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Do timing of injection and status of the suction drain effect postoperative pain scores after intra-articular bupivacaine injection in arthroscopic ACL reconstruction?

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Objective: The aim of this study was to determine if the timing of intra-articular local anesthetic injection and the status of the suction drain affect variable pain scores after ACL reconstruction.

Methods: The study included 40 patients undergoing arthroscopic ACL reconstruction randomized into 4 groups. Patients in Group 1 received intra-articular 20 ml of 0.25% bupivacaine 20 minutes before the start of the operation (preemptive: PE), Group 2 at the end of the operation with the suction drain opened (DO). Group 3 also received intra-articular bupivacaine at the end of the operation and the drain was kept closed for one hour postoperatively (DC). Group 4 did not receive any intra-articular injection (control group: CG) and served as the control group. Visual analog scale (VAS) scores and additional analgesic requirements were recorded.

Results: The PE group had the lowest and the control group the highest VAS scores at the second postoperative hour. At the fourth postoperative hour, VAS scores were significantly higher in the DC group than the DO group ($p<0.05$). At the sixth postoperative hour, the PE and DC groups had significantly lower VAS scores than the other groups ($p<0.05$). At Hour 12, the PE and control groups had higher VAS scores than the DO and DC groups. VAS scores were not different among groups at Hour 24. The interval to first analgesic requirement was significantly shorter in the control group and longer in the PE group in comparison to the other two groups ($p<0.001$).

Conclusion: Intra-articular bupivacaine injection at different stages of the operation yielded variable VAS scores in the postoperative period. Closing the drain after intra-articular injection resulted in an early onset analgesic effect without shortening the duration.

Key words: ACL reconstruction; bupivacaine; drain; postoperative pain; VAS score.

Anterior cruciate ligament (ACL) reconstruction leads to significant postoperative pain, usually in the first two days after the operation.[1,2] Several methods have been described in the past to reduce the postoperative pain in knee surgery.[3-5]

Local anesthetics have been shown to be effective for analgesia in knees undergoing arthroscopic ACL reconstruction. Among these, bupivacaine is the most commonly used and studied drug.[6] Bupivacaine has relatively high lipophilicity which is responsible for its faster uptake

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into the circulation and its removal from the joint, suggesting that bupivacaine has an immediate onset of action but only a short duration.[7] In addition, bupivacaine is commonly used in arthroscopic surgery due to its continued effectiveness despite subsequent saline inflow.[8]

The toxic effect of bupivacaine on cartilage is one of the major concerns with its use. Evidence on the chondrotoxic effect of bupivacaine has been obtained mainly from in vitro studies and/or animal subjects. While Chu et al. reported that in vitro exposure to 0.5% bupivacaine is cytotoxic to bovine articular chondrocytes, intra-articular bupivacaine has a long clinical history with no apparent detrimental effects and the authors concluded that their results should not be interpreted to mean that 0.5% bupivacaine has harmful clinical effects.[8] Not all studies have reported a relationship between bupivacaine and chondrotoxicity. There was no permanent impairment of cartilage function after three months in an in vivo experiment on rabbits.[9]

Despite the strong laboratory evidence for chondrotoxicity, there is a low incidence of chondrolysis following intra-articular administration of bupivacaine in clinical practice.[10] Bupivacaine, as can be seen in the recent literature, is still one of the most commonly used intra-articular agents for postoperative pain management following arthroscopic surgery.[11-13]

Many investigators have suggested the instillation of local anesthetics into the knee joint at the end of arthroscopic surgery,[1,14] whereas others have recommend the application at the beginning of the surgery (preemptive).[15,16] Some variables including timing of the application1,[17] and dose of the local anesthetic[18] may affect pain control capacity of the local anesthetics. The insertion of a suction drain at the end of ACL reconstruction might be another factor that influences pain control. The efficacy of the local anesthetic applied into the knee joint might decrease due to absorption of the agent by the suction drain.

The aim of this prospective study was to assess the analgesic effect of intra-articular local anesthetic (bupivacaine) applied at different stages of the operation in patients who had undergone arthroscopic ACL reconstruction and to determine whether the status of suction drain was influential on pain control.

