

The effect of two perioperative dexamethasone regimens on duration of analgesia after upper limb surgery under supraclavicular brachial plexus block: A randomized-controlled study

Supraklaviküler brakiyal pleksus bloku altında üst ekstremité cerrahisi sonrası analjezi süresi üzerine iki farklı perioperatif deksametazon rejiminin etkisi:
Randomize kontrollü bir çalışma

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ABSTRACT

Background: This study aims to compare the effects of two perioperative dexamethasone regimens on duration of analgesia after upper limb surgery under supraclavicular brachial plexus block (SBPB).

Patients and Methods: Between October 2024 and August 2025, this double-blind, randomized-controlled study included a total of 48 patients who were in the American Society of Anesthesiologists (ASA) Class I-III and underwent elective unilateral osseous surgery of the forearm or hand under ultrasound-guided SBPB with 30 mL of 0.5% ropivacaine. The patients were randomized in 1:1 ratio to oral dexamethasone (OD) group to receive 12 mg OD 2 h before the block and intravenous dexamethasone (ID) group to receive 8 mg of ID at the time of block. The primary outcome was the duration of analgesia. Secondary outcomes included duration of motor block, pain scores at 6, 12 and 24 h, additional postoperative analgesic consumption over the first 24 h and the Quality of Recovery-15 (QoR-15) at 24 h.

Results: Of the patients, 31 were male and 17 were female with a mean age of 34.31 ± 14.15 (range, 18 to 60) years. The mean duration of analgesia was 10.50 ± 3.30 h in group OD and 14.92 ± 3.40 h in group ID ($p < 0.001$). The mean duration of motor block was 9.33 ± 3.12 h in group OD and 12.75 ± 3.40 h in group ID ($p = 0.001$). Pain scores at 6, 12 and 24 h after surgery and additional analgesic requirements were higher in group OD ($p < 0.001$). The QoR-15 scores were higher in group ID at 24 h ($p < 0.001$).

Conclusion: These findings indicate that the ID regimen in SBPB with ropivacaine resulted in prolonged analgesia and motor blockade, lower pain scores, reduced analgesic consumption, and improved quality of recovery compared to the OD regimen.

Keywords: Intravenous dexamethasone, oral dexamethasone, pain score, postoperative analgesia, supraclavicular brachial plexus block.

ÖZ

Amaç: Bu çalışmada, supraklaviküler brakiyal pleksus bloku (SBPB) altında üst ekstremité cerrahisi uygulanan hastalarda iki farklı perioperatif deksametazon rejiminin analjezi süresi üzerindeki etkileri karşılaştırıldı.

Hastalar ve Yöntemler: Ekim 2024 ile Ağustos 2025 tarihleri arasında gerçekleştirilen bu çift kör, randomize kontrollü çalışmaya, Amerikan Anesteziyoloji Derneği (ASA) Sınıf I-III olan ve ultrason eşliğinde 30 mL %0.5 ropivakain kullanılarak SBPB altında elektif, tek taraflı ön kol veya el kemik cerrahisi uygulanan toplam 48 hasta dahil edildi. Hastalar 1:1 oranında, bloktan 2 saat önce 12 mg oral deksametazon (OD) alacak şekilde OD grubuna ve blok uygulaması sırasında 8 mg intravenöz deksametazon (ID) alacak şekilde ID grubuna randomize edildi. Primer sonuç, analjezi süresiydi. Sekonder sonuçlar motor blok süresi, 6, 12 ve 24. saatlerdeki ağrı skorları, ilk 24 saatteki ek postoperatif analjezik tüketimi ve 24. saatte değerlendirilen iyileşme Kalitesi Ölçeği-15 (QoR-15) skoru idi.

Bulgular: Hastaların 31'i erkek, 17'si kadın olup ortalama yaşları 34.31 ± 14.15 (aralık, 18-60) yılı. Ortalama analjezi süresi OD grubunda 10.50 ± 3.30 saat, ID grubunda ise 14.92 ± 3.40 saat idi ($p < 0.001$). Ortalama motor blok süresi OD grubunda 9.33 ± 3.12 saat, ID grubunda ise 12.75 ± 3.40 saat idi ($p = 0.001$). Ameliyat sonrası 6, 12 ve 24. saatlerdeki ağrı skorları ile ek analjezik gereksinimi OD grubunda daha yüksekti ($p < 0.001$). Yirmidördüncü saatte QoR-15 skorları ID grubunda daha yüksekti ($p < 0.001$).

Sonuç: Bu bulgular, ropivakain ile uygulanan SBPB'de ID rejiminin OD rejimine kıyasla daha uzun süreli analjezi ve motor blokaj, daha düşük ağrı skorları, daha az analjezik tüketimi ve iyileşme kalitesinde artış sağladığını göstermektedir.

Anahtar sözcükler: İntravenöz deksametazon, oral deksametazon, ağrı skoru, postoperatif analjezi, supraklaviküler brakiyal pleksus bloku.

