International Journal of
Regional Anaesthesia

Original Article

Comparison of the Efficacy of Intravenous and Regional Dexamethasone in Brachial Plexus Nerve Block

Sushmitha K[1], Shripad Mahadik[1], Deepak Phalgune[2], Sandeep Mutha[1], Sudhir Patil[1]

[1] Department of Anaesthesiology, Poona Hospital & Research Centre, Pune, Maharashtra, India.

[2] Department of Research, Poona Hospital & Research Centre, Pune, Maharashtra, India.

Abstract

The brachial plexus nerve block (BPNB) is a widely employed regional nerve block of the upper extremity. Some trials report longer duration of analgesia with perineural compared to intravenous (IV) dexamethasone, other studies have failed to detect significant differences between the two modalities in BPNB. The present study aims to compare the efficacy of IV and perineural dexamethasone as an adjuvant in BPNB. One hundred ten patients aged between 18 and 60 years, scheduled to undergo upper limb surgery under BPNB were randomly divided into two groups by computer-generated table. Group A patients received IV dexamethasone 8 mg immediately after receiving BPNB with adrenalized lignocaine and bupivacaine. Group B patients received dexamethasone 8 mg along with adrenalized lignocaine and bupivacaine perineurally. The onset time of the sensory block (OTSB), the time for the complete sensory block (TCSB), the onset time of the motor block (OTMB), the time for the complete motor block (TCMB), and the period of sensory and motor blockade were recorded. The visual analogue scale (VAS) score was noted. The mean OTSB, TCSB, OTMB, and TCMB were significantly higher in Group A than in Group B, whereas the mean duration of sensory and motor blockade was significantly higher in Group B than in Group A. The mean VAS score at 16 and 24 hours postoperatively was significantly higher in Group A than in Group B. The efficacy of dexamethasone along with local anaesthetic perineurally was higher than IV dexamethasone in BPNB.

Keywords: Dexamethasone, Intravenous, Motor block, Perineural, Sensory block

Introduction

Regional anaesthesia is an excellent alternative to general anaesthesia for extremity surgery. Post-anaesthetic nausea, vomiting and other side effects of general anaesthesia such as atelectasis, hypotension, ileus, and deep vein thrombosis are reduced if regional anaesthesia is given [1]. The brachial plexus nerve block (BPNB) is a popular and widely employed regional nerve block of the upper extremity. Various approaches to BPNB have been described but the supraclavicular approach is the easiest and most consistent method for anaesthesia and perioperative pain management in surgery below the shoulder joint [2].

Studies have shown that peripheral nerve blocks are usually well-tolerated and provide regional analgesia superior to other modalities such as oral pain medications or general anaesthesia [3]. They are used for various surgical procedures in both inpatient and outpatient settings. Peripheral nerve blocks, as a part of a multimodal analgesic regimen, have decreased recovery times by lessening side effects (e.g. nausea, vomiting, drowsiness) [4]. Dexamethasone is a common adjuvant for local anaesthetics in regional anaesthesia that is used to prolong the duration of peripheral nerve blocks, but the optimal route of administration is controversial [5]. Recent randomized controlled trials have demonstrated

Address of Correspondence
Dr. Deepak Phalgune,
Department of Research, Poona Hospital & Research Centre, Pune, Maharashtra, India.
E-mail: dphalgune@gmail.com

Submitted: February 27-10-2024; Reviewed: 10-11-2024; Accepted: 18-11-2024; Published: 10-12-2024

DOI: https://doi.org/10.13107/ijra.2024.v05.i02.92 | www.ijrajournal.com | Online ISSN 3048-9520

conflicting results on whether perineural versus intravenous (IV) administration is superior in this regard [6].

Dexamethasone can prolong the duration of BPNB [7]. Although some trials reported longer analgesia with perineural compared to IV dexamethasone, other studies have failed to detect significant differences between the two modalities [8-10]. The use of dexamethasone perineurally along with local anaesthetic has been shown to improve the duration of analgesia [11]. IV dexamethasone is also useful in attenuating the postoperative need for analgesics in different clinical settings even without nerve blocks [12]. Hence, it is logical to compare the duration of analgesia with the use of dexamethasone given either perineurally or intravenously in the setting of BPNB. The current study aims to compare the efficacy of IV and perineural dexamethasone as an adjuvant in BPNB.

