Efficacy of intraarticular dexamethasone for postoperative analgesia after arthroscopic knee surgery

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Abstract

Background and Aims: In an attempt to improve the recovery and early rehabilitation after arthroscopic knee surgery, various medications have been administered via intra-articular route to prolong the duration and improve the quality of postoperative analgesia. Among the potentially effective substances, steroids like dexamethasone could be of particular interest.

Materials and Methods: Fifty patients undergoing elective knee arthroscopy were randomly assigned to one of the following groups containing 25 patients each. Group D patients received 8 mg (2 mL) of dexamethasone added to 18 mL of 0.25% levobupivacaine intra-articularly, (total volume 20 mL). Group L patients received 18 mL of 0.25% levobupivacaine and 2 mL of isotonic saline (20 mL in total) intra-articularly. Analgesic effect was evaluated by measuring pain intensity visual analogue scale score and duration of analgesia.

Results: A longer delay was observed between intra-articular injection of study medication and first requirement of supplementary analgesic in Group D (10.24 ± 2.8 hours) compared with Group L (5.48 ± 1.6 h). Total consumption of diclofenac sodium in first 24 h in postoperative period was significantly less in Group D. No significant side effects were noted.

Conclusion: Dexamethasone, used as adjunct to levobupivacaine in patients undergoing arthroscopic knee surgery, improves the quality and prolongs the duration of postoperative analgesia.

Key words: Arthroscopic knee surgery, dexamethasone, intraarticular injection, levobupivacaine

Introduction

Good-quality postoperative analgesia is essential for early rehabilitation after arthroscopic knee surgery. Local anesthetics like lidocaine[1] and bupivacaine,[2] opioids like morphine,[3] alpha2 adrenoceptor agonists like clonidine,[4] dexmedetomidine,[3] and magnesium sulphate[5] have all been tried intra-articularly either as sole agents or in combination, to provide effective postoperative analgesia.

Dexamethasone is potent and highly selective glucocorticoid with minimal mineralocorticoid effect. It blocks the nociceptive impulse transmission along the myelinated C fibers.[7] Studies have shown that dexamethasone increases the duration of regional blocks, when combined with local anesthetics.[8,9] Therefore, it is expected that such a beneficial effect of dexamethasone can be manifested when it is injected in combination with levobupivacaine to intra-articular spaces.

This placebo-controlled, double-blind, prospective study is designed to assess the efficacy of intra-articular dexamethasone administered as adjuvant to local anesthetic levobupivacaine in patients undergoing arthroscopic knee surgery.

Materials and Methods

The study protocol was approved by the institutional ethical committee and informed consent was obtained from every patient. Fifty ASA I-II patients of either sex, aged 18-65 years, undergoing elective knee arthroscopy were randomly assigned to one of the two groups using computer-generated random numbers comprising of 25 patients each. Before performing the study, we hypothesized that the beneficial effect of levobupivacaine alone (in terms of prolonged analgesia) will be evident in at least 25% of the patients, after reviewing
related articles and our experience. Considering an absolute improvement in the primary outcome by 40% (by the addition of dexamethasone) in the study group can be considered as clinically relevant and based on a Type I error level of 0.05, Type II error level of 0.2, and a two-sided test, we needed 21 patients in each treatment groups. Therefore, to account for probable drop outs, a number of 25 patients in each group was proposed.

Surgical procedures mainly consisted of meniscectomy and ligament repair. Patients having history of cardiovascular, cerebrovascular, and respiratory diseases, pregnancy, receiving chronic pain treatment, diabetes, and acid peptic disease were excluded from the study. On preoperative rounds, patients were explained regarding the procedure and were also taught to interpret the visual analogue scale (VAS) (graded from 0 = no pain to 10 = maximum pain).

