Section: Anaesthesia

Original Research Article

BUPRENORPHINE VERSUS TRAMADOL AS ADJUVANTS TO BUPIVACAINE IN ULTRASOUND-GUIDED AXILLARY BRACHIAL PLEXUS BLOCK: A RANDOMIZED COMPARATIVE STUDY FOR POSTOPERATIVE ANALGESIA IN UPPER LIMB SURGERIES

Saurin B. Panchal[1], Siddhi H. Patel[2], Pratixaben A. Dhak[3], Kushal U. Patel[3]

[1]*Assistant Professor, SCL Hospital, NHL Medical College, Ahmedabad-Gujarat, India*
[2]*Tutor, SCL Hospital, NHL Medical College, Ahmedabad-Gujarat, India*
[3]*Resident Doctor, SCL Hospital, NHL Medical College, Ahmedabad-Gujarat, India*

Received *: 20/11/2025*
Received in revised form *: 10/01/2026*
Accepted *: 29/01/2026*

Corresponding Author:
Dr. Pratixaben A. Dhak,
Resident Doctor, SCL Hospital, NHL Medical College, Ahmedabad-Gujarat, India.
Email: pratixadhak@gmail.com

DOI: 10.70034/ijmedph.2026.1.201

Source of Support: Nil,
Conflict of Interest: None declared

Int J Med Pub Health
2026; 16 (1); 1148-1153

ABSTRACT

Background: Effective postoperative pain management is crucial for upper limb surgeries. This study compared buprenorphine and tramadol as adjuvants to bupivacaine in ultrasound-guided axillary brachial plexus block.

Materials and Methods: 60 patients were randomized into two groups: Group A (bupivacaine + buprenorphine 150 µg) and Group B (bupivacaine + tramadol 100 mg). Primary outcome was duration of postoperative analgesia.

Results: Group A had longer analgesia (21.2 vs 14.1 hours, $P < 0.0001$), while Group B had faster onset ($P < 0.0001$). Group A required less rescue analgesic (67.5 vs 132.5 mg, $P < 0.001$). Adverse effects were manageable.

Conclusion: Buprenorphine provided longer and more reliable postoperative analgesia, while tramadol had faster onset but shorter duration. Both are safe and effective adjuvants with bupivacaine.

Keywords: Buprenorphine, tramadol, bupivacaine, axillary brachial plexus block, postoperative analgesia, upper limb surgery.

INTRODUCTION

Effective postoperative pain management is crucial for optimal recovery and outcomes in patients undergoing upper limb surgeries. Regional anaesthesia techniques, such as the axillary brachial plexus block, have become a cornerstone in managing pain for these procedures. However, the duration of action of bupivacaine, a commonly used local anaesthetic, often falls short, lasting only 6-12 hours. This limited duration can lead to inadequate pain control, increased opioid consumption, and related side effects.

To address this limitation, adjuvants like buprenorphine and tramadol have been explored to prolong analgesia. Buprenorphine, a potent opioid with high affinity for mu-receptors, has shown promise in providing long-lasting analgesia (18+ hours) when used as an adjuvant.[1] Tramadol, with its multimodal mechanism of action, offers an alternative option with potentially faster onset and a different side effect profile.[2]

The use of ultrasound-guided axillary brachial plexus block has further enhanced the precision and efficacy of regional anaesthesia. However, there is a need to compare the efficacy of buprenorphine and tramadol as adjuvants in this context. This study aims to evaluate and compare the analgesic efficacy, duration of action, and safety profile of buprenorphine and tramadol as adjuvants to bupivacaine in ultrasound-guided axillary brachial plexus block for upper limb surgeries.

Aims and Objectives

Aim: This study aims to compare the efficacy, duration, and safety of buprenorphine versus tramadol as adjuvants to bupivacaine in ultrasound-guided axillary brachial plexus block, with the goal of optimizing postoperative analgesia for upper limb surgeries, for the objectives like:

Objectives

1. Duration of postoperative analgesia (primary outcome): buprenorphine vs tramadol
2. Onset time of sensory and motor blockade: speed matters
3. Analgesic quality: VAS scores over 24 hours
4. Rescue analgesic consumption: reduced opioid needs
5. Safety profile: adverse effects incidence and severity

MATERIALS AND METHODS

A randomized prospective observational comparative study was conducted at the tertiary care institute after obtaining approval. Sixty adult patients of either sex, weighing 50 to 90 kg, with ASA grade I/II, were included. Patients were randomly divided into two groups (n=30 each) using the odd-even technique.