Material and Methods

The present double-blind randomised controlled research was conducted between November 2022 and June 2024 in the major and minor operation theatres of a tertiary care hospital, in India. Before the commencement of the study, an institutional ethics committee approval (Letter # RECH/ECBHR/2022-23/228 dated 3rd October 2022) was obtained. We obtained written informed consent from all the patients.

The patients aged between 18 and 60 years, scheduled to undergo upper limb surgery under regional anaesthesia and American Society of Anaesthesiologist (ASA) grades I-II were included. Patients using regular analgesic medications for chronic pain, a history of allergy to drugs or drug components, any contraindication to non-steroid anti-inflammatory drugs, local anaesthetics, or drug infection at the local site were excluded. In all 120 patients were assessed for eligibility of which 10 patients were excluded. One hundred and ten patients were included in the study. A detailed pre-anaesthesia checkup was conducted for anaesthesia fitness.

Group A patients received IV dexamethasone 8 mg immediately after receiving BPNB with 15 mL of 2% adrenalized lignocaine and 15 mL of 0.5% bupivacaine (total volume =30 mL). Group B patients received, dexamethasone 8 mg (2 mL) along with 13 mL of 2% adrenalized lignocaine and 15 mL of 0.5% bupivacaine (total volume = 30 mL) perineurally. (Fig 1: CONSORT Flow diagram) The patients were randomly divided into two groups using the computer-generated table. The randomization code was provided to the operation theatre nurse who prepared the study medication in identical syringes under the guidance of a senior anaesthesiologist. The researcher and the patient were blind as to group assignment.

Leurcharusmee P et al. reported the mean duration of sensory block of 16.8 h and 13.9 h in perineural and IV dexamethasone groups respectively with the standard deviation (SD) of 5.4 h [12]. The formula used to calculate the sample size was n [13] = $\{2SD^2 (Z\alpha + Z\beta)^2\} / \Delta^2$, n is the number of subjects in each group, SD from previous data, Δ is the difference between the means of previous study. The term $(Z\alpha + Z\beta)^2$ is sometimes referred to as power index. The sample size calculated was 55 in each group.

In the operation theatre, pulse oximeter, electrocardiography (ECG), and non-invasive blood pressure (NIBP) monitors were attached and adequate IV access was confirmed. We set the initial current of the nerve stimulator to 1.0 mA. Under aseptic precautions and ultrasound guidance, the brachial plexus was identified with the help of a high-frequency transverse probe. Once the desired response was obtained that is the muscle twitch of the deltoid and elbow flexion in case of inter scalene route for shoulder and upper arm surgeries; motor activity of forearm, flexion and extension of fingers and hand in case of a supraclavicular route for elbow and forearm surgeries and movement of fingers and elbow flexion in case of an axillary route for wrist and hand surgeries, the current was decreased to 0.4 mA. If the twitch persisted drug solution was injected.

The sensory block was evaluated by Hollmen Scale and findings were recorded at an interval of every one minute from time-0 till a complete sensory block was achieved i.e. Hollmen score = 4 [14].

Score 1 = Normal sensation of a pinprick.

Score 2 = Pin prick felt as sharp and pointed but weaker compared with the same area in the other upper limb.

Score 3 = Pin prick recognized as touch with a blunt object.

Score 4 = No perception of pinprick.

The period taken till the sensory block started to appear (Hollmen score > 1) was labeled as the onset time of the sensory block (OTSB). The period taken till complete sensory block was achieved (Hollmen score = 4) was labeled as time for the complete sensory block (TCSB).

Motor block was evaluated by using the Modified Bromage Scale (MBS) for the upper extremity and the findings were recorded at an interval of every two minutes from time-0 till complete loss of motor power was achieved i.e. MBS Score= 3 [15].

MBS for upper extremity

0: Able to raise the extended arm to 90° for a full 2 seconds.

1: Able to flex the elbow and move the fingers but not able to raise the extended arm.

2: Not able to flex the elbow but able to move the fingers.

3: Not able to move the arm, elbow and fingers.

The onset time of motor block (OTMB) was taken as the time interval in minutes from time-0 till motor block started appearing i.e. MBS score ≥ 1. Time for complete motor block (TCMB) was taken as the duration of time in minutes from time-0 till complete motor block was achieved i.e. MBS score=3.

