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Comparing the Effects of Infusion and Bolus Doses of Bupivacaine Applied with Infraclavicular Catheter on the Duration and Need of Postoperative Analgesia

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Abstract

Objective

This study aimed to evaluate postoperative analgesia duration, analgesic requirements, and patient satisfaction between continuous infusion and bolus injection techniques using an infraclavicular catheter in patients undergoing forearm surgery.

Material and Method

We examined 100 patients which were divided into 2 groups to evaluate the data retrospectively. Bolus Injection Group (B): Patients who received 4 mL of bupivacaine (0.5%) from the catheter if the VAS value was > 3. Continuous Infusion Group (C): Patients who received 20 mg bupivacaine (0.02%) infusion via catheter using an infusion pump in 24 hours. Demographic data, American Society of Anesthesiologists (ASA) score, intraoperative and postoperative hemodynamic data, sensory and motor block onset times, postoperative Visual Analogue Scale (VAS) (1-2-6-12-24th hour), postoperative 24th and 48th hour satisfaction score, obtained from anesthesia and algology follow-up forms, were evaluated.

Results

When both groups were compared, VAS6 and VAS24 values of Group C were found to be statistically significantly lower than Group B. Satisfaction scores revealed that significantly more patients in Group C reported being very satisfied compared to Group B.

Conclusion

Our findings suggest that continuous local anesthetic infusion via catheter offers more sustainable analgesia compared to bolus administration.

Keywords: Plexus Blockade, Brachial, Catheterization, Peripheral, Analgesia

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Introduction

The use of opioids is limited due to side effects such as sedation, dizziness, respiratory depression, nausea and vomiting (1). Serious complications such as perioperative acute kidney injury, coagulation disorders and anaphylactic reactions are observed in the use of nonsteroidal anti-inflammatory drugs (2,3). Postoperative pain management, which aims to prevent complications, often incorporates multimodal analgesia methods such as intravenous (IV), oral analgesics, and regional techniques.

Infraclavicular block constitutes a good alternative to general anesthesia, especially in patients undergoing forearm surgery and that it can be applied as a single injection or continuous infusion (4). Especially the use of ultrasound (US) has resulted in a significant increase in block success rate. In addition, there has been a reduction in the doses of local anesthetics used (5-10). Peripheral nerve block catheters allow for the administration of local anesthetics and adjuvant drugs to manage postoperative analgesia.

In this study, it was aimed to retrospectively examine the postoperative analgesia duration, analgesic requirement and patient satisfaction of continuous infusion and bolus injection technique performed via infraclavicular catheter in patients who underwent forearm surgery.

Material and Method

After the approval of Suleyman Demirel University Faculty of Medicine Clinical Research Ethics Committee (Date: 31.05.2017, protocol no: 113), the files of 140 patients who underwent elective surgery by Orthopedics and Plastic Surgery between 2016 and 2017 were examined. This study was conducted in accordance with the principles outlined in the Declaration of Helsinki.

Patients who underwent forearm surgery with infraclavicular brachial plexus block, between the ages of 18-75, ASA score I-II, who received continuous infusion or bolus injection of bupivacaine with a catheter for postoperative analgesia were included in the study.

Bolus Injection Group (B): Patients who received 4 mL of bupivacaine (0.5%) from the catheter if the visual analogue scale (VAS) value is > 3.

Continuous Infusion Group (C): Patients who received total 20 mg bupivacaine (0.02%)/ 100ml isotonic infusion via catheter using an infusion pump (Perfusor® Space, B. Braun, Germany) in 24 hours.

Demographic data (age, height, weight), ASA score, intraoperative and postoperative hemodynamic data [(systolic arterial pressure (SAP), diastolic arterial pressure (DAP), oxygen saturation (SpO2), heart rate (HR)] sensory and motor block onset times, postoperative VAS value (1th-2nd-6th-12th-24th hour), postoperative 24th and 48th hour satisfaction score, obtained from anesthesia and postoperative follow-up forms, were evaluated. Patients who expressed no satisfaction were stated as 1 point, those who expressed dissatisfaction 2 points, those who were satisfied 3 points, and those who were very pleased were stated as 4 points.