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Managing acute pain effectively after surgery is essential for ensuring smooth recovery, promoting early mobility, and improving overall patient outcomes. Although general anesthesia is still widely used in surgical practice, there has been a noticeable shift toward regional anesthesia techniques, particularly in orthopedic procedures. In recent years, supraclavicular brachial plexus block (SBPB) has gained prominence for upper limb orthopedic procedures due to its ability to provide dense, rapid-onset anesthesia suitable for procedures involving the mid-humerus, elbow, forearm, and hand and the technique offers a high success rate and consistent nerve coverage when guided by ultrasound. Despite these merits, the main limitation of single-shot SBPB is the finite duration of pain relief, which typically lasts between 8 and 12 h depending on the local anesthetic used.^[1] To extend the duration of analgesia, catheter techniques can be used or adjuvants such as opioids, alpha-2 agonists, magnesium sulfate, and corticosteroids can be added. Among corticosteroids, dexamethasone has shown the most promise due to its strong anti-inflammatory action and ability to extend sensory and motor block duration. Although the precise mechanism of dexamethasone is not completely understood, it is thought to work by decreasing inflammation at the nerve site, reducing abnormal nerve signaling, and potentially affecting central pain pathways.^[2] When given systemically, it reduces postoperative and rebound pain, suggesting a broader analgesic effect beyond the site of injection.^[3]

Dexamethasone can be administered by different routes including perineural, intravenous (IV), and oral. Several studies have shown that the duration of SBPB increases with the simultaneous administration of perineural and IV dexamethasone. When given orally, dexamethasone reaches peak blood levels in about 2 h and provides sustained plasma concentrations over 24 h, making it a practical alternative when administered sufficiently in advance of surgery.^[4] Advantages of oral administration include less patient discomfort, no risk of phlebitis, lower administration costs, and easy utilization on an outpatient basis.^[4] A particularly troublesome side effect seen with IV administration is perineal pruritus, or itching in the perineal area. While this reaction is often temporary, it may be accompanied by burning or tingling sensations which may be disconcerting to the awake patient receiving regional anesthesia. While the exact mechanism remains unclear, it may be related to the dexamethasone phosphate ester.^[5] This discomfort can be prevented

by oral administration. All these properties make oral dexamethasone (OD) an attractive alternative to IV administration, particularly in resource-limited or outpatient settings.

In a recent study, Maagaard et al.^[6] showed that 24 mg and 12 mg of OD increased the time to first postoperative pain compared to placebo in patients having upper limb surgery under infraclavicular brachial plexus block. In the light of these findings, we hypothesized that the use of OD before SBPB could prolong the analgesia of the block to a similar extent as that achieved by the coadministration of IV dexamethasone. In the present study, we, therefore, aimed to compare the effect of two perioperative dexamethasone regimens on the duration of analgesia after osseous forearm or hand surgery under SBPB.

PATIENTS AND METHODS

Study design and study population

This single-center, double-dummy, randomized-controlled study was conducted at Maulana Azad Medical College, Department of Anaesthesia and Critical Care between October 2024 and August 2025. A written informed consent was obtained from each participant. The study protocol was approved by the Institutional Ethics Committee of Maulana Azad Medical College (No. F.1/IEC/MAMC/MD/MS (108/01/2024/No.50, Date: 03/04/2024) and the trial was prospectively registered under the Clinical Trials Registry of India (CTRI/2024/10/074759) on 04/10/2024. The trial was registered prospectively before enrollment of the first participant. This manuscript adheres to the Consolidated Standards of Reporting Trials (CONSORT) guidelines for randomized controlled trials (RCTs).

Inclusion criteria were as follows: male and female adults aged between 18 and 60 years, American Society of Anesthesiologists (ASA) Class I-III, scheduled to undergo unilateral osseous surgery of the forearm or hand of anticipated duration < 3 h under SBPB. Patients with contraindications to SBPB such as deformity of shoulder, coagulopathy, local skin infection, bleeding diathesis, pre-existing nerve disease or neuropathy in the upper limb and long-standing diabetes mellitus, cardiac or neurological disease, neuropsychiatric disorders, hypersensitivity to study drugs, chronic treatment with opioids/sedatives, pregnant women and morbidly obese patients were excluded from the study. Finally, a total of 58 patients were assessed for eligibility, out of which seven did not meet the inclusion criteria and

three did not give consent for inclusion in the study. Forty-eight patients who met the inclusion criteria were recruited (Figure 1).

Intervention

Patients were randomized in a 1:1 allocation ratio to either Group OD (OD) to receive three oral tablets (2 dexamethasone 6 mg tablets + 90 mg etoricoxib) with water 2 h before surgery and IV normal saline 10 mL over 10 min at the time of administration of the SBPB or Group ID (ID) to receive three oral tablets (2 placebo tablets + 90 mg etoricoxib) with water 2 h before surgery and IV dexamethasone 8 mg in 10 mL normal saline over 10 min at the time of administration of the SBPB.

Blinding

Blinding was achieved using a double-dummy design. Participants were blinded to treatment allocation. The premedication tablets administered 2 h before surgery were prepared by the hospital pharmacy and were identical in appearance in both study groups. The IV study medication was administered in a total volume of 10 mL over 10 min in both groups. An independent anesthesiologist, who

was not involved in patient recruitment, anesthetic management, data collection, or outcome assessment, prepared the IV study solutions. Dexamethasone and normal saline were visually indistinguishable. The anesthesiologist performing the SBPB was unaware of group allocation. Intraoperative management and all postoperative assessments, including pain evaluations and QoR-15 assessments, were performed by a separate blinded anesthesiologist. Treatment allocation was concealed until completion of data analysis.