Patients and Methods

This study was approved by our Institutional Ethical Committee. Forty patients (mean age: 26.5 years, range: 18 to 36 years) undergoing elective arthroscopic ACL reconstruction with quadruple hamstring tendon autograft were included in the study. Patients undergoing concurrent meniscus resection or repair were included if additional incisions were not made. Conversely, patients having an incision for additional procedures such as repair or reconstruction of other ligaments were excluded. Patients with a history of chronic pain, drug abuse, or alcoholism were also excluded from the study.

A standardized protocol for general anesthesia was followed. Anesthesia was induced with a sleep dose of propofol (1.5 to 2 mg/kg) and maintained with isoflurane in a mixture of 70% nitrous oxide and oxygen. No narcotics were administered intra-operatively. Patients who did not want to be operated under general anesthesia were excluded from the study.

On the day before surgery, all patients were instructed how to use the visual analogue scale (VAS) for pain score assessment[17,19] with 0 and 10 labeled as 'no pain' and 'worst pain imaginable', respectively. After exclusion, 40 consecutive patients were prospectively randomized into four equal groups using a computer-generated list.

Patients in Group 1 – PE (preemptive) (n=10) received 20 ml of 0.25% bupivacaine intra-articularly 20 minutes before starting intra-articular lavage and surgical procedure. Group 2 – DO (drain open) (n=10) received 20 ml of 0.25% bupivacaine intra-articularly at the end of the operation 10 minutes before releasing the tourniquet, at which time the suction drain was opened. Group 3 – DC (drain closed) (n=10) received 20 ml of 0.25% bupivacaine intra-articularly at the end of the operation 10 minutes before releasing the tourniquet. The suction drain was left closed for one hour before it was opened in the Post Anesthesia Care Unit (PACU). Group 4 – CG (control group) (n=10) did not receive any intra-articular local anesthetic.

Surgical procedures were standardized and performed by the same surgeon in all cases. After diagnostic arthroscopy, the hamstring tendon grafts were harvested and prepared as a 'quadruple tendon'. The tibial and femoral tunnels were prepared. After passing through the tunnels, the graft was fixed with EzLoc™ (Biomet, Warsaw, IN, USA) proximally on the femoral site and with an interference screw and a staple distally on the tibial site. A suction drain was inserted at the end of the operation. All patients were kept for one hour in the PACU and the suction drains of the DC group were released by the staff nurse who was unaware of the study at the end of one hour. Pain scores were evaluated at 1st, 2nd, 4th, 6th, 12th and 24th hours after surgery using the VAS. Supplementary analgesic treatment (escape medication) with a single dose of Xefo (lornoxicam) 8 mg/2 ml was administered intravenously on demand. The analgesic

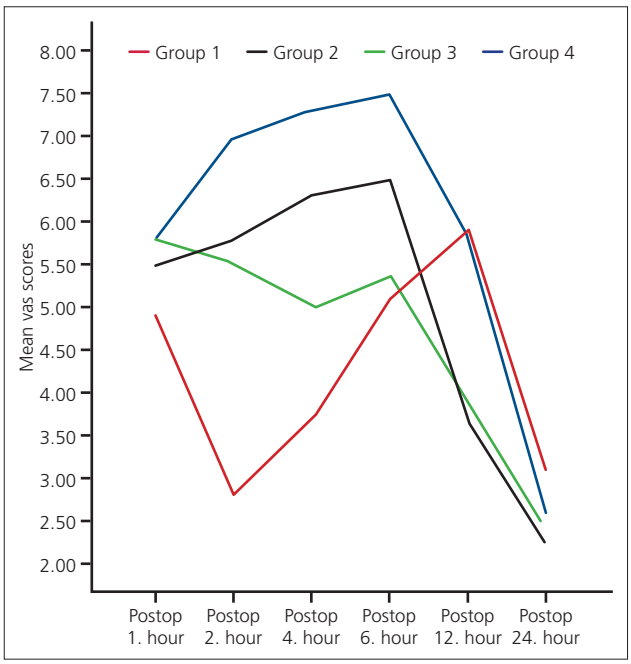

Fig. 1. Alterations in postoperative VAS scores for each group. [Color figure can be viewed in the online issue, which is available at www.aott.org.tr]