Data analysis was performed using SPSS (Statistical Package for Social Sciences INC; Chicago, IL, USA) version 15.0 software. Kolmogorov-Smirnov test was used for distribution of data. While parametric tests were performed on data with normal distribution, non-parametric tests were performed on data that did not show normal distribution. Qualitative data were presented as numbers and percentages, and quantitative data as mean and standard deviation. Chi-square test was used for qualitative analysis and Mann-Whitney U test was used for quantitative analysis. A value of $p<0.05$ was considered statistically significant.

Results

Patients who performed general anesthesia after infraclavicular block and who used postoperative oral or IV analgesics were excluded from the study. Ten patients with missing files, 17 patients who were operated under general anesthesia and 13 patients who used postoperative oral or IV analgesics were excluded from the study. The remaining 100 patients were divided into 2 groups to evaluate the data (Figure 1)

There was no statistically significant difference between the groups in terms of demographic data (Table 1). In the comparison of ASA scores, there was no significant difference between the groups ($p> 0.05$). When the type and duration of the operation performed were compared, no significant difference was observed between the groups ($p> 0.05$) (Table 2). Mean operation time was 93.2 minutes in Group B and 106.4 minutes in Group C.

No significant difference was found between the groups, when the motor and sensory block onset

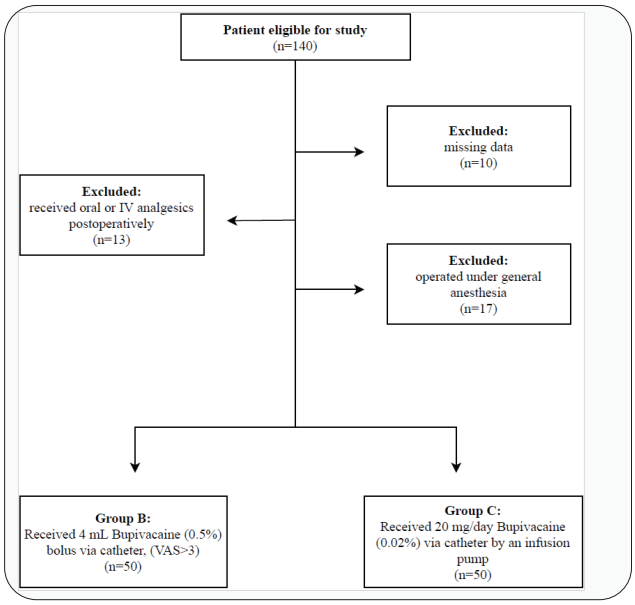

Figure 1
Patient selection flow chart.

times recorded after the block were compared. Motor block onset time was 10.9 minutes on average in Group B, while it was 9.8 minutes in Group C. While the mean sensory block initiation time was 21.24 minutes in Group B, it was found to be 19.3 minutes in Group C (p> 0.05) (Table 3). No statistically significant differences were observed in SAP, DAP, SpO2, and HR measurements recorded before surgery and at various intraoperative intervals (1st, 30th, 60th, 90th, and 120th minutes).

In the algology follow-up forms, no statistically significant difference was found between the SAB, DAB, SpO2, HR values measured at the postoperative 1st-12th-24th hours (p> 0.05). It was observed that when both groups were compared, 6th hour VAS (VAS6) (p <0.001) and 24th hour VAS (VAS24) (p <0.001) values of Group C were found to be statistically significantly lower than Group B (Table 4). Patients who stated that they were very satisfied (4 points) at the 24th hour and the 48th hour were found to be significantly higher in Group C compared to Group B (p = 0.002, p = 0.009 respectively) (Tables 5 and 6). Postoperative VAS scores were consistently lower in Group C compared to Group B across the 1st, 2nd, 6th, 12th, and 24th hours.

Table 1 Demographic Data

	GROUP B (n=50)	GROUP C (n=50)	p value
Age (year)	40,80±16,75	37,92±14,24	0,430
Height (cm)	170,16±6,49	172,86±7,85	0,054
Weight (kg)	73,9±13,76	78,18±12,01	0,097

Mean±SD (p>0.05)

Table 2 Operation Types

	GROUP B	GROUP C
	n (%)	n (%)
Hand injury	29 (58%)	32 (64%)
Tenolysis	6 (12%)	5 (10%)
Tendon injury	2 (4%)	4 (8%)
Amputation	2 (4%)	4 (8%)
Others	11 (22%)	5 (10%)
Total	50 (100%)	50 (100%)