Primary and secondary outcomes

The primary outcome was the duration of analgesia. The secondary outcomes were the duration of motor block, the Numeric Rating Scale (NRS) pain scores at 6, 12 and 24 h after surgery, additional postoperative analgesic consumption over the first 24 h and the Quality of Recovery-15 (QoR-15) score at 24 h.

Randomization

The randomization sequence was generated using a computer-generated random number table. Allocation concealment was achieved using

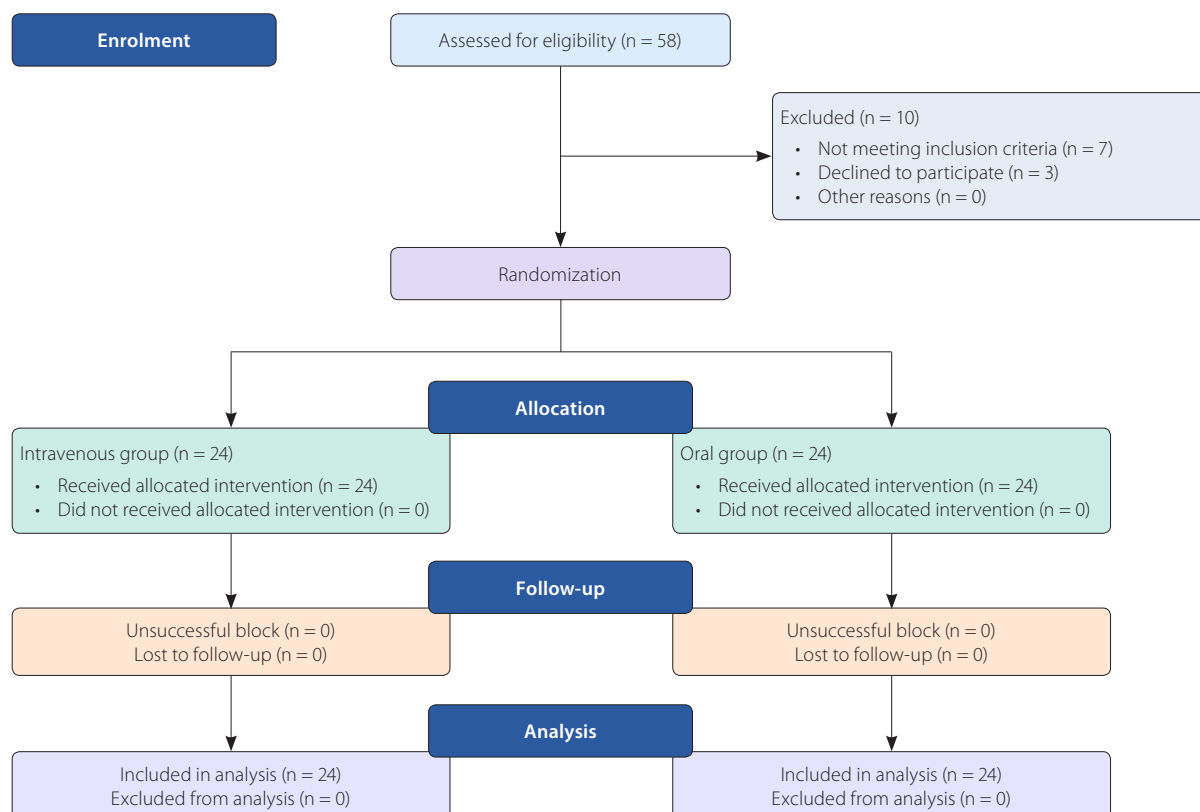


Figure 1. CONSORT study flowchart.

sequentially numbered, sealed, opaque envelopes prepared by an independent investigator. On the day of surgery, patients selected an envelope immediately before the procedure, and the assigned intervention was implemented accordingly.

Anesthesia technique

A detailed pre-anesthetic check-up including history, physical examination, and investigations as indicated was carried out in all patients and the anesthetic procedure was explained. During the preoperative visit, patients were taught how to grade their pain using the NRS scale. They were also familiarized with the QoR-15 questionnaire.^[7] All patients were fasted as per ASA guidelines. Premedication in the form of tablet alprazolam 0.25 mg was given at night and at 6 A.M. on the day of surgery. Oral study drugs (3 tablets) were given to all patients 2 h before administration of SBPB.

In the block room, each patient was placed in the supine position and routine ASA monitors, non-invasive blood pressure monitoring cuff, pulse oximeter, and electrocardiography (ECG), were attached. Intravenous access was secured in the non-operated hand and ringer lactate infusion was commenced. Intravenous midazolam 1 mg was given for procedural sedation. Ultrasound-guided single-injection supraclavicular block was performed by a standard technique using a 6- to 13-MHz 38-mm linear US probe (M-TURBO; SonoSite Inc., Bothell, WA, USA) placed in a sterile sheath and using the in-plane technique. After identifying the brachial plexus trunks and/or divisions over the first rib, lateral to the subclavian artery, and following skin infiltration with 1 mL of lidocaine 1%, a sterile 22-gauge blunt Stimuplex® needle 50 mm (B. Braun, Melsungen, Germany) was advanced to the junction of the first rib and subclavian artery. After negative aspiration, the perineural solution containing 30 mL of 0.5% ropivacaine was injected in 5-mL aliquots ensuring spread in the corner pocket and distension of the brachial plexus sheath. Concurrently, the corresponding IV study solution was infused over 10 min. All blocks were performed by an experienced anesthesiologist who previously administered more than 100 successful SBPB procedures.