Group A (Buprenorphine Group): Bupivacaine (0.375%, 2mg/kg) + Buprenorphine (3 µg /kg, max 150 µg).[1]

Group B (Tramadol Group):Bupivacaine (0.375%, 2mg/kg) + Tramadol (2mg/kg, max100 mg).[2]

Inclusion Criteria

- Age: 18-60 years
- ASA physical status I or II
- Elective upper limb surgeries under ultrasound-guided axillary brachial plexus block
- Body weight: 50-90 kg
- Informed consent

Exclusion Criteria:

- Allergy to study drugs
- Coagulation disorders or anticoagulant therapy
- Infection or anatomical abnormality at injection site
- Severe hepatic or renal impairment
- Pregnancy or lactation
- Chronic opioid use or substance abuse
- Neuropathic pain or neurological deficits in operative limb

Preoperative Assessment: A thorough preoperative assessment was conducted for all patients. This included a detailed medical, surgical, and medication history to identify any potential risks or contraindications to the planned anaesthesia technique.

The physical examination focused on airway assessment (Mallampatti classification), cardiovascular, and respiratory systems to confirm the patient's fitness for the procedure. Relevant laboratory checks, such as coagulation profile, renal function, and liver enzymes, were reviewed if indicated. Written informed consent was obtained from all patients after explaining the procedure, risks, and benefits. Patients were kept nil by mouth (NPO) for ≥6 hours for solids and 2 hours for clear fluids.

On the day of surgery, patients were taken to operating room, 18-gauge intravenous cannula was placed in the non-operative arm for fluid and medication administration. Baseline vitals, including heart rate (HR), non-invasive blood pressure (NIBP), oxygen saturation (SpO_2), and respiratory rate (RR), were recorded. The American Society of Anaesthesiologists (ASA) physical status was confirmed to be I or II for all patients. Patients were also screened for known allergies to the study drugs, and their weight was verified to be between 50-90 kg to ensure accurate dosing.

The block was performed in the operation theatre with the patient positioned supine and the operative arm abducted to 90° and externally rotated. The skin was cleaned with 2% chlorhexidine and draped with sterile sheets. Under ultrasound guidance, the axillary artery, veins, and nerves (median, ulnar, radial, musculocutaneous) were visualized. Local skin infiltration with 1-2 mL of 1% lidocaine was optional. A 23-gauge needle was inserted in-plane, and hydro dissection with 1-2 mL saline confirmed needle tip position. The study drug (32 mL) was injected incrementally after negative aspiration, ensuring spread around the nerves.

Drug Administration:

- Group A: Bupivacaine 0.375% (≤2 mg/kg, max 30 mL) + Buprenorphine (3 µg/kg, max 150 µg)
- Group B: Bupivacaine 0.375% (≤2 mg/kg, max 30 mL) + Tramadol (2 mg/kg, max 100 mg)
- Block Assessment:
- Sensory Block: Assessed every 2 minutes using pinprick test:
  - 0: Normal sensation
  - 1: Analgesia
  - 2: Anaesthesia
- Motor Block: Assessed using Lovett scale:
  - 0: No movement (complete paralysis)
  - 1: Trace movement (slight contraction, no joint movement)
  - 2: Poor strength (moves against gravity, no resistance)
  - 3: Fair strength (against gravity, no added resistance)
  - 4: Good strength (against gravity + some resistance)
  - 5: Normal strength
- Block considered effective when sensory score = 2 and motor score <2 in all nerve distributions; surgery commenced within 30 minutes.

Patients were monitored with ECG, SpO_2, and NIBP every 5 minutes intraoperatively. Sedation or general anaesthesia was provided if the block failed, and those patients were excluded from the study. Postoperatively, patients were transferred to the post-anaesthesia care unit (PACU) for 24-hour monitoring. Rescue analgesic (diclofenac 75 mg IV) was administered upon VAS score ≥4.

