

Analgesics effect of intra-articular bupivacaine injection on pain score in anterior cruciate ligament surgery: a randomized clinical trial

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Abstract

Background: The aim of this study was to examine the effects of injection timing and drainage clamps on patient pain scores in intra-articular local anesthetic applications after arthroscopic anterior cruciate ligament (ACL) reconstruction.

Materials and Methods: Forty patients undergoing arthroscopic ACL reconstruction were randomly allocated to one of the four study groups according to the time of the intraarticular bupivacaine (20 ml) injection and the presence of the drainage clamps as follows: Preoperative injection group (PO) received bupivacaine injection 20 minutes prior to the operation, Drain Open group (DO) received bupivacaine injection following the operation while the hemovac drain was open, Drain closed group (DC) received bupivacaine injection following the operation while the hemovac drain was closed, and the control group in which the subjects did not receive any intraarticular injections.

Results: The VAS score for postoperative joint pain was lowest in PO group among all groups at the postoperative 2nd hour. At the 4th and the 6th postoperative hours the VAS score for postoperative joint pain was similar in the PO and DC groups and was lower than that of the DO group and the controls. However, the VAS score at the postoperative 12th hour was lower in DO and DC groups than the PO group and the controls.

Conclusions: The VAS score for postoperative joint pain changes with respect to the timing of the injection and the presence or absence of drainage.

Key words: intra-articular, bupivacaine, postoperative pain scores

Introduction

Anterior cruciate ligament (ACL) reconstruction causes significant pain, especially during the first two days post-operation (1). A variety of methods to reduce postoperative knee surgery pain have been previously described (2).

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The analgesic efficacy of local anesthetics has been demonstrated in knee reconstruction. Bupivacaine is the most commonly used and arguably one of the most researched local anesthetics (3). The high lipophilic properties of bupivacaine lead to faster transmission from the joint to the bloodstream compared to other drugs, including lidokain, mepivakain, prilokain, etidokain, dibukain, and ropivakain. The action of bupivacaine is rapid; however, short half-life of bupivacain is the major drawback of this agent (4). Although the joint is washed with saline before arthroscopic surgery, maintaining the anesthetic effect of bupivacaine is crucial (5).

The toxic effect of bupivacaine on cartilage tissue presents a major problem. Evidence of the chondrotoxic effect has mostly been delivered from in vitro studies or animal experiments. The findings of the study conducted by Chu et al. have indicated that 0.5% bupivacaine exposure had a cytotoxic effect on the cartilage tissue of bovine animals (5). Controversial results have been reported in other studies concerning the effect bupivacaine on chondrotoxicity. An in vivo study on rabbits conducted in 2009 by Gomoll et al. have reported that no permanent impairment of cartilage function was detected 3 months after intra-articular infusion of bupivacain (6).

Accumulating data suggest that intra-articular local anesthetic injections should be performed after arthroscopic surgery (7). However, there are also reports supporting the administration of the inatraarticular injection prior to the surgery (8). Variables including timing and local anesthetic dose may also influence the pain control with local anesthetics (9, 10). The placement of hemovac drains into the joint after ACL reconstruction surgery may be another factor affecting the pain control. We hypothesized that postoperative use of the local anesthetic agent when the hemovac drain was closed would provide a prolonged and potent analgesic effect compared to preoperative administration and administration of the local anesthetic agent when the hemovac drain was open.

The aim of this study was to evaluate the impact of the timing of the bupivacaine administration on its analgesic effects in patients undergoing arthroscopic ACL reconstruction surgery. The effects of an open and closed hemovac drain with regard to pain control were also examined.

Materials and Methods

40 patients (mean age 32.8 ± 6.1 (20-45) years, 70% male) underwent ACL reconstruction with hamstring tendon autografts. Patients with previous joint surgery and those who underwent additional incisions for procedures such as ligament repair or reconstruction were not included in this study. Patients with a history of chronic pain, drug or alcohol dependence and those rejecting general anesthesia were also not included in this study. Written informed consent was obtained from all subjects. The study was approved by local ethics committee and was conducted in accordance with the Helsinki declaration.