After completion of injection of the perineural solution, a blinded researcher evaluated sensory and motor block onset every 5 min up to 30 min. The extent of sensory block was assessed in the

median, radial, ulnar, and musculocutaneous nerve distributions using a three-point score as 0 = loss of sensation to light touch, 1 = loss of sensation to pinprick, and 2 = normal sensation.

The extent of motor block was also 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.^[8] Block success was defined as the achievement of sensory and motor scores of ≤ 1 in all four nerve distributions within 30 min of injection of the perineural solution.

If required, a supplemental terminal branch nerve block (5 mL of lidocaine 2% per nerve, as needed) at the elbow or forearm was to be administered to patients with a successful block in whom surgical anesthesia (defined as sensory and motor scores = 0 in the distribution of surgery) was not achieved at 30 min. Patients who received a supplemental terminal branch nerve block were to be included in all analyses based on the principle of intention to treat. Patients who did not meet criteria for block success at 30 min were to be excluded from further data analyses. Intraoperatively, if required, conscious sedation was administered with low IV doses of fentanyl (1 µg/kg) titrated to patient comfort. At the end of the surgery, patients were shifted to the post-anesthesia care unit (PACU). On arrival in PACU, all patients received injection paracetamol 1 g IV and, then, every 8 h thereafter.

Postoperative monitoring

Pain scores using NRS were assessed at 0, 6, 12, and 24 h. Although patients were assessed at predetermined intervals, they were also instructed to report pain between assessments. The duration of analgesia was taken as the time from completing administration of drug in SBPB to first rescue analgesic requirement (NRS score ≥ 4) at which point they were given injection diclofenac 75 mg IV. If the patient was not relieved of pain within 30 min, the patient was given injection tramadol 1 to 2 mg/kg slow IV along with injection ondansetron 4 mg. The total rescue analgesic consumption during the first 24 h was recorded. Motor block duration was measured from completion of block administration until the return of voluntary finger movements. At 24 h postoperatively, the QoR-15 score was assessed. Both the patients and the anesthesiologist who followed the patient were blinded to the treatment group that the patient belonged to.

Statistical analysis

Sample size estimation was performed for comparison of two independent mean values. Assuming a clinically significant difference of 180 min in the duration of analgesia between the two groups and an estimated pooled standard deviation of 200 min based on previously published studies, with a two-sided significance level (α) of 0.05 and a statistical power of 80%, the minimum required sample size was calculated to be 21 patients per group. To compensate for a potential attrition rate of 10%, the sample size was increased to 24 patients in each group.

Statistical analysis was performed using the IBM SPSS for Windows version 25.0 software (IBM Corp., Armonk, NY, USA). The distribution of continuous variables was assessed using the Shapiro-Wilk test, supplemented by evaluation of skewness and kurtosis. Normally distributed continuous variables were presented in mean $\pm$ standard deviation (SD), whereas non-normally distributed variables were presented in median and interquartile range (IQR). Categorical

variables were presented in number and frequency. Between-group comparisons of continuous variables were performed using the independent-samples Student t-test for normally distributed data and the Mann-Whitney U test for non-normally distributed data. Comparisons between categorical variables were performed using the chi-square test or Fisher exact test, as appropriate. Changes in postoperative pain scores over time within each group were analyzed using the Friedman test. Between-group comparisons of pain scores at individual postoperative time points were performed using the Mann-Whitney U test. No formal adjustment for multiple comparisons was applied for secondary outcome analyses. A two-tailed p value of <0.05 was considered statistically significant.

RESULTS

Of the patients, 31 were male and 17 were female with a mean age of 34.31 ± 14.15 (range, 18 to 60) years. All the SBPB procedures were successful and a supplemental terminal branch nerve block was not required in any patient in either group.

Table 1. Baseline characteristics of patients

	Oral group (n = 24)				Intravenous group (n = 24)				p
	n	Mean $\pm$ SD	Median	IQR	n	Mean $\pm$ SD	Median	IQR	
Age (year)		34.29 $\pm$ 13.96				34.33 $\pm$ 14.33			0.992*
Sex									0.131†
Male	13				18				
Female	11				6				
Weight (kg)		62.58 $\pm$ 9.31				66.12 $\pm$ 9.85			0.207*
Height (m)		1.48 $\pm$ 0.14				1.52 $\pm$ 0.12			0.267*
BMI (kg/m ²)		28.98 $\pm$ 4.08				28.91 $\pm$ 4.47			0.955*
ASA class									0.806†
I	12				10				
II	7				9				
III	5				5				
Duration of surgery (min)			147.5	140-165			160	120-175	0.812‡
Intraoperative fentanyl requirement									0.146†
Yes	11				16				
No	13				8				
Surgical diagnosis									> 0.05¶
Humerus shaft fracture	2				1				
Distal end humerus fracture	6				7				
Both bone forearm fracture	7				4				
Galleazi fracture	2				2				
Radius fracture	5				6				
Ulna fracture	2				4				

SD, standard deviation; IQR, interquartile range; BMI, body mass index; ASA, American Society of Anesthesiologists; *, parametric tests (t-test); †, chi squared test; ‡, Wilcoxon-Mann-Whitney U test; ¶, Fisher exact test. A p value of <0.05 indicates statistical significance.

