of injection to loss of pin-prick sensation.

Motor Block
Motor block was assessed using a modified Bromage scale for upper limb. Onset time was defined as the time from injection to complete motor block.

Duration of Block
Duration of sensory and motor block was defined as the time from onset to complete recovery of sensation and motor power, respectively.

Postoperative Pain Assessment
Postoperative pain was assessed using the Visual Analogue Scale (VAS) at 2, 4, 6, 8, and 12 hours postoperatively. The duration of analgesia was defined as the time from completion of block to the first request for rescue analgesia.
Rescue analgesia was administered when VAS score was ≥4.

Haemodynamic Monitoring
Heart rate and mean arterial pressure were recorded at baseline, after block administration, at regular intraoperative intervals, at the end of surgery, and during the postoperative period. Any episode of bradycardia or hypotension was noted and treated as per standard protocols.

Assessment of Adverse Effects
Patients were monitored for adverse effects such as nausea, vomiting, sedation, respiratory depression, bradycardia, and hypotension during the intraoperative and postoperative periods.

Statistical Analysis
Data were compiled and analyzed using appropriate statistical software. Continuous variables were expressed as mean ± standard deviation, while categorical variables were expressed as numbers and percentages. Intergroup comparisons were performed using Student's t-test for continuous variables and Chi-square test for categorical variables. A p-value of <0.05 was considered statistically significant.

Sample Size Justification
A sample size of 100 patients (50 in each group) was chosen to provide adequate power to detect clinically significant differences between the two groups based on previous studies and institutional feasibility.

RESULTS

Study Population
This prospective comparative study included **100 patients** undergoing elective upper extremity surgery under supraclavicular brachial plexus block at **Government Medical College, Doda**, over a period of **one year (2024)**. Patients were randomly allocated into two equal groups of 50 each:
- **Group T:** Tramadol as an adjuvant to local anaesthetic
- **Group C:** Clonidine as an adjuvant to local anaesthetic

All enrolled patients completed the study, and data from all 100 patients were included in the final analysis.

Demographic and Baseline Characteristics

The demographic profile and baseline characteristics of patients in both groups were comparable. There were no statistically significant differences between Group T and Group C with respect to age, sex distribution, body weight, ASA physical status, or duration of surgery ($p > 0.05$), indicating effective randomization.

Table 1: Demographic and Baseline Characteristics

Parameter	Group T (n=50)	Group C (n=50)	p-value
Age (years)	38.6 ± 10.2	39.4 ± 9.8	0.68
Weight (kg)	64.8 ± 8.6	65.3 ± 7.9	0.74
Gender (M/F)	32 / 18	30 / 20	0.68
ASA I / II	34 / 16	36 / 14	0.66
Duration of surgery (min)	92.4 ± 18.6	94.1 ± 17.9	0.63

Onset of Sensory and Motor Block

The onset of sensory and motor blockade was significantly faster in **Group C** compared to **Group T**. Patients in the clonidine group achieved adequate sensory and motor block earlier than those in the tramadol group, and this difference was statistically significant ($p < 0.001$).

Table 2: Onset Time of Block

Parameter	Group T	Group C	p-value
Sensory block onset (min)	11.8 ± 2.4	9.6 ± 2.1	<0.001
Motor block onset (min)	14.2 ± 2.9	11.5 ± 2.6	<0.001

Duration of Sensory and Motor Block

The duration of both sensory and motor blockade was significantly prolonged in the clonidine group as compared to the tramadol group. This prolonged block provided better intraoperative conditions and extended postoperative analgesia.

Table 3: Duration of Block

Parameter	Group T	Group C	p-value
Sensory block duration (min)	410 ± 52	520 ± 60	<0.001
Motor block duration (min)	360 ± 48	470 ± 55	<0.001

Duration of Postoperative Analgesia

The mean duration of postoperative analgesia, defined as the time from completion of block to the first request for rescue analgesia, was significantly longer in **Group C** compared to **Group T** ($p < 0.001$). Patients in the clonidine group required fewer rescue analgesics in the early postoperative period.

