

Comparing the Effectiveness of Intra-Articular Injection of Bupivacaine, Dexmedetomidine versus 0.9% Saline on Pain Control after Arthroscopic Anterior Cruciate Ligament Reconstruction

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Abstract

Background: In different ways, drugs are administered to reduce postoperative analgesia after arthroscopic anterior cruciate ligament (ACL) reconstruction. The purpose of this study is to compare the dexmedetomidine (DEX) intra-articular injection with bupivacaine hydrochloride and sterile 0.9% saline administration following arthroscopic ACL reconstruction.

Methods: Sixty cases who underwent ACL reconstruction were randomly divided into three groups. The first group received intra-articular DEX; the second group received intra-articular bupivacaine, and the final group received intra-articular 0.9% saline. Postoperative pain was measured by Visual Analogue Scale (VAS).

Results: The mean VAS scores at 6 and 24 hours after surgery were lower in the bupivacaine group, compared to the other groups. Pain was more severe in the control group (0.9% saline), with higher VAS scores reported at 1, 6, and 24 hours after surgery.

Conclusion: Bupivacaine has more significant effects than DEX in postoperative pain management after arthroscopic ACL reconstruction.

Keywords: Intra-Articular Injections; Postoperative Pain; Arthroscopy; Anterior Cruciate Ligament Reconstruction; Bupivacaine; Dexmedetomidine

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Background

Anterior cruciate ligament (ACL) injury has shown to be one of the most common and serious knee injuries (1). Today, arthroscopic ACL reconstruction is frequently performed (2). Postsurgical pain management is one of the surgeon's priorities, as reduced postoperative pain can increase the patient's mobility and improve rehabilitation and recovery (3-9). Several mechanisms have been used to induce analgesia following arthroscopic operations. Systemic medications like non-steroidal anti-inflammatory drugs (NSAIDs), central and peripheral nerve blocks, and intra-articular injection of various medications have been recommended. Multiple studies have assessed the efficacy of intra-articular local anesthetics and reported variable outcomes (5, 10-12).

Intravenous (IV) dexmedetomidine (DEX) is used frequently for inducing analgesia (2, 4, 6, 13), which is a selective α_2 adrenergic receptor agonist that can exert sedative, analgesic, anxiolytic, and sympatholytic effects (12, 13).

Evidence suggests that intra-articular injection of DEX has an effective role in postoperative pain control after knee arthroscopy (2, 4).

On the other hand, bupivacaine is one of the most common local anesthetics used during orthopedic surgery, that inhibits N-methyl-D-aspartate (NMDA) receptor currents, so increasing the possibility that this

function justifies for some of its specific clinical effects for pain relief (3, 8). Recent studies have suggested that intra-articular bupivacaine can be given in joint surgery postoperative pain management (3, 5, 8).

The present study aimed to compare the DEX intra-articular injection with bupivacaine hydrochloride and 0.9% saline administration following arthroscopic ACL reconstruction.

Methods

A total of sixty cases underwent ACL reconstruction in summer and autumn 2019 in Taleghani Hospital, Tehran, Iran. This research was approved by the Ethics Committee of Shahid Beheshti University of Medical Sciences, Tehran (IR.SBMU.REC.1398.076) and the written consent was obtained from all patients. The following inclusion criteria were considered: 1) the age range of 20-50 years, 2) willingness for participation in the study, 3) being a candidate for the arthroscopic reconstruction of isolated ACL injury, and 4) being types I and II of the American Society of Anesthesiologists (ASA) classification. The exclusion criteria included any medical diseases with contraindications for local anesthetics, drug abuse, and associated injuries besides ACL tear.

Before the study, all patients were informed about the Visual Analogue Scale (VAS), in which 0 score represents

“lack of pain”, and 10 indicates “unbearable pain”. All cases received spinal anesthesia according to the Standard Institute protocols. Under aseptic conditions in a lateral position, the patients received a 10 ml/kg crystalloid preload, followed by 3 ml of bupivacaine 0.5% (spinal anesthesia). Arthroscopic ACL reconstruction based on the transfemoral technique was performed for all patients. A hamstring autograft was used for this purpose. Femoral fixation was achieved by end button and a bioabsorbable interference screw was used for the tibial fixation.

The cases were randomly divided into three groups via simple random sampling. The first group (20 patients) received 20 cc of intra-articular DEX (0.5 mcg/kg) plus 5% hyper saline, the second group (20 patients) received 20 cc of intra-articular 0.25% bupivacaine, and the final group (control group, 20 patients) received the same volume of intra-articular 0.9% saline.

Both surgeon and data analyzer were blinded to the random assignment. The anesthesiologist was responsible for allocating patients and delivering the unlabeled preloaded syringes to the surgeon. The intra-articular injections were administered based on the aseptic technique through the anterolateral port site and graft-harvested site, right before skin closure. After 10 minutes, the tourniquet was gradually deflated. A compression bandage was applied along with an additional crepe bandage on top. The knee was immobilized with a knee brace.

After the surgery, pethidine was administered intramuscularly, and continuously by injecting 1 mg/kg three times daily, if needed. Patients' postoperative pain was assessed after 1, 6, 12, and 24 hours based on VAS (range: 0-10) by an orthopedic resident blinded to the study groups.

Statistical analyses were done with SPSS software (version 24.0, IBM Corporation, Armonk, NY). Continuous variables such as age, weight, tourniquet duration, duration of surgery, and VAS pain score were compared by Kruskal-Wallis test between the three groups. Categorical variables such as gender and narcotic requirement were analyzed with chi-square contingency tables.

