Comparative study on the efficacy of perineural vs intravenous dexamethasone as an adjunct to bupivacaine to prolong analgesia after axillary brachial plexus block in a tertiary care center, Pokhara

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ABSTRACT

Introduction: In resource-limited settings, adjuvant drugs offer an alternative to extend peripheral nerve block analgesia. This study compared perineural and intravenous dexamethasone for post-operative analgesia in upper limb surgery patients under axillary brachial plexus block. **Methods:** An experimental study was done on 60 patients undergoing unilateral upper limb surgery under axillary brachial plexus block, randomized into two groups. Group A received bupivacaine 0.25% 30ml with perineural dexamethasone 8mg, and Group B received the same bupivacaine dose with intravenous dexamethasone 8mg. The duration of analgesia, reported as the time of breakthrough pain at the operative site, was considered the primary outcome. The duration of sensory blockade, VAS scores, and postoperative rescue analgesic consumption were noted. Student's t-test applied to compare difference in mean between two groups. **Results**: In 60 patients (30 per group), group A showed a statistically significant longer duration of analgesia (9.67±0.92 hours) than group B (8.89±0.93 hours) (p=0.002, 95% CI 0.31–1.27). VAS scores at 4 and 8 hours postoperatively were significantly lower in group A (1.20±0.85 and 1.97±0.67) than in group B (1.80±0.85 and 2.60±0.72). Group A also had significantly lower rescue analgesic consumption (4.17±9.48 mg) than group B (12.50±17.06 mg) (p=0.023). **Conclusions:** Perineural dexamethasone significantly prolonged analgesia compared to intravenous dexamethasone in patients undergoing upper limb surgery under ultrasonography-guided axillary brachial plexus block.

Keywords: Axillary brachial plexus block, bupivacaine, dexamethasone, perineural.

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INTRODUCTION

Pain, defined as "an unpleasant sensory and emotional experience associated with, or resembling that associated with, actual or potential tissue damage" is a significant consideration in the expanded role of anaesthesiologists.[1] Brachial plexus block has become a preferred choice for upper limb surgeries, not only ensuring effective surgical anaesthesia but also providing postoperative pain management. However, the duration of analgesia from single-shot techniques using local anaesthetics pose a limitation. Adjuncts like dexamethasone offer a valuable option to extend sensory blockade. While studies elsewhere compare perineural and intravenous routes for dexamethasone administration, our institution lacks such data.[2] The majority of studies that compare perineural and intravenous dexamethasone have focused on various nerve block techniques and anatomical locations, with limited specific emphasis on axillary brachial plexus blocks. Given the unique anatomical considerations and clinical implications of this particular block, it is imperative to ascertain whether the purported benefits of perineural dexamethasone translate uniformly across different nerve block

sites. Moreover, existing evidence regarding the optimal dose and concentration of perineural dexamethasone for axillary brachial plexus blocks is variable, with conflicting findings across studies. By directly comparing perineurial and intravenous dexamethasone as adjuncts to bupivacaine in our study, we aim to contribute valuable insights into the optimal dosing regimen for maximizing sensory analgesia duration while minimizing potential adverse effects.

While existing literature provides a foundation for the benefits of perineural dexamethasone in regional anaesthesia, this study seeks to address critical gaps in knowledge specific to axillary brachial plexus blocks. Through a comparative analysis of perineural and intravenous dexamethasone, this study aimed to delineate the optimal approach for enhancing sensory analgesia duration while considering both local and systemic implications, thereby informing evidence-based practice and improving patient care.

METHODS

This is a single-blinded quantitative experimental study conducted in Gandaki Medical College Teaching Hospital from August 2022 to September 2023. After obtaining clearance from the Institutional Review Committee of Gandaki Medical College (Ref. No. 251/079/080), 60 patients undergoing unilateral upper limb surgery under axillary brachial plexus block at Gandaki Medical College Teaching Hospital were enrolled in the study. The sample size was calculated using the formula for a two-sample t-test with mean and standard deviation values taken from the research done by Abdallah et al.[2] The inclusion criteria encompassed American Society of Anaesthesiologists Physical Status (ASA-PS) I & II patients aged between 20 and 60 years undergoing unilateral upper limb surgery under axillary brachial plexus block, weighing more than 40 kg, with a body mass index (BMI) between 20 to 29 kg/m^2. Exclusion criteria included patients unable to provide informed consent, patients with a significant cognitive or psychiatric history, diabetes mellitus, pre-existing chronic pain, pre-existing neurological deficit or neuropathy in the upper extremities, allergy to local anaesthetics or dexamethasone, local skin infection, coagulopathy, bleeding diathesis, and intraoperative use of greater than 30ml of inj. bupivacaine 0.25% and supplemental analgesic administration.