Data are shown as n (%), p>0.05

Table 3 Motor and Sensory Block Onset Times

	GROUP B	GROUP C	p value
MB onset time (min.)	10.9±4,48	9.8±4,73	0.162
SB onset time (min.)	21.24±9,41	19.3±7,21	0.347

MB: Motor block, SB: Sensory block min: Minutes. Mean±SD (p>0.05)

Table 4 VAS values

	GRUP B	GRUP C	p value
VAS1	2.58±0,81	2.32±0,71	0.120
VAS2	2.3±0,61	2.14±0,70	0.237
VAS6	2.68±0,84	1.96±0,63	<0.001*
VAS12	2.18±0,74	1.78±0,67	0.007
VAS24	1.96±0,66	1.46±0,54	<0.001*

Mean±SD (p<0.05)*

Table 5 Satisfaction Scores After 24 Hours

	Satisfaction/ 24th			TOTAL
	2 points	3 points	4 points	
Group B	10	33	7	50
Group C	1	31	18*	50
TOTAL	11	64	25	100

*p=0,002

Table 6 Satisfaction Scores After 48 Hours

	Satisfaction/ 48th			TOTAL
	2 points	3 points	4 points	
Group B	2	35	13	50
Group C	0	23	27*	50
TOTAL	2	58	40	100

*p=0,009

Discussion

In this study, we found that adequate analgesia can be achieved with both methods, since VAS values were below 3 in bolus injection and continuous infusion groups in patients who underwent forearm surgery under infraclavicular brachial plexus block with a perineural catheter for postoperative analgesia. Although it was observed that sufficient analgesia was obtained in both groups, higher satisfaction scores were achieved especially in the Group C (0.02% bupivacaine) ($p < 0.05$). In addition, while a steady decrease was observed in VAS values of Group C, a statistically significant increase was observed in the Group B, especially at the 6th hour.

Klein et al. compared two different infusion protocols (0.2% ropivacaine 10 mL/hour and placebo) in interscalene block applications for rotatory cuff operation and achieved lower pain scores in the ropivacaine group compared to the placebo group, and thus it was shown that the continuous infusion method can be used in pain management (11). Ilfeld et al. showed that 0.2% ropivacaine infusion administered for 3 days to patients via infraclavicular catheters significantly reduced postoperative pain, oral opioid use and related side effects. Overall satisfaction was also found to be significantly higher in the ropivacaine group (12). In both studies mentioned above, it has been shown that continuous local anesthetic infusion applied through an infraclavicular catheter can be used effectively in reducing pain. In the present study, the effects of bolus injection or continuous infusion techniques on patient satisfaction and pain scores were compared in patients who were administered bupivacaine via infraclavicular perineural catheter for postoperative analgesia.

In studies comparing supraclavicular and infraclavicular brachial plexus block approaches by Gürkan et al, Koscielniak et al, Sandhu et al. and Sauter et al, the mean time to occurrence of infraclavicular block was reported to be 12.5, 19.0, 9.7, and 13.9 minutes, respectively (13-16). In this study, the mean time to occurrence of sensory block was 21.24 minutes in the Group B and 19.3 minutes in the Group C, the mean time to occurrence of motor block was 10.9 minutes in the Group B and 9.8 minutes in the Group C. These values are consistent with the times found in the literature and no statistically significant difference was found between the two groups.

It is unclear whether local anesthetic concentration or total drug dose is the main determinant of continuous peripheral nerve block effects. For this purpose, in a multi-center study conducted by Ilfeld et al, ropivacaine infusion in two different concentrations was applied to the patients for postoperative analgesia via the infraclavicular catheter. The presence of numbness in the extremities, pain scores, opioid needs and satisfaction scores of the patients were evaluated after 24 hours. High concentration (0.4%) ropivacaine was administered to 27 of 50 patients included in their study, and limb numbness was observed more frequently in these patients compared to the other group (0.2% ropivacaine). While 67% of the high concentration group described numbness in the extremities, this rate was 37% in the low concentration group. Although there was no difference between the pain scores of both groups, patient satisfaction was found to be significantly higher in the patients in the low concentration group. Consequently, in continuous infusion protocols, it has been stated that side effects such as numbness in the extremities will decrease and patient satisfaction will increase by decreasing the local anesthetic drug concentrations (17). In spite of the total amount of local anesthetic administered in the present study was less in the infusion group, we think that the reason for the higher patient satisfaction was the lower bupivacaine concentration we gave.