Power calculations based on our pilot study with 16 patients revealed that at least 42 patients were required for an adequate samples size with an effect size of 0.80, an alpha error of 0.5 and power of 0.80 (11).

Forty patients meeting the inclusion criteria were randomly assigned to one of the four study groups using a randomization software (Figure 1). Preoperative injection group (PO) received bupivacaine injection 20 minutes prior to the operation, Drain Open group (DO) received bupivacaine injection 10 minutes after the operation while the hemovac drain was open, Drain closed group (DC) received bupivacaine injection 10 minutes after the

operation while the hemovac drain was closed for one hour, and the control group did not receive any intraarticular injections.

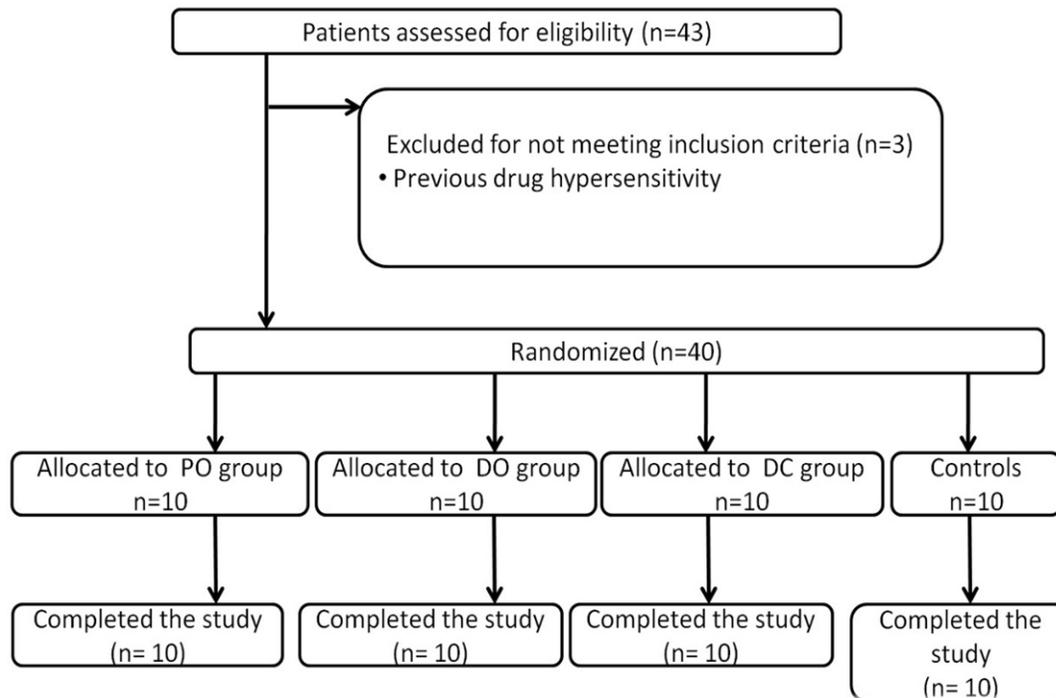


Figure 1. Flow-chart demonstrating patients enrolment.

All patients received a standard general anesthesia protocol. Anesthesia inductions were performed with propofol (1.5 to 2 mg/kg) and maintained with isoflurane. A ten points visual analogue scale (VAS) was used for pain scoring (0 points indicating no pain and 10 points indicating the highest possible pain) (12).

All surgical procedures were performed by the same surgeon using the same methods. Diagnostic arthroscopy was initiated and hemovac drain insertions were performed routinely. All patients were monitored at the recovery room for the first postoperative hour. The closed drain clamps of DC group were opened at the end of the first hour by nurses who were blinded to patient data. After the operation, patient pain scores were recorded at the 1st, 2nd, 4th, 6th, 12th and 24th hours. 75 mg of diclofenac sodium was administered for rescue analgesia.