The adequacy of the block was evaluated by the Allis clamp test before the surgery [15]. The duration of the surgery was noted. The heart rate, NIBP, ECG, and SpO_2 (oxygen saturation) were monitored throughout the surgery. OTSB, TCSB, OTMB and TCMB were noted.

During the pre-operative visit, the visual analogue scale (VAS) method of reporting pain was explained to all the patients [16]. The VAS score was measured at 0, 2, 4, 8, 16 and 24 hours. At any time, if the pain was more than or equal to 5 on VAS, Inj diclofenac 1.5 mg/Kg IV in 100 mL normal saline over 15-20 minutes was administered. If the pain did not subside after an hour, Inj. tramadol 2 mg/Kg IV in 100 mL normal saline was given.

Statistical tests

The data on categorical variables is shown as n (% of cases), whereas the normally distributed continuous variables are reported as the mean and SD. The inter-group comparison of the distribution of categorical variables was tested using the Chi-square test or Fisher's exact test. The inter-group comparison of means was done using an independent t-test. The underlying normality assumption was tested before subjecting the study variables to an independent t-test. The medians of nonparametric variables were tested using the Mann-Whitney U test. The statistical significance was taken as the p-values < 0.05. The data was statistically analyzed using Statistical Package for Social Sciences (version 24.0, IBM Corporation, USA) for MS Windows.

Results

Of 120 patients assessed for eligibility, 10 were excluded (Patients using regular analgesic medications for chronic pain -8 and contraindication to non-steroid anti-inflammatory drugs -2). In all 110 patients were randomized into two groups (Fig. 1: CONSORT Flow diagram).

The mean age, gender, weight, ASA grades and median duration of surgery were comparable between the two groups (Table 1). The mean OTSB, TCSB, OTMB, and TCMB were significantly higher in Group A as compared to Group B, whereas the mean duration of sensory and motor blockade was significantly higher in Group B as compared to Group A (Table 2). The mean VAS score at 16 and 24 hours postoperatively was significantly higher in Group A than in Group B (Table 3). The incidence of postoperative nausea

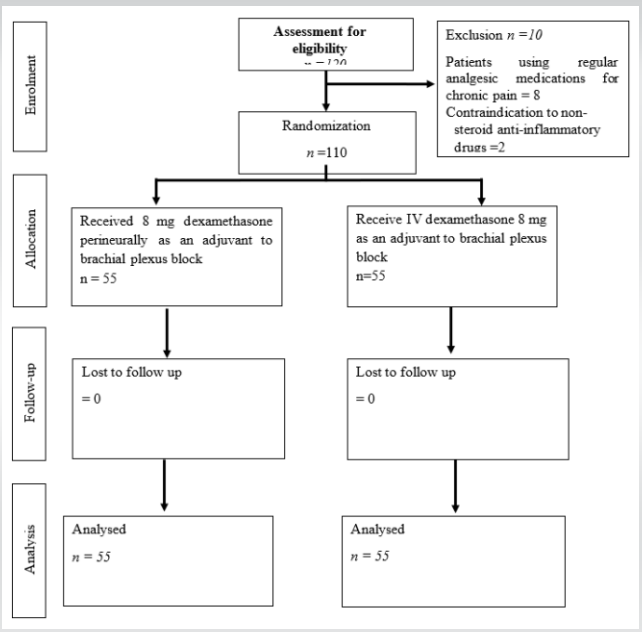

Figure 1: Consolidated Standards of Reporting Trials (CONSORT) flow diagram

Table 1: Comparison of baseline characteristics between the two groups

	Group A n (%)	Group B n (%)	p-value n (%)
Age ± SD in years	38.1 ± 14.1	38.7 ± 13.2	0.950 *
Gender			
Male	24 (43.6)	29 (52.7)	0.340**
Female	31 (56.4)	26 (47.3)	
Mean weight ± SD in Kg	60.8 ± 9.0	61.0 ± 8.9	0.898*
ASA Grades			
I	29 (52.7)	28 (50.9)	0.849**
II	26 (47.3)	27 (49.1)	
Median duration of surgery in minutes	90	70	0.285***

*An unpaired t-test was used
**The Chi-square test was used
*** The Mann-Whitney U test was used
SD – Standard deviation
ASA – American Society of Anesthesiologists