Outcome Measures

The primary outcome was the duration of analgesia, defined as the time from block completion to the first request for rescue analgesic, measured in hours. Secondary outcomes included:

- Onset of sensory block (time to complete loss of pinprick sensation, minutes)

- Onset of motor block (time to motor score <2, minutes)
- Quality of analgesia (VAS scores 0-10) at 0, 5, 10, 15, 30 minutes, 1, 2, 3, 6, 12, 16, 20, and 24 hours postoperatively
- Total rescue analgesic consumption (diclofenac dose, mg) in the first 24 hours
- Incidence of adverse effects (nausea, vomiting, sedation, respiratory depression, others)

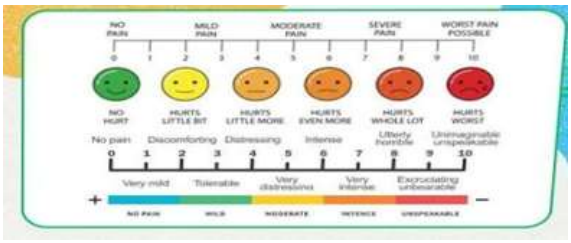

Figure 1: Visual Analog Scale (VAS) for Pain

Statistical analysis: Statistical analysis was done using IBM SPSS version 24 software with unpaired t test & chi square test. The data was collected, compiled and analysed statistically. All continues variables are reported as mean±standard deviation. P value < 0.05 was considered statistically Significant difference for all statistical tests.

Grade	Ability to move
5	The muscle can move the joint it crosses through a full range of motion, against gravity, and against full resistance applied by the examiner.
4	The muscle can move the joint it crosses through a full range of motion against moderate resistance.
3	The muscle can move the joint it crosses through a full range of motion against gravity but without any resistance.
2	The muscle can move the joint it crosses through a full range of motion only if the part is properly positioned so that the force of gravity is eliminated.
1	Muscle contraction is seen or identified with palpation, but it is insufficient to produce joint motion even with elimination of gravity.
0	No muscle contraction is seen or identified with palpation; paralysis.

Figure 2: Lovett Scale for Motor Block Assessment

RESULTS

Table 1: Demographic and Baseline Characteristics

Parameter	Group a	Group b	P value
Age (years)	39 ± 8.6	40.6 ± 8.13	0.46
Gender (M/F)	18/12	15/15	0.44
ASA status (I/II)	21/9	18/12	0.42
Weight (kg)	69.3 ± 7.0	68.3 ± 6.5	0.57
Duration of surgery (min)	83.4 ± 16.2	79.8 ± 14.9	0.38

Demographic and Baseline Characteristics compared two groups (Group A and Group B) receiving bupivacaine with either buprenorphine or tramadol as adjuvants.

Table 2: Diagnosis and Type of Surgery

Diagnosis	Surgery	Group A	Group B	Total
Carpal Tunnel Syndrome	Carpal Tunnel Release	6	6	12
Distal End Radius Fracture	ORIF	6	5	11
Wrist Ganglion	Wrist Ganglion Excision	6	6	12
Radius Ulna Shaft Fracture	ORIF	5	6	11
Flexor tendon laceration	Tendon Repair	4	3	7
Extensor tendon laceration	Tendon Repair	3	4	7

The randomization between Group A and Group B was successful, as the distribution of surgical cases was nearly equal across both groups.

Table 3: Duration of Analgesia

Parameter	Group A	Group B	P Value
Duration of Analgesia (hours)	21.2 ± 1.35	14.1 ± 0.7	<0.0001

Group A (buprenorphine) provided a significantly longer duration of postoperative analgesia (21.2 hours) compared to Group B (tramadol, 14.1 hours), with a highly significant P-value (< 0.0001).

Table 4: Onset and Block Characteristics

Parameter	Group A	Group B	P Value
Onset of sensory block (mins)	10.06 ± 1.31	8.4 ± 1.03	<0.0001
Onset of motor block (mins)	13.03 ± 1.35	11.4 ± 1.03	<0.0001

Tramadol (Group B) achieved a significantly faster sensory (8.4 vs. 10.06 mins) and motor (11.4 vs. 13.03 mins) block onset than buprenorphine (Group A), with P < 0.0001.