Upon obtaining informed written consent regarding the patients' participation in the study, a detailed pre-anaesthetic evaluation was performed. Patient identity and the nature of the operation were confirmed, intravenous (i.v.) access with an 18G cannula was established, a bupivacaine skin sensitivity test was conducted, and Ringers Lactate 500ml was started intravenously. Continuous electrocardiography, pulse oximetry, and non-invasive blood pressure monitoring were conducted until the patient was transferred out of the operation theatre.

Patients were randomized into two groups, Group A and Group B, using a sealed envelope method. Axillary brachial plexus block was performed under ultrasonography guidance using a 3-12 MHz linear ultrasound probe of the Alpinion E-CUBE 5 ultrasound machine and a 21G x 4" Stimuplex insulated nerve block needle with 30ml of 0.25% inj. bupivacaine. Patients in group A received Injection Dexamethasone 8mg (2ml) perineurally during the axillary brachial plexus block, while patients in group B received an equal dose and volume of Injection Dexamethasone intravenously.

After the completion of the block, an assessment of the sensory and motor block was performed every five minutes. The extent of the sensory block was evaluated in the median, radial, ulnar, and musculocutaneous nerve distributions using a 3-point score: 0 = loss of sensation to light touch, 1 = loss of sensation to pinprick, and 2 = normal sensation. The extent of motor block was tested in the distribution of the median (thumb opposition), radial (thumb abduction), ulnar (thumb adduction), and musculocutaneous (flexion of the elbow in supination and pronation) nerves using a 3-point scale, where 0=no movement, 1=paresis, 2=normal movement. Surgery commenced when sensory and motor scores of 1 or less were achieved in all 4 nerve distributions within 30 minutes of block administration.

The duration of analgesia was recorded as the time in hours to the first report of postoperative pain at the surgical site. The degree of sensory block was assessed at 0, 2, 4, 8, and 12 hours postoperatively using the 3-point score mentioned above. Visual Analogue Scale (VAS) scores were also assessed at 0, 2, 4, 8, and 12 hours postoperatively. VAS for grading of pain was done with two end points representing no pain and worst possible pain, where 0=no pain, 1–3=mild, 4–6=moderate and 7–10=severe pain.[3] Rescue analgesics were administered upon patient request for supplemental analgesia or if the VAS score was greater than 4.

The primary outcome was the duration of analgesia reported as the time of breakthrough pain at the operative site. Secondary outcomes measured were the degree of sensory blockade at 0, 2, 4, 6, 8, and 12 hours postoperatively, VAS scores at 0, 2, 4, 6, 8, and 12 hours postoperatively, and the total amount of rescue analgesics used within 12 hours postoperatively. Statistical analysis was performed with

statistical package for social science (SPSS) was used to interpret the collected data. Student's T-test was used to test for a significant difference in the duration of analgesia, degree of sensory block, VAS score, and total rescue analgesic use within 12 hours between the two groups. The p values of <0.05 was taken to be statistically significant.

RESULTS

A total of 60 patients participated in this study, with 30 patients in each group (Group A: n=30; Group B: n=30). Demographic parameters such as age, gender, weight, and body mass index between the two groups are presented in Table 1.

Table 1: Demographic details of the study participants (N=60)

	Perineural Dexamethasone (n=30)	Intravenous Dexamethasone (n=30)
Age (years)	42.03±11.31	40.80±10.80
Sex (M/F)	18/12	16/14
Weight (kg)	63.10±8.29	61.33±8.66
BMI (kg/m^2)	26.06±1.70	25.85±1.93

The duration of analgesia in Group A was found to be 9.67 (0.92) hours, whereas in Group B, it was 8.89 (0.93) hours as demonstrated in Figure 1, showing a statistically significant difference (p=0.002) (95% CI 0.31–1.27).