Table 2. Primary and secondary outcomes and side effects

	Oral group (n = 24)				Intravenous group (n = 24)				p
	n	Mean $\pm$ SD	Median	IQR	n	Mean $\pm$ SD	Median	IQR	
Duration of analgesia (h)		10.50 $\pm$ 3.30				14.92 $\pm$ 3.40			< 0.001*
Duration of motor block (h)		9.33 $\pm$ 3.12				12.75 $\pm$ 3.40			0.001*
NRS (h)									
0			0	0-1			0	0-0	0.243‡
6			2	0-3			0	0-1.25	0.048‡
12			3	2-4			2	1-2	< 0.001‡
24			3	2.75-5			2.5	2-4	0.027‡
Average NRS in 24 h			2	1.69-2.75			1.25	0.94-1.75	0.001‡
Diclofenac required									< 0.001†
Yes	16				4				
No	8				20				
Number of diclofenac doses									0.04¶
0	8				20				
1	7				1				
2	6				2				
3	3				1				
Tramadol required									0.137†
Yes	7				2				
No	17				22				
Number of tramadol doses									0.109¶
0	17				22				
1	4				2				
2	3				0				
QoR-15 scores at 24 h									
Part A		75.21 $\pm$ 8.38				85.79 $\pm$ 8.02			< 0.001*
Part B		36.83 $\pm$ 5.21				43.04 $\pm$ 4.96			0.001‡
Total		112.04 $\pm$ 11.63				128.83 $\pm$ 12.21			< 0.001*
Side effects									
None	11				19				0.036¶
Nausea	6				1				0.097¶
Nausea + vomiting	4				1				0.348¶
Headache	1				3				0.609¶
Pruritus	2				0				0.489¶

SD, standard deviation; IQR, interquartile range; NRS, numerical rating scale; QoR-15, quality of recovery 15 score; *, parametric tests (t-test); †, chi squared test; ‡, Wilcoxon-Mann-Whitney U test; ¶, Fishers exact test. A p value of <0.05 indicates statistical significance.

No differences in baseline patient characteristics were observed between the study groups. The intraoperative fentanyl requirement was also similar (Table 1).

The mean duration of analgesia was 10.50 $\pm$ 3.30 h in Group OD and 14.92 $\pm$ 3.40 h in Group ID (p < 0.001) (Table 2 and Figure 2).

The mean duration of motor block was 9.33 $\pm$ 3.12 h in Group OD and 12.75 $\pm$ 3.40 h in Group ID (p = 0.001) (Table 2). The NRS scores were significantly higher in Group OD at 6, 12 and

24 h after surgery. The mean NRS over 24 h was also higher in Group OD (Table 2 and Figure 3).

More patients in Group OD required diclofenac in the first 24 h after surgery, while the number of patients requiring tramadol in the first 24 h after surgery were comparable between both the groups (Table 2). The number of diclofenac doses required in the first 24 h was significantly higher in Group OD than Group ID (Table 2 and Figure 4), while the number of doses of tramadol required were similar (Table 2 and Figure 5).

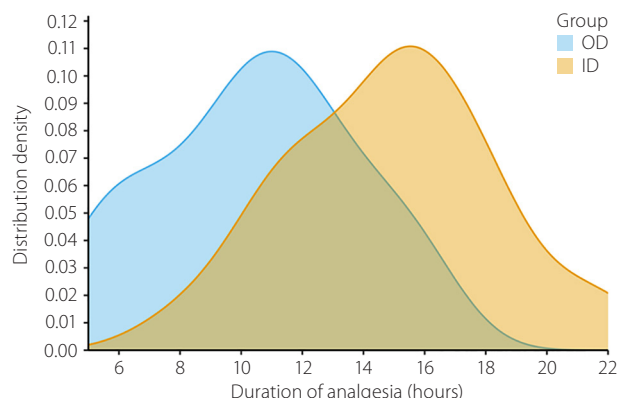


Figure 2. Density plot of duration of analgesia in the OD and ID groups.

OD, oral dexamethasone; ID, and intravenous dexamethasone.

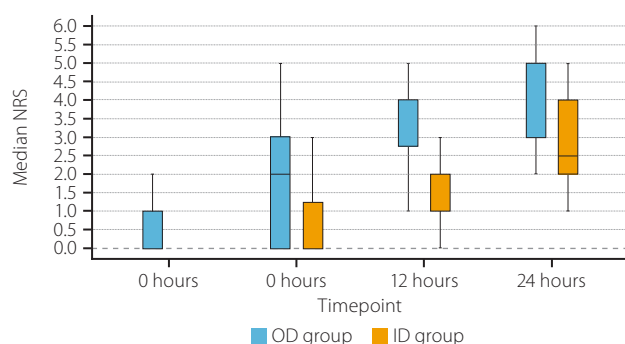


Figure 3. Box and whisker plot of NRS scores at 0, 6, 12 and 24 h.

OD, oral dexamethasone; ID, and intravenous dexamethasone; NRS, numeric rating scale.