Results

In this study, sixty patients participated. There was no significant difference on groups regarding age, gender, or weight. The three groups showed no significant difference in terms of tourniquet time or length of surgery. A significant difference was found in the VAS score in all three groups between the three time points (1, 6, and 24

hours). In all three groups, VAS score was the highest in the first hour and reached the minimum level after 24 hours. The mean VAS score at first hour was significantly lower in the bupivacaine group than the DEX and control groups. In addition, the mean VAS scores at the 6 and 24 hours after surgery were lower in the bupivacaine group, compared to the other groups. However, our measurements showed no significant difference among the groups at 6 and 24 hours post-surgery. The pain was more severe in the control group, with higher VAS scores reported at 1, 6, and 24 hours post-surgery (Figure 1). Regarding the control subjects, 13 out of 20 cases (65%) showed narcotic requirement for pain management, while it was 3 out of 20 (15%) in bupivacaine group and 8 out of 20 (40%) in the DEX group. These differences were statistically significant among groups (Table 1). We found no adverse effects of drugs like nausea, vomiting, headache, and skin scratching in the studied groups.

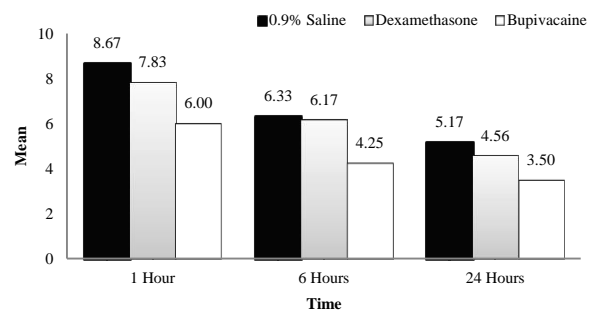


Figure 1. Visual Analogue Scale (VAS) between groups at various time points

Discussion

Various methods of postoperative analgesia have been employed following knee arthroscopy. Intra-articular drug administration has shown to be one of the best and simplest techniques for pain relief following arthroscopic knee surgery, which facilitates early ambulation of patients (5, 14). In the present research, the pain-relieving effect of intra-articular DEX injection was compared with bupivacaine and 0.9% saline after arthroscopic ACL reconstruction. We observed better outcomes in the bupivacaine group, compared to the other groups at 24 hours postoperatively. DEX intra-articular injection reduced narcotic use after surgery, like analgesics, and also increased the duration of analgesic effect.

Table 1. Summary of patient characteristics and findings

Groups		Dexamethasone	Bupivacaine	Hyper saline	P-value
Gender	Male	13 (65)	12 (60)	11 (55)	0.812
	Female	7 (35)	8 (40)	9 (45)	
Age (year)		31.20 ± 6.96	30.00 ± 6.80	30.90 ± 6.90	0.842
Weight (kg)		75.62 ± 13.00	76.20 ± 13.20	76.10 ± 14.20	0.990
Tourniquet duration (minute)		91.20 ± 5.82	95.20 ± 7.34	98.70 ± 7.93	0.011*
Duration of surgery (minute)		101.20 ± 5.82	105.20 ± 7.34	108.70 ± 7.93	0.011*
Narcotic requirement	No	12 (60)	17 (85)	7 (35)	0.005*
	Yes	8 (40)	3 (15)	13 (65)	
VAS		3.50 ± 1.10	3.10 ± 1.25	3.90 ± 1.02	0.129

Data are presented as mean ± standard deviation (SD) or number (percentage)

*Significant at 0.05 level

VAS: Visual Analogue Scale

Sivapurapu et al. determined a group of analgesics, which can be administered intra-articularly to induce a longer analgesic effect with higher quality among cases receiving arthroscopic ACL repair using spinal anesthesia. The intra-articular injection of combined bupivacaine and clonidine provided a longer period of postoperative analgesia. However, analgesia quality was comparable between this group and the groups receiving a combination of bupivacaine and morphine, and bupivacaine alone (9).

Alipour et al. evaluated the pain relief caused by DEX intra-articular injection after knee arthroscopy. Intra-articular injection of DEX after arthroscopic knee surgery alleviated pain in the patients, reduced narcotic requirement after surgery, and increased the time to the first analgesic use (15). In a systematic review and meta-analysis article, Peng et al. evaluated the analgesic effects induced by intra-articular DEX. In arthroscopic knee surgery, intra-articular DEX or combined DEX and local anesthetic increased the time to the first analgesic request after surgery when compared to the saline or local anesthetics alone (16).

In a study by Al-Metwalli et al., the effect of intra-articular DEX on pain relief after arthroscopic knee surgery was evaluated. The results showed that intra-articular DEX increased postoperative pain relief and the time to the first analgesic request, whereas the postoperative analgesia requirement decreased (17).

What distinguishes our study from others is comparison of the effects of intra-articular DEX with bupivacaine for the first time. Also, we assumed that the pain-relieving effect of intra-articular DEX was greater than that of bupivacaine due to older studies. However, our hypothesis was rejected, and our results showed that intra-articular injection of bupivacaine had better efficacy in reducing postoperative pain.

There were two major limitations in this study that could be addressed in future research. The first drawback to this study was the limited number of cases in each group, and the second one was using VAS questionnaire for evaluation of postoperative pain. Further studies with larger sample size and more complete questionnaire can establish current study statement.

Conclusion

Bupivacaine has more significant effects than DEX in reducing postoperative pain after arthroscopic ACL reconstruction. Therefore, intra-articular injection of DEX alone does not seem to be adequate for controlling post-arthroscopic ACL reconstruction pain.

Conflict of Interest

The authors declare no conflict of interest in this study.

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