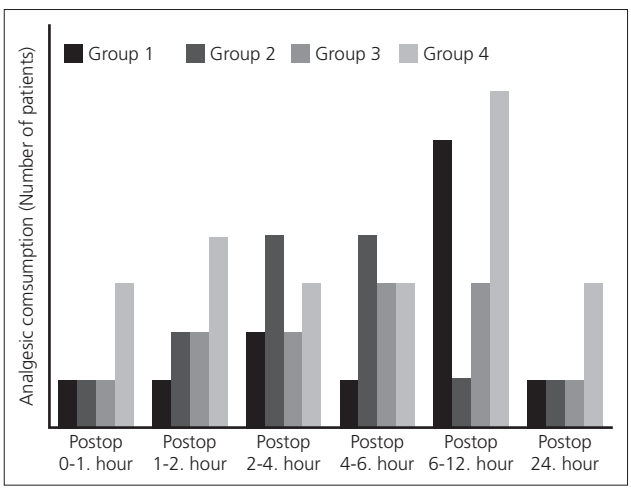

Fig. 2. Postoperative analgesic consumption at different time intervals.

requirements in the 0 to 1, 1 to 2, 2 to 4, 4 to 6, 6 to 12 and 12 to 24 hour intervals were recorded separately and the total analgesic requirement was recorded.

Pain scores, analgesic consumption and time of administration were recorded by an observer blinded to the randomization.

Pain scores were analyzed using one-way ANOVA (analysis of variance). For group comparisons, Tukey's HSD test was utilized. P<0.05 was accepted as the level of significance. *Post hoc* power analysis was performed for each group. Analgesic requirements were analyzed by one-way ANOVA. P<0.001 was accepted as the level of significance.

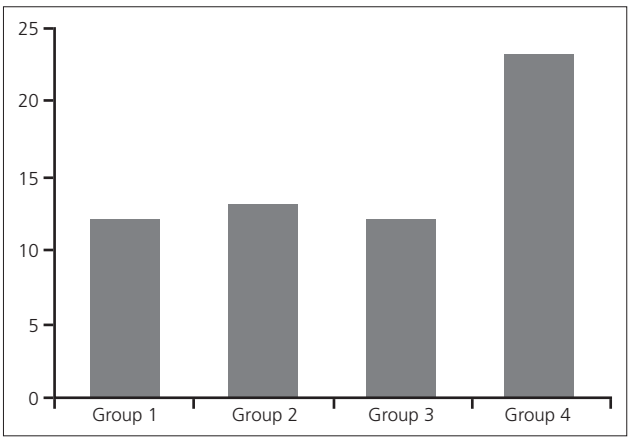

Fig. 3. Total number of analgesic administrations for each patient group.

Results

There was no statistically significant difference in VAS scores among the groups at the first postoperative hour (Fig. 1). At the second postoperative hour, the PE group had significantly lower pain score than the other groups (p<0.05; power=0.99).

At Hour 4, the PE group had the lowest and the CG the highest VAS scores. The DC group had lower VAS scores than the DO group. The difference among the groups were statistically significant (CG>DO>DC>PE) (p<0.05; power=0.99).

At the sixth postoperative hour, the control group had the highest VAS score followed by the DO group. The difference was statistically significant (p<0.05). The PE and DC groups had lower VAS scores with regard to the former groups (CG>DO>DC=PE) (p<0.05; power=0.85).

At Hour 12, the PE and control groups had higher VAS scores than the DC and DO groups. The difference between the paired groups were statistically significant (CG=PE>DC=DO) (p<0.05; power=0.71).

There was no statistically significant difference in pain scores among the groups at the 24th postoperative hour.

The interval to the first analgesic requirement was significantly shorter in the CG (Group 4) and longer in the PE (Group 1) in comparison with the other two groups, between which there was no statistically significant difference (CG<DO=DC<PE) (p<0.001) (Fig. 2).

The total analgesic consumption was higher in the CG in comparison to the other three groups (CG>PE=DO=DC) (p<0.001) (Fig. 3).