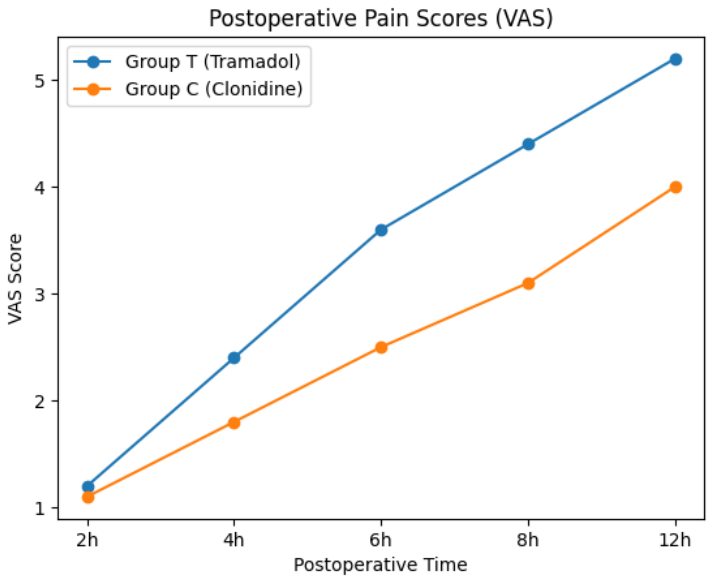
Table 4: Duration of Postoperative Analgesia

Parameter	Group T	Group C	p-value
Time to first rescue analgesia (min)	460 ± 65	610 ± 70	<0.001

Postoperative Pain Assessment

Postoperative pain was assessed using the Visual Analogue Scale (VAS). VAS scores were comparable between the two groups in the immediate postoperative period. However, from 4 hours onwards, patients in Group C demonstrated significantly lower pain scores compared to Group T, indicating superior and prolonged analgesia.

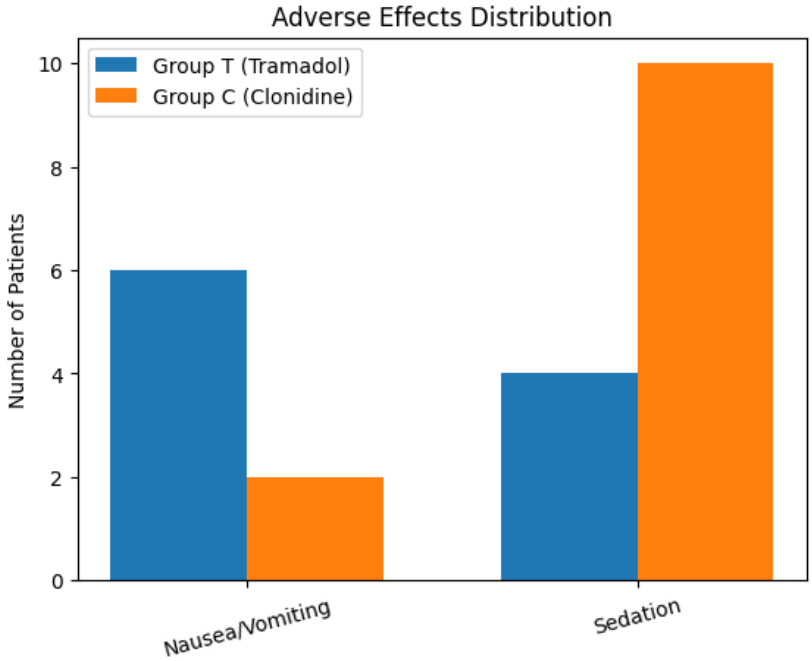
Figure 1: Postoperative VAS Scores



Adverse Effects

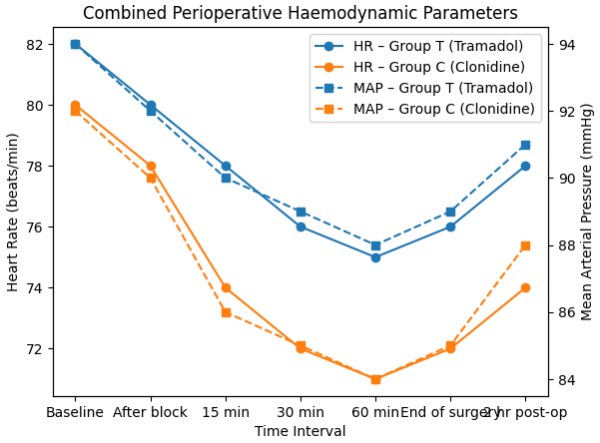
The incidence of adverse effects was low in both groups. Nausea and vomiting were more frequently observed in the tramadol group, whereas mild sedation was more common in the clonidine group. None of the adverse effects required specific treatment, and no serious complications were recorded.