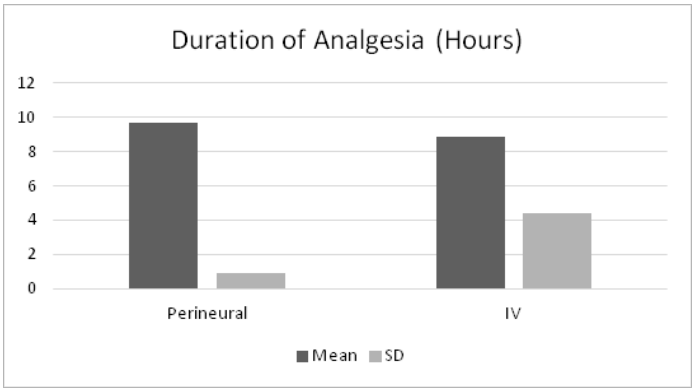

Figure 1: Graph showing duration of analgesia in both groups

Among the secondary outcomes observed in the study, VAS Scores at 0 and 2 hours postoperatively were 0(0.0) in both Group A and Group B. There was a difference in VAS scores at 4, 8, and 12 hours postoperatively, with VAS scores in Group A being 0.03(0.18), 1.20(0.85), and 1.97(0.67), and in Group B being 0.17(0.46), 1.80(0.85), and 2.60(0.72), respectively, at 4, 8, and 12 hours as shown in Figure 2. VAS scores at four hours postoperatively were not statistically significant (p=0.14), whereas VAS scores at 8 (p=0.008) and 12 hours (p=0.001) post-operatively were statistically significant.

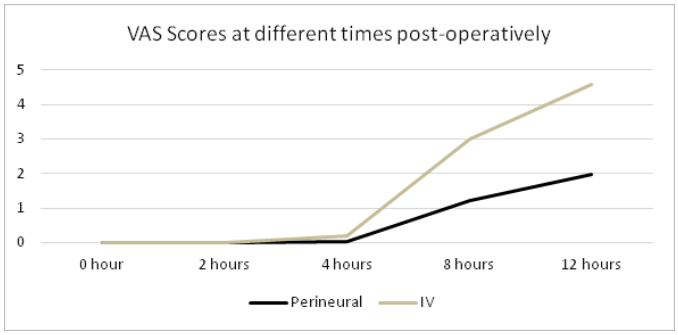

Figure 2: Graph showing VAS scores post-operatively

The degree of sensory blockade in both Group A and Group B was 0(0.0) at 0 and 2 hours post-operatively. Sensory blockade at 4 and 8 hours postoperatively was found to be 0.10(0.31), 1.57(0.50) in Group A, and 0.27(0.45), 1.33(0.48) in Group B, which were not statistically significant (4 hours (p=0.98), 8 hours (p=0.71)). The degree of sensory blockade at 12 hours postoperatively was found to be 1.60(0.49) in Group A and 1.93(0.25) in Group B, respectively, which was statistically significant. (p=0.002)

The amount of rescue analgesics consumed was 4.17(9.48) mg in Group A and 12.50(17.06) mg in Group B within the study duration, showing statistical significance (p=0.023) as shown in Figure 3.

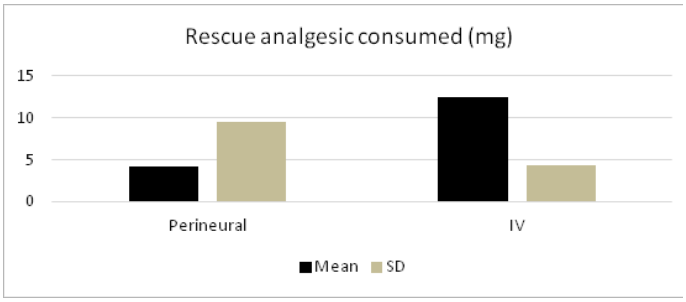

Figure 3: Graph showing amount of rescue analgesic consumed between two groups

Table 2: Comparison between perineural and intravenous dexamethasone (N=60)