Table 2: Comparison of outcome variables between the two groups

Variables	Group A n (%)	Group B n (%)	p-value
The mean onset time of sensory block ± SD in minutes	6.1 ± 0.8	4.3 ± 0.8	0.001*
The mean onset time of motor block ± SD in minutes	8.5 ± 1.2	7.4 ± 0.8	0.001*
The mean time of complete sensory block ± SD in minutes	13.2 ± 1.0	10.9 ± 1.3	0.001*
The mean time of complete motor block ± SD in minutes	17.8 ± 1.0	14.8 ± 1.1	0.001*
The mean duration of sensory blockade ± SD in hours	12.1 ± 1.2	27.8 ± 8.6	0.001*
The mean duration of motor blockade ± SD in hours	10.4 ± 3.8	16.9 ± 4.0	0.001*

*The unpaired t-test was used
SD – Standard deviation

Table 3: Comparison of mean visual analogue scale score

	Group A (n=55)	Group B (n=55)	p-value
Visual analogue scale score	**Mean ± SD**	**Mean ± SD**	
0-hours	0.00 ± 0.00	0.00 ± 0.00	0.999
2- hours	0.00 ± 0.00	0.00 ± 0.00	0.999
4- hours	0.00 ± 0.00	0.00 ± 0.00	0.999
8- hours	0.00 ± 0.00	0.00 ± 0.00	0.999
16- hours	5.47 ± 0.50	0.00 ± 0.00	0.001
24- hours	5.35 ± 0.48	0.00 ± 0.00	0.001

An unpaired t-test was used
SD – Standard deviation

and vomiting was similar (4.3%) in both groups.

Discussion

Peripheral nerve blocks have become an integral part of surgical anaesthesia and postoperative analgesia in the present era of anaesthetic practice, amongst which BPNB is one of the widely practised techniques for upper extremity surgeries [17]. The introduction of newer aids like the use of nerve stimulators and ultrasound for peripheral nerve block has improved the efficacy, success rate and safety profile of the peripheral nerve block [18]. It is necessary to lengthen the duration of sensory and motor blockade of regional anaesthetic procedures frequently. This provides adequate anaesthesia for lengthy surgeries and produces pain relief in the immediate postoperative period. Various adjuncts like opioids, ketamine, and α2 agonists have been used to prolong brachial block and corticosteroids have been studied recently as adjuncts to local anaesthetics in regional block [19].

Mathew R et al. reported that the OTSB was 10.2 and 11.6 minutes in the Group DP (perineural dexamethasone) and the Group DI (IV dexamethasone) respectively (p-value = 0.001), the OTMB in Group DP and Group DI was 13.9 and 15.0 minutes respectively (p-value = 0.02), and the duration of analgesia was 817.2 and 858.0 minutes in Group DP and Group DI respectively (p-value = 0.104) [20]. A study conducted by Leurcharusmee P et al. reported that the duration of motor block, sensory block and postoperative analgesia were significantly higher in the perineural dexamethasone group than IV dexamethasone group (15.7 Vs 12.9, p-value = 0.009, 16.8 Vs 13.9, p-value = 0.002, 22.1 Vs 18.6, p-value = 0.014 respectively) [12]. A study conducted by Sakae TM et al. reported that the mean OTSB was 13.86 and 11.6 minutes in dexamethasone IV (Div) and dexamethasone perineural (Dpn) groups respectively, the mean duration of motor block (min) was 1111.75 and 1408.0 in Div and Dpn groups respectively and the mean duration of sensory block (min) was 1641.75 and 2323.25 in Div and Dpn groups respectively. The study concluded that perineural but not intravenous administration of dexamethasone at a dose of 4 mg significantly prolonged the duration of effective postoperative analgesia [21]. Our research substantiated the findings of the above-mentioned studies.

A study conducted by Abdallah FW et al. reported that the duration of analgesia in the dexamethasone IV (Dex IV) group (25 hours [17.6–23.6]) was similar to the dexamethasone perineural (Dex P) group (25 hours [19.5–27.4]; The Dex IV group experienced longer motor block (30.1 hours) compared with Dex P (25.5 hours), but there were no differences in pain between the Dex IV and Dex P groups. The study concluded that in a single-injection supraclavicular block with a long-acting local anaesthetic, the effectiveness of IV dexamethasone in prolonging the duration of analgesia seems similar to perineural dexamethasone [8]. The research carried out by Desmet M et al. concluded that dexamethasone significantly prolonged the duration of analgesia, independent of the mode of administration [9]. Rosenfeld DM et al in 2016, conducted a randomised, double-blind, placebo-controlled study in the USA which compared the effect of perineural with IV dexamethasone, both administered concomitantly with interscalene brachial plexus block for shoulder surgery. The study reported that perineural and IV dexamethasone resulted in the duration of the block to 16.9 hours and 18.2 hours respectively [22]. Our findings are different from the results of the above-stated studies.