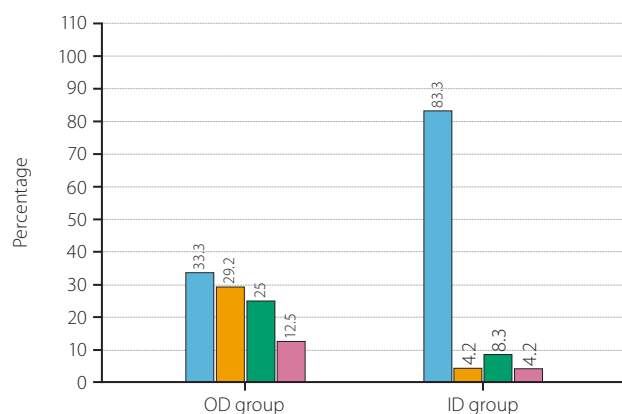


Figure 4. Number of diclofenac doses in both groups.

OD, oral dexamethasone; ID, and intravenous dexamethasone.

The Part A, Part B, and total QoR-15 was significantly higher in Group ID than Group OD at 24 h (Table 2 and Figure 6).

The overall incidence of side effects was higher in the OD group ($p = 0.036$); however, the individual

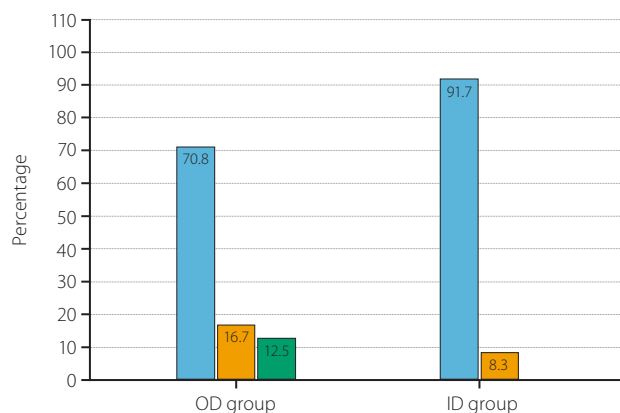


Figure 5. Number of tramadol doses in both groups.

OD, oral dexamethasone; ID, and intravenous dexamethasone.

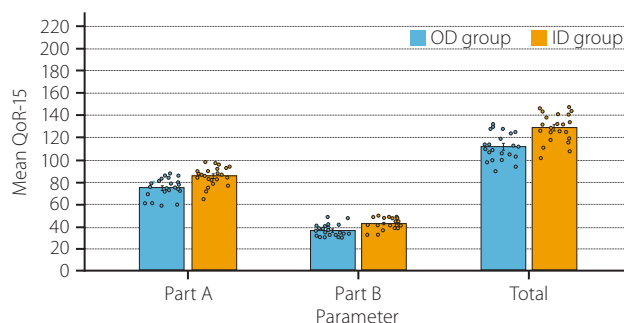


Figure 6. The bar graph depicts the means of QoR-15 in the two groups.

OD, oral dexamethasone; ID, and intravenous dexamethasone.

side effects remained comparable in both the groups (Table 2).

DISCUSSION

In the present study, we compared the effect of two perioperative dexamethasone regimens on the duration of analgesia after osseus forearm or hand surgery under SBPB. Our study results showed that that ID, when used as an adjunct to SBPB with ropivacaine, significantly prolonged analgesia and motor blockade, reduced postoperative pain and supplemental analgesic requirements, and improved quality of recovery compared to OD. These findings suggest that an intermediate-dose dexamethasone regimen may provide more effective and prolonged postoperative analgesia than a lower-dose regimen when used as an adjunct to ropivacaine-based SBPB in this patient population.

Dexamethasone has been extensively evaluated as an adjuvant to prolong block duration, with multiple studies investigating both IV and

perineural routes. Several meta-analyses suggest that perineural dexamethasone offers a modest additional benefit over IV administration in terms of prolonging block duration, but the clinical relevance is debatable. Intravenous dexamethasone (ID) is thus most commonly used, but its most distressing side effect is transient perineal pruritus or a burning sensation that occurs immediately after injection. This has been reported in 25 to 100% of patients depending upon the dose and rate of administration.^[5] Although self-limiting, it can be uncomfortable and embarrassing for patients, thereby limiting the acceptability of IV dosing in certain contexts. Thus, while IV dexamethasone remains preferred for its predictable pharmacokinetics and familiarity, the oral route offers an appealing alternative.

Chadha et al.^[9] examined the influence of different volumes of 0.5% ropivacaine on the characteristics of ultrasound-guided SBPB. The mean duration of analgesia was found to be significantly shorter in the 20 mL group, averaging 576 ± 104 min, compared to 731 ± 102 min in a 35 mL group. We used 0.5% ropivacaine in a volume of 30 mL as the local anesthetic drug for SBPB in this study. Dexamethasone, when given IV, provides predictable bioavailability ($\approx 100\%$) and reliable timing, ensuring peak systemic concentrations which coincide with the early inflammatory response triggered by needle trauma and surgical stimulation. The oral route is attractive, as it is non-invasive and convenient, but it has a lower and variable bioavailability (~ 70 to 78%) due to absorption differences and first-pass hepatic metabolism.^[4] Based on this, we selected an oral dose of 12 mg to approximate the effective systemic exposure of 8 mg of IV dexamethasone.