All patients were given tab. diazepam 10 mg and tab. ranitidine 150 mg orally on the night before surgery and tab. ranitidine was repeated on the day of surgery 2 h before induction with sips of water. On the operation table, routine monitoring (electrocardiography, pulse oximetry, noninvasive blood pressure) was started and baseline vital parameters like heart rate (HR), blood pressure (systolic, diastolic, and mean), and arterial oxygen saturation (SpO₂) were recorded. An intravenous line was secured.

After preoxygenation for 3 min, induction of anesthesia was done by fentanyl 2 μg/kg and propofol 2 mg/kg intravenously (i.v.). Trachea was intubated with appropriate size endotracheal tube after muscle relaxation with vecuronium bromide in a dose of 0.08 mg/kg i.v. Anesthesia was maintained with 33% oxygen in nitrous oxide and isoflurane was adjusted to maintain a minimum alveolar concentration (MAC) of 0.7. Muscle relaxation was maintained by intermittent bolus doses of vecuronium bromide. The patients were mechanically ventilated to keep EtCO₂ between 35 and 40 mm Hg. Patients received top-up of i.v. fentanyl (1μg/kg) at 1 hourly interval. HR and mean arterial pressure were maintained within 20% of baseline value by giving additional bolus dose of fentanyl 25 μg and propofol 10 mg i.v. Patients were randomly allocated using a computer-generated randomization list into two groups (n = 25). Prefilled syringes were prepared with either levobupivacaine and saline or levobupivacaine and dexamethasone and kept in number coded sealed envelopes, made sterile by Sterrad Sterilization Machine. The anaesthesiologist and surgeon were unaware of the nature of the drug in each syringe. At the end of the operation, ondansetron 4 mg was administered i.v. for prophylaxis against nausea and vomiting. Residual neuromuscular paralysis was reversed using intravenous glycopyrrolate and neostigmine and subsequently extubation was done. All patients were observed postoperatively by resident doctors who were unaware of the study group. Patients were transferred to postanesthesia care unit and intensity of pain and vital parameters were assessed after 30 min and then an hourly interval for 24 h. Diclofenac sodium (75 mg) was administered i.v. as analgesic supplement if the recorded VAS pain score was 4 or more and was repeated every 8 h, if required. Tramadol 100 mg i.v. was used as a rescue analgesic, if the patients continued to have pain after diclofenac administration. The time to the first analgesic requirement and the total diclofenac consumption during first 24 h after operation were also recorded.

Statistical analysis

The primary outcome variable in the study was the duration of analgesia following the surgery and the secondary outcome variables were total diclofenac consumption and the requirement of rescue analgesic between the study groups.

The numerical data were expressed as mean ± standard deviation (SD). Student’s t-test was employed to calculate the statistical differences in continuous variables between the groups, categorical variables were compared with chi-square test(or Fisher’s exact test; as applicable). A “P” value of <0.05 was considered to be statistically significant. SSPS; version 16.0 (SPSS, Chicago, IL, USA) was used for analysis.

Results

The two groups were comparable with regard to age, sex, body weight, and duration of surgery [Table 1]. The groups were also comparable regarding fentanyl and propofol consumption during intraoperative period (P > 0.05) [Table 2]. Intensity of pain was significantly less in Group D compared with Group L upto 9 h following surgery. However, from 10 h, intensity of pain was comparable in both groups [Table 3, Figure 1].

| Variables/groups | Group L (n = 25) | Group D (n = 25) | P value |
|------------------|-----------------|-----------------|---------|
| Age (year)       | 41.8±10.6       | 43.4±11.8       | 0.47    |
| Sex (M/F)        | 20/5            | 18/7            |         |
| Weight (kg)      | 55.35±10.84     | 56.6±10.48      | 0.54    |
| Duration of surgery (min) | 78.42±18.8 | 80.8±20.6      | 0.63    |

Similarly Group D patients received 8 mg dexamethasone (2 mL) added to 18 mL 0.25% levobupivacaine (again making a volume of 20 mL).