	Perineural Dexamethasone (n=30)	Intravenous Dexamethasone (n=30)
Duration of Analgesia (hours)	9.67±0.92	8.89±0.93
Rescue Analgesic Consumed(mg)	4.17±9.48	12.50±17.06
Sensory Blockage (0 hours)	0.0±0.0	0.0±0.0
Sensory Blockage (2 hours)	0.0±0.0	0.0±0.0
Sensory Blockage (4 hours)	0.10±0.305	0.27±0.450
Sensory Blockage (8 hours)	1.57±0.504	1.33±0.479
Sensory Blockage (12 hours)	1.60±0.498	1.93±0.254
VAS (0 hours)	0.0±0.0	0.0±0.0
VAS (2 hours)	0.00±0.183	0.00±0.00
VAS (4 hours)	0.03±0.183	0.17±0.461
VAS (8 hours)	1.20±0.847	1.80±0.847
VAS (12 hours)	1.97±0.669	2.60±0.724

No complications were noted in either group intra-operatively or post-operatively throughout the study period. The results of the statistical analysis are summarized in Table 2.

DISCUSSION

This study demonstrates that perineural administration of dexamethasone prolongs the duration of postoperative analgesia compared to intravenous administration of dexamethasone in patients undergoing upper limb surgery under axillary brachial plexus block.

The analgesic effect of dexamethasone has been previously evaluated and demonstrated.[4] The mechanism and site of action by which glucocorticoids exert their effects remain unknown. Perineurally administered dexamethasone is believed to exert its effect through direct inhibition of signal transmission in nociceptive C-fibres, local anti-inflammatory effects, and locally induced vasoconstriction, thus extending the local anaesthetic effect.

In a multicentre randomized trial, it was concluded that perineural dexamethasone provided a longer duration of motor block, sensory block, and postoperative analgesia. However, no intergroup differences were observed ($p>0.05$) in a comparison between intravenous and perineural dexamethasone for ultrasound-guided Infraclavicular brachial plexus block.[5]

Kawanishi et al. compared the perineural and intravenous routes for 4 mg of dexamethasone in a single injection interscalene block with 20 ml ropivacaine 0.75%.[6] Although these authors reported that only the perineural route prolonged the analgesic duration of the interscalene block, this study lacked adequate statistical power to definitively differentiate outcomes between the two experimental groups.

Abdallah et al. conducted a study where seventy-five patients were randomized to receive supraclavicular block using 30 ml bupivacaine 0.5% alone (Control), with concomitant intravenous dexamethasone 8 mg (DexIV), or with perineural dexamethasone 8 mg (DexP). The study found that intravenous dexamethasone was equally effective in prolonging the duration of analgesia compared to perineural dexamethasone.[2]

Veena et al. conducted a study on 68 patients with ultrasound-guided ICBP block, randomly allocating them into two groups (34 each) to compare the analgesic efficacy of perineural and intravenous dexamethasone as an adjuvant to levobupivacaine. Similar to our results, they found that perineural dexamethasone significantly reduced pain intensity and the need for rescue analgesia in the postoperative period compared with intravenous dexamethasone.[7]

A systematic review and meta-analysis conducted by Tan et al. on the efficacy of perineural versus intravenous dexamethasone in prolonging the duration of analgesia with peripheral nerve blocks reviewed fifteen randomized controlled trials (1,467 cases; 738 perineural dexamethasone, 729 intravenous dexamethasone). They concluded that perineural dexamethasone exhibited greater efficacy in prolonging the analgesic duration of peripheral nerve blocks compared to intravenous dexamethasone.[8]

Another systematic review and meta-analysis of randomized controlled trials by Zhao et al. on perineural versus intravenous dexamethasone for brachial plexus block reviewed twelve RCTs with a total of 1,345 subjects.[9] They found that perineural dexamethasone prolonged the duration of analgesia, motor block, and sensory block in the main analysis with a significant difference compared to IV dexamethasone. However, in the absence of epinephrine, there were no significant differences between perineural dexamethasone and IV dexamethasone.[9]

Several limitations are associated with this study. Firstly, a limited number of cases were enrolled (30 in each group). The study was also conducted for a brief period and did not follow up on the duration of sensory blockade beyond the 12-hour observation period. Furthermore, this study did not observe or follow up on any complications that may be associated with the perineural use of dexamethasone.