The difference in Visual Analog Scale (VAS) scores for the joint pain and rescue analgesic requirements were the primary outcome measure of the study.

Statistical analysis

All analyses were performed on SPSS v21 (SPSS Inc., Chicago, IL, USA). Shapiro-Wilk test was used to determine whether variables were distributed normally or not. The homogeneity of variances was assessed with the Levene test. Data are given as median (minimum-maximum) for continuous variables and as frequency (percentage) for categorical variables. Kruskal Wallis test was used for comparison of the groups with respect to the VAS scores. Tamhane's T2 test was employed for posthoc analysis. Pearson chi-square test was used for comparison of the rescue analgesic requirements among the groups. P value of <0.05 was accepted as statistically significant.

Results

Demographic features of the study group are demonstrated in Table 1. The groups were similar with respect to age, gender and comorbide diseases.

Table 2 demonstrated the VAS scores recorded at different time points. The VAS score for postoperative joint pain was lowest in PO group among all groups at the postoperative 2nd hour. At the 4th and the 6th postoperative hours the VAS score for postoperative joint pain was similar in the PO and DC groups and was lower than that of the DO group and the controls. However, the VAS score at the postoperative 12th hour was lower in DO and DC groups that the PO group and the controls. The VAS score for postoperative joint pain was lowest in the DO group at the postoperative 24th hour (Figure 2).

Table 1. Demographic features of the study groups.

	Controls n=10	PO n=10	DO n=10	DC n=10	P value
Age, years	33.4 ± 6.2	34.1 ± 6.1	30.6 ± 6.3	33.1 ± 6.2	0.618
Gender, male (%)	7 (70%)	7 (70%)	7 (70%)	7 (70%)	1.000
Weight, kg	78 ± 9	76 ± 8	78 ± 9	77 ± 10	0.965
Height, cm	171 ± 7	172 ± 6	171 ± 6	168 ± 6	0.673
Diabetes, n	2 (20%)	3 (30%)	3 (30%)	2 (20%)	0.912
Hypertension, n	3 (30%)	4 (40%)	3 (30%)	3 (30%)	0.953

PO = Preoperative injection group, DO = Drain open group, DC = Drain closed group.

Table 2. Comparison of the groups with respect to the postoperative VAS scores.

	Controls n=10	PO n=10	DO n=10	DC n=10	P value
1 st hour VAS	6 (5-7)	5 (4-7)	5.5 (4-7)	6 (5-7)	0.053
2 nd hour VAS	7 (6-8) ^a	3 (2-4) ^b	6.5 (5-8) ^{a,c}	5 (5-7) ^c	<0.001
4 th hour VAS	7.5 (7-8) ^a	4 (2-6) ^b	7 (6-8) ^a	5 (4-7) ^b	<0.001
6 th hour VAS	8 (7-9) ^a	5 (3-7) ^b	7.5 (6-9) ^a	5 (4-7) ^b	<0.001
12 th hour VAS	6 (5-7) ^a	6 (4-8) ^a	3.5 (3-4) ^b	4 (3-6) ^b	<0.001
24 th hour VAS	3 (2-4) ^a	3.5 (3-4) ^a	2 (1-3) ^b	5 (4-6) ^c	<0.001

Data are presented as median (minimum-maximum).The same letter inthe same row denotes the lack of statistical significance between the two groups in posthoc analysis.

PO= Preoperative intraarticular injection, DO= Postoperative intraarticular injection while the hemovac drain was open, DC= Postoperative intraarticular injection while the hemovac drain was closed.