A study conducted by Holland D et al. reported that the perineural route significantly prolonged the mean block duration by 2.0 hours, but 8 mg of dexamethasone did not significantly prolong the mean block duration compared with 4 mg. The mean block durations, in hours, were 24.0, 24.8, 25.4, and 27.2 for intravenous doses of 4 and 8 mg and perineural doses of 4 and 8 mg, respectively [23]. In this study, different doses of dexamethasone were compared intravenously and perineurally, but they concluded that perineural dexamethasone (either 4 mg or 8 mg) was better than IV dexamethasone (either 4 mg or 8 mg) in prolonging the duration of block which is similar to our study.

Zhao WL et al. in a systematic review and meta-analysis of perineural versus IV dexamethasone as an adjuvant in regional anaesthesia concluded that perineural dexamethasone can prolong the effects of analgesic duration when compared to the intravenous route [4]. Tan ESJ et al. in a systematic review and meta-analysis of the efficacy of perineural versus intravenous dexamethasone in prolonging the duration of analgesia when administered with peripheral nerve blocks concluded that the greater efficacy of perineural compared to IV dexamethasone in prolonging the analgesic duration [24]. Bei T et al. in their Systematic Review and Meta-analysis of Randomized Controlled Trials of Perineural Versus Intravenous Dexamethasone for Brachial Plexus Block concluded that perineural dexamethasone can prolong the duration of analgesia, sensory block, and motor block, when compared with IV dexamethasone. The study concluded that perineural dexamethasone was superior to IV dexamethasone for prolonging the postoperative analgesic time, sensory block, and motor block [15].

It is widely believed that dexamethasone improves the quality and duration of peripheral nerve block over local anaesthetic alone. The addition of dexamethasone may provide patients

who are otherwise not eligible for extended, continuous perineural techniques, to experience an extended period of analgesia compared with local anaesthetic BPNB alone.

Limitations

The sample size was small. We also could not do a long-term follow-up of patients given perineural dexamethasone for any delayed neurological complications. Further multi-centric trials with large sample size are required to elucidate the role of IV and perineural dexamethasone for other types of nerve blocks. We have given a fixed dose of 8 mg of dexamethasone, not given according to the body weight of the patients.

Conclusions

The mean OTSB, TCSB, OTMB, and TCMB were significantly higher in Group A as compared to Group B, whereas the mean duration of sensory and motor blockade was significantly higher in Group B as compared to Group A. The mean VAS score at 16 and 24 hours postoperatively was significantly higher in Group A than in Group B. The efficacy of dexamethasone perineurally along with local anaesthetic was higher than IV dexamethasone.

References

1. Brown DL, Birdenbaugh DL, Cousins MJ, Bridenburgh PO. The upper extremity. 3rd ed. Chapter 10. In: Neural blockade; 1998. pp.345-6.

2. Pathak RG, Satkar AP, Khade RN. Supraclavicular brachial plexus block with and without dexamethasone–a comparative study. Int J Sci Res Pub. 2012;2(12):1-7.

3. Chang A, Dua A, Singh K, White BA. Peripheral Nerve Blocks. [Updated 2023 Jul 6]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK459210/

4. Zhao WL, Ou XF, Liu J, Zhang WS. Perineural versus intravenous dexamethasone as an adjuvant in regional anesthesia: a systematic review and meta-analysis. J Pain Res. 2017; 10:1529-43.

5. Chong MA, Berbenetz NM, Lin C, Singh S. Perineural versus intravenous dexamethasone as an adjuvant for peripheral nerve blocks: a systematic review and meta-analysis. Reg Anesth Pain Med. 2017;42(3):319-26.

6. Kirkham KR, Jacot-Guillarmod A, Albrecht E. Optimal dose of perineural dexamethasone to prolong analgesia after brachial plexus blockade: a systematic review and meta-analysis. Anesth Analg. 2018; 126(1):270-9.