We studied 48 patients undergoing elective upper limb surgery under SBPB with 30 mL 0.5% Ropivacaine who received either oral or IV dexamethasone. The demographic data was comparable in both the groups. The mean duration of analgesia in the IV dexamethasone group was 14.92 ± 3.40 h, which, was prolonged as compared to the OD group (10.50 ± 3.30 h). Cummings et al.^[10] observed a much longer mean duration of 22.2 h with 8 mg of IV dexamethasone, compared to 11.8 h in controls. Similarly, Desmet et al.^[11] found prolongation to 21.25 h with 10 mg of IV dexamethasone. Abdallah et al.^[12] reported the longest duration, with IV dexamethasone extending block duration to 25 h, compared to 13.2 h in controls. Clement et al.^[13] found a mean duration of 20.9 h,

while Rosenfeld et al.^[14] reported 18.2 ± 6.4 h. More recently, Hong et al.^[15] found a comparatively shorter prolongation (~ 10.7 h with IV dexamethasone *vs.* 8.1 h in controls). Bindal et al.^[16] also demonstrated significant prolongation, with a mean of 20.2 h in the dexamethasone group versus 4.7 h with ropivacaine alone. Our results align with earlier studies that consistently demonstrate the analgesia prolonging effects of dexamethasone when combined with long-acting local anesthetics in brachial plexus blocks. However, the variability in the prolongation of the duration of analgesia by IV dexamethasone across studies suggests that the block prolongation may be influenced by various factors such as the patient population, surgical type, definitions of analgesic endpoint, anesthetic pharmacodynamics, pharmacogenetics and dexamethasone dose. Our observed duration (~ 15 h) falls at the lower end of the published range, likely reflecting these factors.

Clinical evidence for OD administration is limited. In our study, 12 mg of OD with 0.5% ropivacaine 30 mL yielded a mean analgesia duration of 10.50 ± 3.30 h, which is markedly shorter than the ~ 19.5 h ($1,171 \pm 318$ min) reported by Maagaard et al.^[6] with 12 mg of OD, and the ~ 20.9 h ($1,256 \pm 395$ min) observed with 24 mg OD. These discrepancies may stem from differences in block approach (supraclavicular *vs.* infraclavicular), timing of oral dosing and variability in absorption and first-pass metabolism. Maagaard et al.^[6] administered OD 45 min before block and about 2.5 h before surgery, whereas we administered it 2 h before block and about 3.5 h before surgery. Our findings were inferior to those of Maagaard et al.^[6] and suggest that, while OD remains attractive for its convenience, its effect appears less predictable than that of IV administration. Indeed, the duration of analgesia in the oral group in our study was comparable to that reported in the control groups of previous studies, suggesting that OD administered 2 h prior to SBPB may not have a significant clinical effect in prolonging the analgesic duration achieved with 30 mL of 0.5% ropivacaine in SBPB. Even with administration of OD 2 h before the block, the pharmacokinetic variability of oral administration may reduce the uniformity and magnitude of its clinical effect. We observed that the duration of motor block was significantly longer in the IV group compared to the oral group (12.75 ± 3.40 h *vs.* 9.33 ± 3.12 h). Maagaard et al.^[6] reported motor block duration in terms of time to recovery of biceps movement after infraclavicular block as 813 min (13.55 h) with placebo, 1,144 min (19.06 h) with

12 mg OD, and 1,144 min (19.06 h) with 24 mg OD, confirming the ability of systemic dexamethasone to prolong motor as well as sensory block. Similarly, Kumar et al.^[17] observed that patients receiving 8 mg of IV dexamethasone with ropivacaine had a markedly longer motor block compared to those who received ropivacaine alone (18.88 ± 1.77 h vs. 7.76 ± 0.90 h). Bindal et al.^[16] also found that the addition of dexamethasone significantly prolonged motor block (16.26 ± 0.41 h) compared to ropivacaine alone (3.03 ± 0.17 h).

In our study, postoperative NRS scores were consistently lower in the IV group at 6, 12, and 24 h compared to the OD group. The difference was most pronounced at 12 h. Earlier investigators have also reported lower pain scores when using IV dexamethasone.^[16,17] In our study, the requirement for supplemental analgesics in the first 24 h after surgery was also significantly lower in the IV group compared to the oral group. All participants received preoperative etoricoxib as part of a standardized multimodal analgesic regimen. Although etoricoxib may have contributed to improved postoperative analgesia and recovery, its administration was identical in both groups, minimizing the likelihood of confounding. Nevertheless, the use of concomitant analgesics may have reduced overall pain scores and attenuated the observable differences between the dexamethasone regimens.

In the current study, the overall incidence of perioperative side effects was significantly lower in the IV group, whereas individual side effects remained comparable. Among reported symptoms, nausea and vomiting occurred in more patients in the oral group indicating that the IV route may offer a slight advantage in minimizing nausea and vomiting, consistent with its more reliable pharmacokinetics, but the differences were not statistically significant in our sample. The occurrence of perineal pruritus with IV dosing of dexamethasone was another of our concerns. Earlier reports have suggested an incidence of 25 to 100% depending on the dose and speed of administration. There seems to be female preponderance and a relationship with the phase of the menstrual cycle.^[18,19] In our study, the majority of patients were males (31 males vs. 17 females) and the IV study drug was given slowly over 10 min using a syringe infusion pump. Also, all patients received 1 mg of midazolam for procedural sedation and had also received oral alprazolam premedication. These may be some of the reasons why none of our patients complained of pruritus.