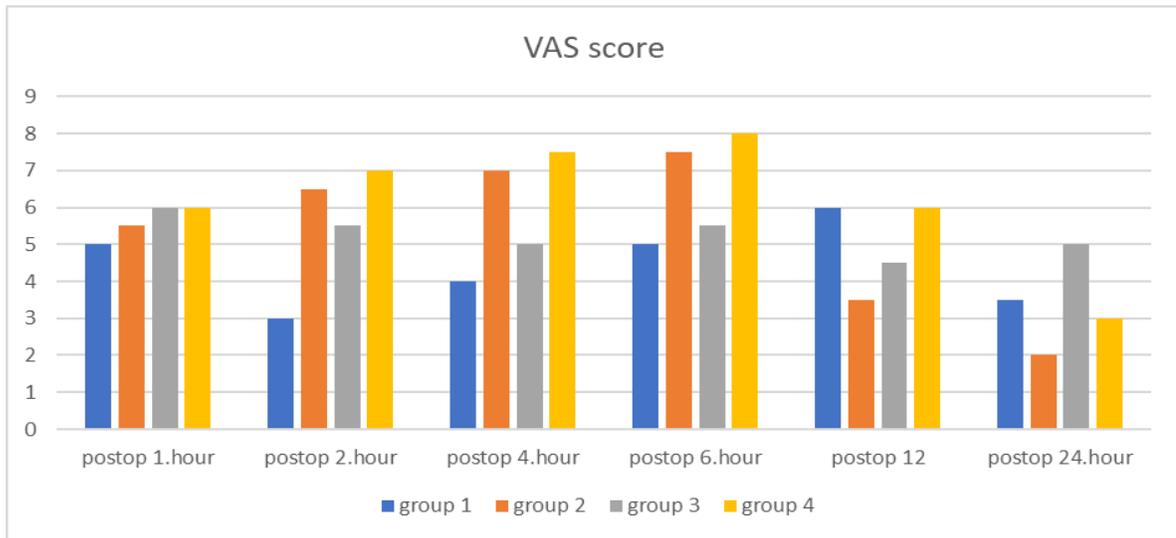


Figure 2. Relationship between postop duration and vas score.

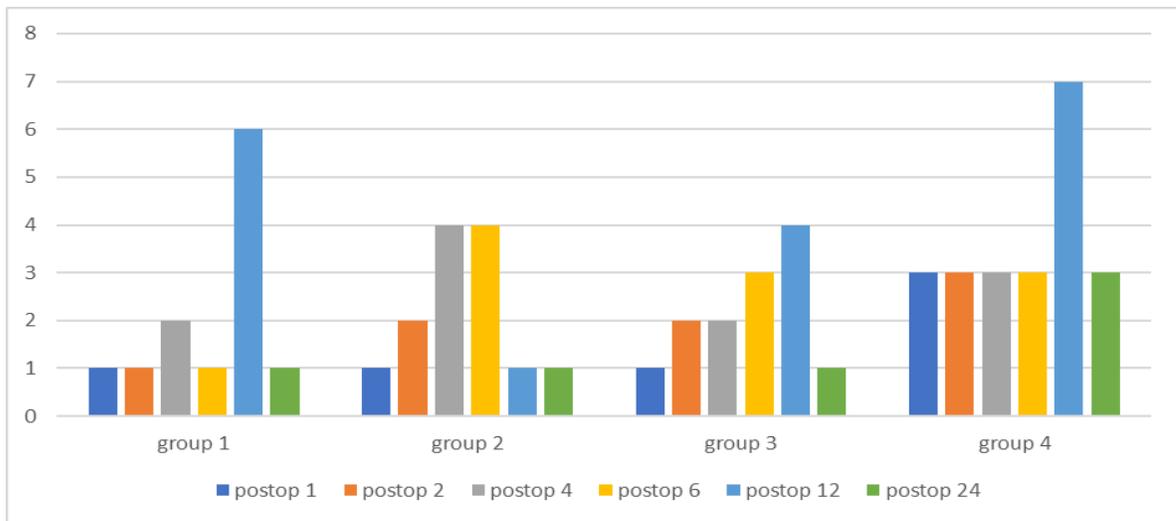


Figure 3. Number of patients requiring rescue analgesic (diclofenac 75 mg iv.). Time to first rescue analgesic administration was shortest in control group and longest in PO group (Figure 3). Total analgesic requirement of the control group was significantly higher than that of the other groups (Figure 4).