7. Kawanishi R, Yamamoto K, Tobetto Y, Nomura K, Kato M, Go R, 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.

8. Abdallah FW, Johnson J, Chan V, et al. Intravenous dexamethasone and perineural dexamethasone similarly prolong the duration of analgesia after supraclavicular brachial plexus block. Reg Anesth Pain Med. 2015;40:125–132

9. Desmet M, Braems H, Reynvoet M, et al. I.V. and perineural dexamethasone are equivalent in increasing the analgesic duration of a single-shot interscalene block with ropivacaine for shoulder surgery: a prospective, randomized, placebo-controlled study. Br J Anaesth. 2013; 111:445–452

10. Movafegh A, Razazian M, Hajimaohamadi F, Meysamie A. Dexamethasone added to lidocaine prolongs axillary brachial plexus blockade. Anesth Analg. 2006; 102:263–7

11. De Oliveira GS Jr, Almeida MD, Benzon HT, McCarthy RJ. Perioperative single dose systemic dexamethasone for postoperative pain: a meta-analysis of randomized controlled trials. Anesthesiology. 2011;115(3):575-88.

12. Leurcharusmee P, Aliste J, Van Zundert TC, 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.

13. Harvey Motulsky. Intuitive Biostatistics. New York: Oxford University Press; 1995.

14. Wedel DJ, HorlockerTT. Nerve Blocks. In: Miller RD. Editor Miller's Anesthesia: 7th ed. Philadelphia: Churchill Livingstone;2010. p.1639-74.

15. Bei T, Liu J, Huang Q, Wu J, Zhao J. Perineural Versus Intravenous Dexamethasone for Brachial Plexus Block: A Systematic Review and Meta-analysis of Randomized Controlled Trials. Pain Physician. 2021;24(6): E693-707.

16. Kelly AM. Does the clinically significant difference in visual analogue scale pain scores vary with gender, age, or cause of pain? Acad Emerg Med. 1998; 5(11):1086-90.

17. Héroux J, Bessette PO, Belley-Côté E, Lamarche D, Échavé P, Loignon MJ, et al. Functional recovery with peripheral nerve block versus general anesthesia for upper limb surgery: a systematic review. BMC Anesthesiol. 2023;23(1):91

18. Abrahams MS, Aziz MF, Fu RF, Horn JL. Ultrasound guidance compared with electrical neurostimulation for peripheral nerve block: a systematic review and meta-analysis of randomized controlled trials. Br J Anaesth. 2009;102(3):408-17

19. Swain A, Nag DS, Sahu S, Samaddar DP. Adjuvants to local anesthetics: Current understanding and future trends. World J Clin Cases. 2017;5(8):307-23

20. Mathew R, Radha KR, Hema VR. Effect of perineural and intravenous dexamethasone on duration of analgesia in supraclavicular brachial plexus block with bupivacaine: a comparative study. Anesth Essays Res. 2019;13(2):280-3.

21. Sakae TM, Marchioro P, Schuelter-Trevisol F, Trevisol DJ. Dexamethasone as a ropivacaine adjuvant for ultrasound-guided interscalene brachial plexus block: a randomized, double-blinded clinical trial. J Clin Anesth. 2017; 38:133-6.

22. Rosenfeld DM, Ivancic MG, Hattrup SJ, Renfree KJ, Watkins AR, Hentz JG, et al. Perineural versus intravenous dexamethasone as adjuncts to local anaesthetic brachial plexus block for shoulder surgery. Anaesthesia. 2016;71(4):380-8.

23. Holland D, Amadeo RJJ, Wolfe S, Girling L, Funk F, Collister M, et al. Effect of dexamethasone dose and route on the duration of interscalene brachial plexus block for outpatient arthroscopic

shoulder surgery: a randomized controlled trial. Can J Anesth. 2018; 65(1):34-45.

24. 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

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.

Conflict of interest: Nil **Source of support:** None

How to cite this article: Sushmitha K, Mahadik S, Phalgune D, Mutha S, Patil S | Comparison of the Efficacy of Intravenous and Regional Dexamethasone in Brachial Plexus Nerve Block | International Journal of Regional Anaesthesia | July-December 2024; 5(2): 4-9 | DOI: https://doi.org/10.13107/ijra.2024.v05.i02.92