There are some concerns about hyperglycemia with use of dexamethasone. A meta-analysis^[20] reported no evidence that a single dose of dexamethasone increased the risk of postoperative systemic or wound infection, or delayed wound healing, but did increase glucose values in the first 12 h after surgery, *albeit* with low-quality evidence for this last-named outcome. Desmet et al.^[11] found an increase of mean postoperative blood glucose concentrations in patients receiving IV dexamethasone 10 mg along with interscalene brachial plexus block of only 5.1 (13) mg/dL⁻¹. Single dose dexamethasone is routinely being administered to surgical patients for its analgesic and antiemetic effects without routine blood glucose monitoring. We did not perform blood glucose measurement perioperatively.

The concept of quality of recovery has gained increasing importance in perioperative research, as pain scores and block duration alone do not fully capture the patient's postoperative experience. The QoR-15 questionnaire is a validated patient-reported outcome measure that assesses multiple domains of recovery, including physical comfort, physical independence, psychological support, and emotional state.^[7,21] It provides a more holistic assessment of perioperative interventions, with higher scores reflecting better overall recovery. More importantly, even modest improvements in QoR-15 (≥ 8 points)^[22] are considered clinically meaningful, making it a sensitive tool to evaluate the patient-centered impact of adjuvants such as dexamethasone. An earlier study found that IV dexamethasone can reduce the rebound pain after adductor block and sciatic popliteal nerve block in patients with ankle fracture surgery, prolong the duration of nerve block, and improve the quality of early postoperative recovery. The QoR-15 score was significantly higher in the IV dexamethasone group 117 (111-119) as compared to 109 (104-113) in the control group.^[3] We found that the QoR-15 score at 24 h was significantly higher in the IV regimen group compared to the oral regimen group across all domains. The mean total QoR-15 scores were 112.04 ± 11.63 in the oral group and 128.83 ± 12.21 in the IV group. These results indicate that IV dexamethasone not only prolonged block duration and reduced analgesic requirements, but also enhanced the overall quality of recovery as experienced by patients. The nearly 17-point higher mean total QoR-15 score in the IV regimen group exceeds the established threshold for minimal clinically important difference, confirming that

the benefit was not only statistically significant, but also clinically relevant. The significantly higher total QoR-15 score observed in the IV dexamethasone group was accompanied by improvements in both Part A and Part B scores. Part A primarily reflects dimensions of physical recovery, including comfort, independence, and pain-related aspects of postoperative recovery, whereas Part B reflects emotional and psychological well-being. The higher Part A score in the IV dexamethasone group is consistent with the prolonged duration of analgesia and lower postoperative pain burden observed in this group. Notably, Part B scores were also significantly higher, suggesting that improved pain control and overall postoperative comfort may have contributed to better emotional recovery and patient well-being. Together, these findings support the clinical plausibility of the observed improvement in overall quality of recovery following administration of the IV dexamethasone regimen.

Nonetheless, this study has certain limitations that should be acknowledged. It is a single-center study and only adult ASA Class I-III patients were recruited which limits the applicability of this study to all patient populations. As only surgical procedures of < 3 h duration were included, our results cannot be extrapolated to patients undergoing prolonged surgical procedures under SBPB. This study was powered for the primary outcome of duration of analgesia. Multiple secondary outcomes, including pain scores at several postoperative time points, were analyzed without formal adjustment for multiple comparisons. Consequently, the risk of type I error may have been increased, and findings relating to secondary outcomes should be interpreted with caution and considered exploratory. Rebound pain is discussed, but was not formally measured; this is also a limitation. Also, it remains uncertain whether the duration of analgesia could have been further prolonged if OD had been administered at a time point different from 2 h before surgery. We evaluated only a single OD dose of 12 mg; therefore, potential dose-response effects could not be assessed and we did not have a placebo arm in our study.

In conclusion, our study results showed that the IV dexamethasone regimen in SBPB with ropivacaine provided longer analgesia and motor blockade, lower pain scores, reduced analgesic consumption and a better quality of recovery as compared to the OD regimen. Taking these findings into consideration, future research should focus on evaluating different dosing regimens of OD, as well as assessing its effects by administration at varied preoperative

time intervals in larger and more diverse study populations.

Author Contributions

A.S.: Conceptualization, methodology, software; V.V., A.R.B.: Conceptualization, methodology, data curation, writing-original draft preparation; R.S., S.D.: Methodology, visualization, investigation, snighda singh; M.A.: Supervision, software, validation.

Conflict of Interest

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The data that support the findings of this study are available from the corresponding author upon reasonable request.

AI Disclosure

The authors declare that artificial intelligence (AI) tools were not used, or were used solely for language editing, and had no role in data analysis, interpretation, or the formulation of conclusions. All scientific content, data interpretation, and conclusions are the sole responsibility of the authors. The authors further confirm that AI tools were not used to generate, fabricate, or 'hallucinate' references, and that all references have been carefully verified for accuracy.

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