Table 5: VAS Scores Over 24 Hours

Time	Group A	Group B	P Value
0 min	0.0 ± 0.0	0.0 ± 0.0	–
5 mins	0.06 ± 0.25	0.07 ± 0.2	0.86
10 mins	0.2 ± 0.4	0.16 ± 0.37	0.69
15 mins	0.26 ± 0.52	0.2 ± 0.4	0.62
30 mins	0.5 ± 0.77	0.4 ± 0.67	0.59
1 hour	0.56 ± 0.89	0.46 ± 0.77	0.64
2 hours	0.73 ± 1.04	0.6 ± 0.96	0.62
3 hours	0.96 ± 1.24	0.83 ± 1.14	0.67
6 hours	1.66 ± 1.68	1.7 ± 1.70	0.92
12 hours	2.43 ± 1.5	3.5 ± 1.43	0.006
16 hours	2.5 ± 1.57	2.3 ± 1.02	0.561
20 hours	3.26 ± 1.72	2.1 ± 0.95	0.002
24 hours	3.33 ± 1.70	5.2 ± 1.62	<0.001

1. 1.0–6 hours: Both groups show low VAS scores due to bupivacaine's strong local anaesthetic effect masking any adjuvant difference. The early postoperative pain control is uniform, with no noticeable gap between buprenorphine and tramadol.
2. 6–12 hours: A significant gap emerges (2.43 vs 3.5, P = 0.006), with buprenorphine keeping VAS < 3 (mild pain).Tramadol lets pain rise to VAS > 3 (moderate), indicating buprenorphine gives better intermediate analgesia.
3. 16–20 hours: VAS scores are similar (< 3) because rescue analgesics were given in Group B.The adjuvant difference is obscured by the rescue medication in this interval.
4. 24 hours: The difference widens (3.33 vs 5.2, P < 0.001), with Group A in moderate pain (VAS 3–5).Group B approaches severe pain (VAS > 5), showing buprenorphine provides longer analgesia than tramadol.

Table 6: Postoperative Heart Rate Over 24 Hours

Time	Group A Mean ± SD (bpm)	Group B Mean ± SD (bpm)	P-value
0 min	79.9 ± 5.8	79.8 ± 5.7	0.94
5 min	78.1 ± 5.9	77.8 ± 5.9	0.81
10 min	76.0 ± 6.1	75.9 ± 6.0	0.95
15 min	75.7 ± 6.1	75.9 ± 6.0	0.86
30 min	77.4 ± 5.5	77.6 ± 5.4	0.86
1 hr	79.4 ± 5.6	79.6 ± 5.5	0.88
2 hr	81.1 ± 5.3	81.3 ± 5.2	0.88
3 hr	81.5 ± 5.7	83.0 ± 5.3	0.29
6 hr	83.2 ± 5.3	84.6 ± 5.8	0.33
12 hr	85.3 ± 5.3	89.2 ± 5.1	0.005
16 hr	87.5 ± 5.7	81.7 ± 5.7	0.0002
20 hr	89.5 ± 5.7	83.2 ± 5.1	<0.0001
24 hr	91.5 ± 5.6	93.2 ± 4.9	0.21

Table 7: Postoperative Systolic Blood Pressure Over 24 Hours

Time	Group A Mean ± SD (mmHg)	Group B Mean ± SD (mmHg)	P-value
0 min	127.9 ± 6.7	128.0 ± 6.0	0.95
5 min	126.1 ± 6.8	126.0 ± 6.1	0.95
10 min	124.6 ± 6.8	124.0 ± 6.1	0.66
15 min	124.3 ± 6.9	124.1 ± 6.3	0.89
30 min	126.4 ± 6.6	125.9 ± 5.9	0.73
1 hr	128.0 ± 6.7	128.0 ± 6.0	1.00
2 hr	129.7 ± 6.4	129.8 ± 5.8	0.94
3 hr	129.8 ± 6.6	131.7 ± 5.7	0.23
6 hr	131.8 ± 6.5	133.6 ± 5.7	0.25
12 hr	133.9 ± 6.5	137.6 ± 5.7	0.022
16 hr	135.6 ± 6.1	129.8 ± 5.9	0.0004
20 hr	137.3 ± 5.8	131.6 ± 5.8	0.0003
24 hr	138.8 ± 5.4	141.2 ± 5.6	0.096