Ilfield et al. compared 3 different dosing regimens in patients who were administered infraclavicular perineural local anesthetic to provide postoperative analgesia. They concluded that the addition of patient-controlled bolus administration to continuous infusion is more ideal than bolus or infusion regimen alone in terms of providing postoperative analgesia and patient satisfaction, and minimizing the need for oral analgesic (18). In the present study, the VAS values of both groups at the 1st-2nd-6th-12th-24th hour and their satisfaction after 24-48 hours were compared. The VAS values of the Group C tended to decrease continuously during the day and were lower than the Group B, especially the difference in VAS6 and VAS24 values between the groups was found to be statistically significant. In addition, in the end-of-day satisfaction questionnaires, patients in the Group C had statistically significantly higher satisfaction scores compared to the Group B. These results are consistent with the studies in the literature, and accordingly, we think that local anesthetic infusion application via catheter provides a more sustainable analgesia than bolus application.

The safety and efficacy of peripheral nerve blocks have been proven in many prospective studies (19-21). However, the local anesthesia concentrations (0.1-0.5%, ropivacaine, 0.1-0.2% bupivacaine) and volumes (up to 10 mL/hour) used in these studies

are relatively high and this has been associated with an increase in muscle weakness due to motor block (22-23). It has been stated that muscle weakness, which is the result of motor block, prevents patients from starting physical therapy, but also increases the duration of hospital stay. In the study conducted by Qing Liu et al, 1768 patients who underwent knee arthroplasty between 2010 and 2012 were evaluated. One group (n = 439) received postoperative hydromorphone infusion and non-opioid analgesic without block, while the other group (n = 1329) received 0.03% bupivacaine infusion (3 ml / hour) via sciatica or femoral nerve catheters after the block. Patients with perineural catheters also received 3 ml bolus 0.03% bupivacaine per hour when needed. Resting VAS values and opioid use on postoperative first and second days were found to be significantly lower in those who received local aneshetic via catheter compared to the other group. There was no difference between the groups in VAS values after the pain caused by activity. While 96.41% of the patients with perineural catheter on the postoperative first day started physical therapy, this rate remained at 57.14% in the group without catheter, and this difference between the two groups was found to be statistically significant (24). In the present study, the concentration of bupivacaine (0.02%) used in the infusion group was lower than in the previous study. Despite the lower concentration, we found results consistent with the resting VAS values determined by Qing et al. Therefore, we think that more studies should be conducted on the concentration of local anesthetic administered for postoperative analgesia.

The present study has some limitations. The first of these is that the study is retrospective. In addition, the deficiencies in the postoperative nurse observation form and the epicrisis forms in the service and the complexity in accessing archive documents caused difficulties. Apart from this, we could not obtain results related to the postoperative physical therapy participation process and motor block evaluation of the patients were not documented.

In conclusion, although analgesia and patient satisfaction were found to be sufficient in both bolus and infusion methods, statistically significant low VAS values and high satisfaction scores were found in the lower concentration infusion group. The application of continuous local anesthetic infusion via catheter provides a more sustainable analgesia than bolus application.

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Conflict of Interest Statement
The authors have no conflicts of interest to declare.

Ethical Approval
Suleyman Demirel University Faculty of Medicine Clinical Research Ethics Committee, (Date: 31.05.2017, protocol no: 113). This study was conducted in line with the principles of the "Helsinki Declaration".

Consent to Participate and Publish
Studies involving human subjects should include a statement that: Written informed consent to participate and publish was obtained from all individual participants or legal guardians included in the study.

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

Authors Contributions
ÜF: Conceptualization; Data curation; Formal analysis; Investigation; Methodology; Validation; Visualization; Writing-original draft.

AK: Investigation; Validation; Writing-original draft

FAS: Data curation; Formal analysis; Resources; Writing- review & editing

MSÖ: Formal analysis; Visualisation; Writing- review & editing

PK: Supervision; Writing- review & editing

Editorial Statement
Although one of the authors of the article in question, PK, is one of the journal's sectional editorial board members, he was not involved in any stage of the article's publication process.

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