CONCLUSIONS

The findings from this study showed that administering dexamethasone 8mg perineurally significantly extends the duration of analgesia compared to administering dexamethasone 8mg intravenously during ultrasonography-guided axillary brachial plexus block with 0.25% bupivacaine.

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CONFLICTS OF INTEREST: None declared

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AUTHORS' CONTRIBUTION

TP led the study design, coordinated the research efforts, and performed the procedures. KMB and PP were responsible for data collection. TP, RH, and PP conducted data analysis and interpretation. The compilation of reports and preparation of the initial manuscript draft was carried out by TP and SN. All authors, including TP, RH, SN, KMB, and PP contributed to the revision and preparation of the final manuscript draft.

REFERENCES

1. Raja SN, Carr DB, Cohen M, Finnerup NB, Flor H, Gibson S, et al. The revised International Association for the Study of Pain definition of pain: Concepts, challenges, and compromises. Pain. NLM (Medline); 2020;161:1976–82. DOI: 10.1097/j.pain.0000000000001939 PMID: 32694387.
2. Abdallah FW, Johnson J, Chan V, Murgatroyd H, Ghafari M, Ami N, et al. Intravenous dexamethasone and perineural dexamethasone similarly prolong the duration of analgesia after supraclavicular brachial plexus block: A randomized, triple-arm, double-blind, placebo-controlled trial. Reg Anesth Pain Med. 2015;40(2):125–32. DOI: 10.1097/AAP.0000000000000210 PMID: 25629321.
3. Mohamed RE, Amin MA, Omar HM. Computed tomography-guided celiac plexus neurolysis for intractable pain of unresectable pancreatic cancer. The Egyptian Journal of Radiology and Nuclear Medicine. 2017;48(3):627–37. DOI: 10.1016/j.ejrnm.2017.03.027
4. Maher DP, Serna-Gallegos D, Mardirosian R, Thomas OJ, Zhang X, McKenna R, et al. The combination of IV and perineural dexamethasone prolongs the analgesic duration of intercostal nerve blocks compared with IV dexamethasone alone. Pain Medicine (United States). 2017;18(6):1152–60. DOI: 10.1093/pm/pnw149 PMID: 27473629.
5. Leurcharusmee P, Aliste J, Van Zundert TCRV, Engsusophon P, Arnuntasupakul V, Tiyaprasertkul W, et al. A multicenter randomized comparison between intravenous and perineural dexamethasone for ultrasound-guided infraclavicular block. Reg Anesth Pain Med. 2016;41(3):328–33. DOI: 10.1097/AAP.0000000000000386 PMID: 27015546.
6. Tanaka K, Kawanishi R, Tsutsumi YM, Takeda Y, Yamamoto K, Nomura K, et al. Perineural but not systemic low-dose dexamethasone prolongs the duration of interscalene block with ropivacaine: A prospective randomized trial. Local Reg Anesth. 2014;7:5-9. DOI: 10.2147/LRA.S59158 PMID: 2481781.
7. Veena G, Pangotra A, Kumar S, Prakash J, Rao N, Priye S. Comparison of perineural and intravenous dexamethasone as an adjuvant to levobupivacaine in ultrasound-guided infraclavicular brachial plexus block: A prospective randomized trial. Anesth Essays Res. 2021;15(1):45. DOI: 10.4103/aer.aer_69_21 PMID: 34667347.
8. Tan ESJ, Tan YR, Liu CWY. Efficacy of perineural versus intravenous dexamethasone in prolonging the duration of analgesia when administered with peripheral nerve blocks: a systematic review and meta-analysis. Korean J Anesthesiol. 2022;75(3):255–65. DOI: 10.4097/kja.21390 PMID: 34963269.
9. Zhao J, Bei T, Liu J, Huang Q, Wu J. Systematic Review Perineural Versus Intravenous Dexamethasone for Brachial Plexus Block: A Systematic Review and Meta-analysis of Randomized Controlled Trials. Available from: www.painphysicianjournal.com