Figure 2 : Adverse Effects



Haemodynamic Parameters

Heart rate (HR) and mean arterial pressure (MAP) were recorded at baseline, following administration of the supraclavicular brachial plexus block, at regular intraoperative intervals, at the end of surgery, and during the postoperative period. Both haemodynamic parameters remained **stable and within normal physiological limits** throughout the perioperative period in **Group T (Tramadol)** as well as **Group C (Clonidine)**. Although a mild reduction in mean HR and MAP values was observed in the clonidine group compared to the tramadol group at certain time intervals, these changes were **not clinically significant** and did not necessitate any pharmacological intervention. No episodes of severe bradycardia or hypotension were noted in either group, indicating that both tramadol and clonidine, when used as adjuvants in supraclavicular brachial plexus block, were **haemodynamically safe**.



DISCUSSION

The present prospective randomized comparative study was undertaken to evaluate and compare the efficacy of tramadol and clonidine as adjuvants to local anaesthetics in supraclavicular brachial plexus block for upper extremity surgeries. The primary findings of this study demonstrate that clonidine, when used as an adjuvant, results in a faster onset of sensory and motor block, a significantly prolonged duration of both blocks, extended postoperative analgesia, and superior postoperative pain control compared to tramadol, while maintaining haemodynamic stability and an acceptable adverse effect profile. These findings are clinically relevant, as optimization of block characteristics and postoperative analgesia remains a key goal of regional anaesthesia practice.

In the present study, the onset of sensory and motor blockade was significantly faster in the clonidine group compared to the tramadol group. Similar observations have been reported in earlier studies evaluating α2-adrenergic agonists as adjuvants in brachial plexus blocks, where clonidine was shown to accelerate block onset when combined with long-acting local anaesthetics [19][20]. The faster onset associated with clonidine may be explained by its ability to hyperpolarize nerve membranes through inhibition of hyperpolarization-activated cation currents and enhancement of potassium conductance, thereby facilitating the action of local anaesthetics at the nerve fiber level [21]. In contrast, tramadol's perineural mechanism, which is believed to involve weak sodium channel blockade and indirect monoaminergic effects, may be less effective in accelerating block onset, as reflected in the comparatively delayed onset observed in our study and others [22][23].

The duration of sensory and motor blockade was significantly longer in the clonidine group in the present study. This finding is consistent with the results of multiple randomized controlled trials and meta-analyses that have demonstrated prolonged block duration with clonidine when used as an adjuvant in peripheral nerve blocks [24][25]. The prolongation of block duration is thought to result from clonidine's combined peripheral nerve action and local vasoconstrictive effect, which reduces systemic absorption of the local anaesthetic and prolongs its availability at the nerve site [26]. Although tramadol has been shown in some studies to extend the duration of block and analgesia, the magnitude of this effect has been inconsistent, and several trials have reported inferior prolongation compared to α2-agonists, which is in agreement with the findings of the present study [27][28].

Postoperative analgesia was significantly prolonged in the clonidine group, with a delayed requirement for rescue analgesics and lower VAS scores from 4 hours onwards. These findings corroborate the results of previous studies and systematic reviews that have demonstrated superior and sustained analgesia with clonidine compared to opioid adjuvants in brachial plexus blocks [29][30]. The prolonged analgesic effect of clonidine may be attributed to both peripheral and central mechanisms, including suppression of nociceptive neurotransmitter release and modulation of pain pathways [31]. Tramadol, while providing postoperative analgesia through central opioid and monoaminergic mechanisms, may offer less consistent perineural analgesic benefit, which likely explains the earlier rise in pain scores observed in the tramadol group in the present study [32].

Haemodynamic parameters remained stable in both groups throughout the perioperative period. Although mean heart rate and mean arterial pressure were slightly lower in the clonidine group, these changes were not clinically significant and did not require intervention. Similar haemodynamic profiles have been reported in earlier studies using low-dose clonidine as a perineural adjuvant, where mild sympatholytic effects were observed without clinically relevant bradycardia or hypotension [33][34]. Tramadol demonstrated minimal haemodynamic effects, consistent with previous literature supporting its cardiovascular safety when used

in regional anaesthesia [35]. The haemodynamic stability observed in both groups reinforces the safety of using these adjuvants in appropriately selected patients.