At the end of the operation, ondansetron 4 mg was administered i.v. for prophylaxis against nausea and vomiting. Residual neuromuscular paralysis was reversed using intravenous glycopyrrolate and neostigmine and subsequently extubation was done. All patients were observed postoperatively by resident doctors who were unaware of the study group. Patients were transferred to postanesthesia care unit and intensity of pain and vital parameters were assessed after 30 min and then an hourly interval for 24 h. Diclofenac sodium (75 mg) was administered i.v. as analgesic supplement if the recorded VAS pain score was 4 or more and was repeated every 8 h, if required. Tramadol 100 mg i.v. was used as a rescue analgesic, if the patients continued to have pain after diclofenac administration. The time to the first analgesic requirement and the total diclofenac consumption during first 24 h after operation were also recorded.

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The mean duration of analgesia (delay between the intraarticular injection and the first postoperative analgesic demand) was longer in Group D compared with Group L (10.24 ± 2.8 h vs. 5.48 ± 1.6 h; mean ± SD; P < 0.01) [Table 4]. Total diclofenac consumption in first 24 h was significantly less in Group D compared with Group L (P < 0.01) [Table 4]. None of the patients received tramadol. Arterial pressure and HR did not change significantly.

Discussion

In an attempt to improve the recovery and early rehabilitation after arthroscopic knee surgery, research has been directed toward developing newer techniques for postoperative analgesia.

Dexamethasone a 9α-derivative synthetic glucocorticoid was selected because of its highly potent anti-inflammatory property with minimal mineralocorticoid activity, thus found to be safer and devoid of potential side effects. Steroids have block prolonging effect according to their anti-inflammatory potency.[7] Local anesthetic agents can provide analgesia for limited period of time when used as single injection.

As steroids block the transmission of impulse in nociceptive C fibers,[8,9] we were interested in determining whether dexamethasone might prolong the duration of analgesia when administered intra-articularly along with local anesthetic agents. Dexamethasone is a powerful and predominantly anti-inflammatory steroid. So, it prolongs the action of local anesthetics when used together.[7] Few preliminary studies[9,10] reported that steroids significantly prolong the duration of analgesia in extremity nerve blocks. Dexamethasone has been reported to result in significant prolongation of supraclavicular brachial plexus block when added as an adjuvant to local anesthetic bupivacaine.[10] We assumed the similar probable mechanism regarding dexamethasone and levobupivacaine combination as bupivacaine and levobupivacaine were comparable regarding quality and duration of blockade when used in three-in-one blocks in a study by Urbanek et al.[11] The dense and prolonged block in the dexamethasone group is due to the synergistic action with local anesthetic levobupivacaine on blockade of nerve fibers.[7] The block prolonging effect of dexamethasone is due to its local action,
not a systemic one.\textsuperscript{12,13} It has been found that this effect of steroid is mediated via steroid receptors.\textsuperscript{14} When steroids alone were used in regional blocks, the blockade is not produced. Steroids might bring about this effect by altering the function of potassium channels in excitable cells.\textsuperscript{15}

The delay between intra-articular injection of levobupivacaine with dexamethasone and supplementary analgesic administration was 10.24 ± 2.8 h in our study. We could not find studies using dexamethasone with levobupivacaine intraarticularly for prolongation of postoperative analgesia after arthroscopic knee surgery. In a study performed by Paul et al.,\textsuperscript{4} it was found that time period for first analgesic request for intra-articular bupivacaine and magnesium sulphate combination was 12.32 ± 2.8 h, intra-articular bupivacaine and clonidine was 10.16 ± 2.4 h. In another study by Paul et al.,\textsuperscript{5} time for first analgesic request for intra-articular dexmedetomidine in combination with ropivacaine was 10.84 ± 2.6 h. It seems that dexamethasone administered as adjuvant to levobupivacaine was able to provide analgesia which was comparable to other intra-articular agents used in previous similar studies.

**Conclusions**

Dexamethasone administered intra-articularly as an adjuvant to local anesthetic levobupivacaine improves the quality and duration of postoperative analgesia and reduces the consumption of diclofenac sodium in patients undergoing elective knee arthroscopy.

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