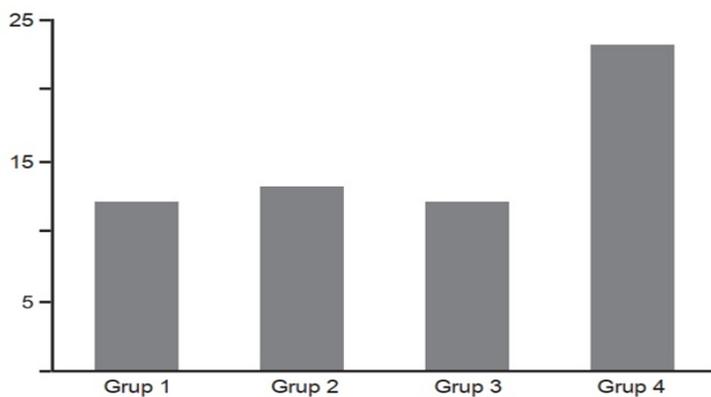


Figure 4. Number of analgesic applications for each group.

Discussion

Our primary finding in the study was that intra-articular bupivacaine injections provided significant analgesic effects early on after arthroscopic anterior cruciate ligament reconstruction and reduced total analgesic consumption. In addition, we found that injection timing and hemovac drain status were associated with the efficacy and duration of the analgesia.

Our findings revealed that intra-articular bupivacaine injections administered 20 minutes before the operation resulted in significantly lower pain scores for up to four hours compared to the control group and other groups that received postoperative bupivacaine injections. After the twelfth hour; however, no long-acting analgesic effect had been achieved as the pain scores were equivalent to those in the control group. Similar findings were reported in the study of Höher et al, which demonstrated that analgesic effect of bupivacaine injections administered before operation was only prominent in the first hours of the postoperative period (1).

In our study we observed that hemovac drains that were closed for one hour affected VAS scores earlier compared to hemovac drains that were left open. The effect of indoor draining was present until the twelfth hour and equalized with the open drain group at the end of the twelfth hour. The VAS score of DC group, where the drain clamp was closed, were higher in the first two hours compared to group PE, who were injected before the operation. The scores equalized at the end of the sixth hour. The same effect was not achieved in the DO group. This finding indicates that drain clamp closure after intra-articular injections was of significant benefit for pain control. This finding is compatible with positive outcomes reported by Guler et al. that indicates improved pain control following the closure of the drain clamp after intra-joint bupivacaine injection (13).

Patients in CG group had the highest VAS score for the postoperative first hour and the earliest analgesic need. Initial analgesic requirements within the first 24 hours showed that although there were differences in the timing of the rescue analgesic, in no group, other than group (CG), was this difference significant. This finding contradicts the results of Heard's 2003 study where he failed to identify a difference in the timing of the first analgesic requirement within the first 24 hours. In that study; however, only knee arthroscopy surgery patients who underwent surgery and experienced a low inflammatory effect were enrolled (14).

Conclusion

Our findings show that post-operation intra-articular injections provide longer term analgesia than pre-operation injections. In addition, bupivacaine injections reduce postoperative VAS scores earlier when clamp is kept closed compared to those with open clamps. Our findings suggest that intra-articular bupivacaine injections in knee surgeries reduce patient discomfort in the postoperative period. Closure of the hemovac drainage may reduce VAS scores the need for rescue analgesics.

Ethics Committee Approval: Yes

Informed Consent: Yes

Peer-review: Externally peer-reviewed.

Conflict of Interest: No conflict of interest was declared by the author.

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