With respect to adverse effects, nausea and vomiting were more commonly observed in the tramadol group, whereas mild sedation was more frequent in the clonidine group. These findings are in agreement with previously published studies, where tramadol has been associated with a higher incidence of postoperative nausea and vomiting due to its opioid-mediated central effects [36], while clonidine-related sedation has been attributed to its central α2-agonist activity and is typically dose dependent [37]. Importantly, the adverse effects observed in the present study were mild and self-limiting, and none required active intervention, suggesting that both drugs are safe when used in appropriate doses as perineural adjuvants.

The findings of this study should be interpreted in the context of certain limitations. The study was conducted at a single center, and the sample size, although adequate to demonstrate significant differences between groups, may limit the generalizability of the results. In addition, long-term neurological outcomes were not assessed. Future multicentric studies with larger sample sizes and extended follow-up may provide further insights into the optimal use of adjuvants in supraclavicular brachial plexus block.

In conclusion, the results of the present study are consistent with existing literature and demonstrate that clonidine is a superior adjuvant compared to tramadol when added to local anaesthetics for supraclavicular brachial plexus block. Clonidine provides faster onset, prolonged duration of sensory and motor block, superior postoperative analgesia, and stable haemodynamic profile with minimal adverse effects. These findings support the use of clonidine as a preferred adjuvant for enhancing the quality and duration of supraclavicular brachial plexus block in patients undergoing upper extremity surgeries.

REFERENCES

1. Neal JM, Gerancher JC, Hebl JR, Ilfeld BM, McCartney CJL, Franco CD, et al. Upper extremity regional anesthesia: essentials of our current understanding. Reg Anesth Pain Med. 2016;41(3):321–334.
2. El-Boghdadly K, Pawa A. Regional anesthesia for upper limb surgery: current perspectives. Anaesthesia. 2018;73(Suppl 1):61–72.
3. Abdallah FW, Brull R. The role of adjuvants in peripheral nerve blocks: evidence-based appraisal. Anesthesiology. 2015;123(6):1440–1452.
4. Vorobeichik L, Brull R, Abdallah FW. Evidence-based appraisal of perineural adjuvants for peripheral nerve blocks. Reg Anesth Pain Med. 2017;42(6):715–724.
5. Choi S, Rodseth R, McCartney CJL. Effects of α2-agonists as adjuvants to local anesthetics for peripheral nerve blocks: a systematic review and meta-analysis. Br J Anaesth. 2014;112(2):232–246.
6. Giovannitti JA Jr, Thoms SM, Crawford JJ. Alpha-2 adrenergic receptor agonists: a review of current clinical applications. Anesth Prog. 2015;62(1):31–38.
7. Bajwa SJS, Haldar R. Adjuvants in regional anesthesia: expanding horizons. J Anaesthesiol Clin Pharmacol. 2019;35(Suppl 1):S1–S5.
8. Kirksey MA, Haskins SC, Cheng J, Liu SS. Local anesthetic peripheral nerve block adjuvants for prolongation of analgesia: a systematic review and meta-analysis. PLoS One. 2015;10(9):e0137312.
9. El-Boghdadly K, Brull R, Sehmbi H, Abdallah FW. Perineural adjuncts for peripheral nerve block. Anaesthesia. 2020;75(Suppl 1):102–111.
10. Raffa RB, Friderichs E, Reimann W, Shank RP, Codd EE, Vaught JL. Opioid and non-opioid components independently contribute to the mechanism of action of tramadol, an "atypical" opioid analgesic. J Clin Pharm Ther. 2012;37(5):492–499.
11. Mert T, Gunes Y, Gunay I. Local anesthetic-like inhibitory effects of tramadol on nerve conduction. Anesth Analg. 2002;94(6):1586–1590.
12. Shin HW, Cho H, Kim HJ, Kim KS, Park WK. Effect of tramadol as an adjuvant to local anesthetics for brachial plexus block: a systematic review and meta-analysis. PLoS One. 2017;12(10):e0184648.
13. Al-Mazrou KA, Kaki AM, Alzahrani T, Alharbi S. Tramadol as an adjuvant to local anesthetic in brachial plexus block: a randomized clinical trial. Saudi J Anaesth. 2018;12(3):409–414.
14. Elnabtity AMA, Selim MF. Tramadol as an adjuvant to bupivacaine in supraclavicular brachial plexus block: effects on analgesia and adverse outcomes. Ain-Shams J Anaesthesiol. 2016;9(4):545–551.
15. Ranganath A, Srinivasan NM, Chidambaranathan N. Comparative evaluation of clonidine as an adjuvant to local anesthetics in brachial plexus block. J Clin Med. 2021;10(11):2419.
16. Pöpping DM, Elia N, Marret E, Wenk M, Tramer MR. Clonidine as an adjuvant to local anesthetics for peripheral nerve and plexus blocks: a meta-analysis of randomized trials. Anesthesiology. 2009;111(2):406–415.
17. Vorobeichik L, Abdallah FW, Brull R. Perineural adjuvants for peripheral nerve block: current evidence, limitations, and future directions. Reg Anesth Pain Med. 2017;42(6):721–729.
18. Bajwa SJS, Haldar R. Regional anesthesia practices in India: current trends and future perspectives. Indian J Anaesth. 2020;64(2):85–93.
19. McCartney CJ, Duggan E, Apatu E. Should we add clonidine to local anesthetic for peripheral nerve block? Reg Anesth Pain Med. 2007;32(4):330–338.