Table 8: Postoperative Diastolic Blood Pressure Over 24 Hours

Time	Group A Mean ± SD (mmHg)	Group B Mean ± SD (mmHg)	P-value
0 min	78.8 ± 5.1	79.0 ± 5.0	0.87
5 min	77.0 ± 5.4	77.2 ± 5.3	0.88
10 min	75.6 ± 5.4	75.5 ± 5.4	0.94
15 min	75.0 ± 5.5	75.5 ± 5.4	0.72
30 min	77.2 ± 5.5	77.5 ± 5.3	0.83
1 hr	79.3 ± 5.4	79.5 ± 5.4	0.88
2 hr	81.2 ± 5.3	81.4 ± 5.2	0.88

3 hr	81.2 ± 5.3	83.3 ± 5.2	0.13
6 hr	83.0 ± 5.2	85.1 ± 5.3	0.13
12 hr	85.0 ± 5.2	89.0 ± 5.1	0.004
16 hr	87.1 ± 5.2	81.4 ± 5.2	0.0001
20 hr	89.2 ± 5.3	83.4 ± 5.2	0.0001
24 hr	90.9 ± 4.9	90.9 ± 4.8	1.00

[Tables 6-8] show no significant differences in HR, SBP and DBP between Group A and Group B from 0–6 hours (P = 0.09–1.0). At 12 hours, Group B had higher HR (P = 0.005), SBP (P = 0.022) and DBP (P = 0.004). At 16–20 hours, Group A showed higher values (P = 0.0001–0.0004). By 24 hours, differences mostly resolve (P = 0.087–1.0, HR P = 0.21).

Table 9: Total Rescue Analgesic (mg)

Diclofenac	Group A	Group B	P value
Total rescue analgesic dose (mg)*	67.5 ± 53.4	132.5 ± 54.6	<0.001

Group A (buprenorphine) required significantly less diclofenac (67.5 mg vs. 132.5 mg, P<0.001), indicating superior and prolonged analgesia. Group B (tramadol) needed higher rescue analgesic doses in the first 24 hours, reflecting tramadol's shorter duration of action.

Table 10: Adverse Effects

Adverse Effect	Group A (n, %)	Group B (n, %)	P Value
Nausea	6 (20.0%)	11 (36.7%)	0.15
Vomiting	3 (10.0%)	7 (23.3%)	0.17
Sedation	9 (30.0%)	4 (13.3%)	0.12
Pruritus	1 (3.33%)	0 (0%)	1.00
Respiratory depression	0 (0%)	0 (0%)	–

Nausea & Vomiting: Tramadol showed trends toward higher incidence (nausea: 36.7% vs. 20.0%, p = 0.15; vomiting: 23.3% vs. 10.0%, p = 0.17).

Sedation: Buprenorphine had a notable trend of higher incidence (30.0% vs. 13.3%, p = 0.12), highlighting a mild sedation risk.

Pruritus: Rare occurrence (3.3% in Group A, 0% in Group B, P = 1.00).

Respiratory Depression: Zero incidence in both groups confirms safety at these doses, with buprenorphine's partial agonism providing a protective effect.

DISCUSSION

Effective postoperative pain management is crucial for upper limb surgeries, which often cause moderate-to-severe pain lasting 24–48 hours. The axillary brachial plexus block, guided by ultrasound, is a preferred technique due to its safety and efficacy in targeting the median, ulnar, radial, and musculocutaneous nerves.

Bupivacaine (0.375%, 30 mL, 2 mg/kg) provides 6–12 hours of analgesia but is insufficient for prolonged postoperative pain relief. To address this, opioids like buprenorphine and tramadol were used as adjuvants, enhancing analgesia duration and quality. Buprenorphine (100–300 µg) and tramadol (50–100 mg or 2 mg/kg) doses were selected based on efficacy and safety profiles, balancing analgesia duration and side effects.

The use of ultrasound guidance reduced local anaesthetic volumes by 30–50% and minimized complications, aligning with existing literature. Buprenorphine and tramadol, being cost-effective and safe, improved postoperative analgesia when added to bupivacaine, supporting their role as valuable adjuvants in brachial plexus blocks.

This randomized prospective observational comparative study (n=60) compared buprenorphine (150 µg) and tramadol (100 mg) as adjuvants to bupivacaine (0.375%, 30 mL) in ultrasound-guided axillary brachial plexus block for upper limb surgeries.