Discussion

Our primary finding is that intra-articular bupivacaine provides significant analgesia and decreases total analgesic consumption in the postoperative period after arthroscopic ACL reconstruction. This finding is consistent with those of Chirwa et al.[14] and Smith et al.[18] who demonstrated that 20 ml of 0.25% and 30 ml of 0.5% bupivacaine, respectively, was superior to placebo in analgesia after knee arthroscopy. However, we found that analgesic efficacy and duration showed variations according to the timing of the injection and the status of the drain whether it was closed or left open.

The administration of an intra-articular bupivacaine injection 20 minutes before the start of the operation yielded a significant reduction in pain scores up to four hours after the operation when compared to the control and the postoperative injection groups. However, we were unable to detect a long lasting effect and pain scores of all groups were similar at the 12th hour. This finding is consistent with those of Höher et al. who were unable to show a sustained pain reducing effect of preemptive bupivacaine administration.[1] Saunders and Wing suggested that this limited outcome was due to the washout effect of bupivacaine during arthroscopy with saline irrigation.[20] However, in the current study, the preemptive group had the lowest VAS scores in the early postoperative period despite the washout effect of the surgery. This indicated that 20 minutes was sufficient for tissue binding of the agent. In our opinion, the decreased efficacy of the preoperatively injected bupivacaine after an apparent time is related to the half-life of the injected agent which is approximately six hours.[21]

Closing the suction drain for one hour after the intra-articular bupivacaine injection led to an earlier onset effect on VAS scores in comparison to leaving the drain open. The effect on VAS scores continued in favor of drain closed group until Hour 12, at which time scores converged. Although the drain closed group yielded higher VAS scores at the second postoperative hour in comparison to the preemptive group, its influence reached an equilibrium at Hour 6. Scores in the drain open group were not higher at the sixth postoperative hour, showing the obvious beneficial effect of closing the drain after intra-articular injection. This finding is in accordance with Güler et al.[22] who also showed the beneficial effect of drain closure after intra-articular bupivacaine injection. However, their study was unable to clearly detect the effect of drain closure on VAS scores due to the lack of a control group and comparison of VAS scores after intra-articular bupivacaine injection before tourniquet release with those after tourniquet release with closed drain. Güler et al. recorded average pain scores in their two groups lower than those of our study groups.[22] This difference was most likely related to the higher dose of 0.25% bupivacaine of 40 ml applied in their study. This is in agreement with Smith et al. who advocated a lower postoperative opioid medication requirement with higher doses of bupivacaine.[18]

The interval between surgery and the first required analgesic administration is closely related with VAS scores. The VAS score was highest in the control group at postoperative Hour 1 and this group had the shortest interval to the first analgesic requirement. Twenty percent of patients who received postoperative bupivacaine required the first analgesic between the first and second postoperative hour, which demonstrated a relation with the VAS scores. In the preemptive group, 75% of the patients required their first analgesia between Hours 6 and 12, the same time in which their VAS score reached those of the control group. The correlation with the first analgesic requirement and VAS scores was in accordance with the findings of Khoury et al.[23]

Although there were variations in the first analgesic requirement between the groups, there were no significant differences in the total 24-hour period, with the exception of the control group. This finding is at odds with the data of Heard et al.[4] who did not find a difference in total analgesic consumption throughout the 24-hour period between the control group and the groups injected with intra-articular bupivacaine or morphine. However, their study was performed on patients undergoing knee arthroscopy which can be defined as a 'low inflammatory' surgical intervention group.[24] This difference may be explained by the fact that arthroscopic ACL reconstruction is in the 'high inflammatory' surgical intervention category.

In conclusion, intra-articular bupivacaine injections yielded a positive effect on postoperative pain scores in arthroscopic ACL reconstruction. However, efficacy differed according to the timing and the status of the suction drain. Preemptive injection yielded the earliest affirmative effect on VAS scores and continued for six hours postoperatively. Postoperative local anesthetic injection had a longer efficacy in comparison to preemptive injection. In addition, closing of the drain after bupivacaine injection yielded an earlier onset effect on VAS scores compared with leaving the suction drain open. In knee surgery, closing the drain after intra-articular bupivacaine injection enables the patient a more comfortable postoperative period by decreasing VAS scores earlier and prolonging the analgesic effect of the agent.

Conflics of Interest: No conflicts declared.

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