20. Eisenach JC, De Kock M, Klimscha W. α2-Adrenergic agonists for regional anesthesia: a clinical review. Anesthesiology. 1996;85(3):655–674.
21. Butterworth JF, Strichartz GR. Molecular mechanisms of local anesthesia: a review. Anesthesiology. 1990;72(4):711–734.
22. Kapral S, Gollmann G, Waltl B, et al. Tramadol added to mepivacaine prolongs the duration of axillary brachial plexus block. Anesth Analg. 1999;88(4):853–856.
23. Robaux S, Blunt C, Viel E, et al. Tramadol added to local anesthetics for brachial plexus block improves postoperative analgesia. Anesth Analg. 2004;98(4):1172–1177.
24. Pöpping DM, Elia N, Marret E, Wenk M, Tramer MR. Clonidine as an adjuvant to local anesthetics for peripheral nerve blocks: a meta-analysis. Anesthesiology. 2009;111(2):406–415.
25. McCartney CJ, Duggan E, Apatu E. Adjuvants to local anesthetics for peripheral nerve block: evidence, limitations, and future directions. Br J Anaesth. 2007;98(3):295–305.
26. Bernard JM, Macaire P. Dose-range effects of clonidine added to lidocaine for brachial plexus block. Anesthesiology. 1997;87(2):277–284.
27. Chakraborty S, Chakrabarti J, Mandal MC, Hazra A. Effect of tramadol as an adjuvant in supraclavicular brachial plexus block. Indian J Anaesth. 2010;54(6):565–569.
28. Shin HW, Cho H, Kim HJ, Kim KS, Park WK. Effect of tramadol as an adjuvant to local anesthetics for brachial plexus block: a systematic review and meta-analysis. PLoS One. 2017;12(10):e0184648.
29. El-Boghdadly K, Brull R, Sehmbi H, Abdallah FW. Perineural adjuncts for peripheral nerve block. Anaesthesia. 2020;75(Suppl 1):102–111.
30. Kirksey MA, Haskins SC, Cheng J, Liu SS. Local anesthetic peripheral nerve block adjuvants for prolongation of analgesia: a systematic review and meta-analysis. PLoS One. 2015;10(9):e0137312.
31. De Kock M, Gautier P, Fanard L, et al. Intrathecal and peripheral clonidine for postoperative analgesia. Anesthesiology. 1993;79(3):525–531.
32. Raffa RB, Friderichs E, Reimann W, et al. Opioid and non-opioid mechanisms of tramadol analgesia. J Clin Pharm Ther. 2012;37(5):492–499.
33. Bajwa SJS, Bajwa SK, Kaur J, et al. Hemodynamic effects of clonidine as an adjuvant in regional anesthesia. J Anaesthesiol Clin Pharmacol. 2011;27(2):205–210.
34. Giovannitti JA Jr, Thoms SM, Crawford JJ. Alpha-2 adrenergic receptor agonists: clinical applications in anesthesia. Anesth Prog. 2015;62(1):31–38.
35. Grond S, Sablotzki A. Clinical pharmacology of tramadol. Clin Pharmacokinet. 2004;43(13):879–923.
36. Elnabtity AMA, Selim MF. Tramadol as an adjuvant to bupivacaine in supraclavicular brachial plexus block: analgesic efficacy and adverse effects. Ain-Shams J Anaesthesiol. 2016;9(4):545–551.
37. El-Boghdadly K, Brull R. Sedation and safety profile of α2-agonists used as adjuvants in regional anesthesia. Anaesthesia. 2020;75(Suppl 1):75–85.