Demographic and baseline characteristics were comparable between groups (all P > 0.05), ensuring fair comparison [Table 1]. Both groups had similar diagnoses and surgeries, balancing pain levels and surgical stress.[1,2]

Duration of Analgesia: Buprenorphine provided longer postoperative analgesia (21.2 ± 1.35 hours) vs. tramadol (14.1 ± 0.7 hours, P < 0.0001), supported by Kaur et al, Gupta et al, and Patel et al. This reflects buprenorphine's high mu-opioid receptor affinity and long half-life (24–60 hours) vs. tramadol's weaker effect and shorter half-life (6–7 hours).[3-6]

Onset of Blockade: Tramadol had faster sensory (8.4 ± 1.03 minutes) and motor (11.4 ± 1.03 minutes) onset vs. buprenorphine (P < 0.0001), attributed to tramadol's sodium channel blockade.[4,5]

VAS Scores: Buprenorphine maintained lower pain scores at 12–24 hours (P = 0.006–<0.001), indicating longer and reliable postoperative analgesia.[6,7]

Hemodynamic: Tramadol patients had higher HR and BP at 12 hours (P = 0.005–0.022), likely due to pain.[8]

Rescue Analgesic: Buprenorphine patients needed half the diclofenac dose (67.5 ± 53.4 mg vs. 132.5 ± 54.6 mg, P < 0.001).[9,10]

Adverse Effects: Tramadol caused more nausea/vomiting; buprenorphine caused more sedation/pruritus. No respiratory depression occurred. Effects were manageable with IV medications.[11,12] Non-significant P-values suggest a small sample size (n=30).

CONCLUSION

From the present study, we conclude that Group A (buprenorphine 150 µg) provided longer and more reliable postoperative analgesia, while Group B (tramadol 100 mg) had a faster onset but shorter duration. Both groups showed safe and effective analgesia with bupivacaine (0.375%, 30 mL) in ultrasound-guided axillary brachial plexus block for upper limb surgeries. The complications observed were manageable with minimal intervention, with no major adverse events like respiratory depression reported in either group.

REFERENCES

1. Kaur U, Singh B, Jindal P, et al. Buprenorphine as an adjuvant to ropivacaine in supraclavicular brachial plexus block. J Anaesthesiol Clin Pharmacol. 2017;33(2):214-218.
2. Gupta K, Tripathi M, Saksena S, et al. Comparison of tramadol and buprenorphine as adjuvants to ropivacaine in brachial plexus block. J Clin Diagn Res. 2016;10(7):UE01-UE04.
3. Patel S, Shah S, Parikh M, et al. Comparison of buprenorphine and tramadol as adjuvants to bupivacaine in brachial plexus block. J Anaesthesiol Clin Pharmacol. 2018;34(3):366-370.
4. Casati A, Fanelli G, Albertin A, et al. Tramadol prolongs the duration of sensory block of bupivacaine in brachial plexus block. Anesthesiology. 2000;93(3A):A937.
5. Robaux S, Blunt C, Debaene B, et al. Tramadol added to bupivacaine in brachial plexus block: does it improve analgesia? Anesthesiology. 2001;95(3A):A817.
6. Kehlet H, Jensen TS, Woolf CJ. Persistent postsurgical pain: risk factors and prevention. Lancet. 2006;367(9522):1618-1625.
7. Vadivelu N, Mitra S, Narayan D. Recent advances in postoperative pain management. Yale J Biol Med. 2010;83(1):11-25.
8. Marret E, Kurdi O, Zufferey P, et al. Effects of nonsteroidal anti-inflammatory drugs on patient-controlled analgesia morphine side effects: meta-analysis of randomized controlled trials. Anesthesiology. 2005;102(6):1249-1260.
9. Moore RA, Derry S, McCarthy D, et al. Single dose oral ibuprofen for acute postoperative pain in adults. Cochrane Database Syst Rev. 2015;(9):CD011603.
10. El-Boghdadly K, Chin KJ. Ultrasound-guided brachial plexus block: a review of the literature. J Clin Anesth. 2016;34:576-584.
11. Neal JM, Gerancher JC, Hebl JR, et al. Ultrasound guidance for brachial plexus block: a review of the evidence. Reg Anesth Pain Med. 2016;41(2):266-275.
12. Gadsden J, Hadzic A, Gandhi K, et al. The effect of local anesthetic volume on postoperative pain after ultrasound-guided brachial plexus block. Anesth Analg. 2015;120(2):485-491.