The Effect of Preemptive Ankle Block using Ropivacaine and Dexamethasone on Postoperative Analgesia in Foot Surgery

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Abstract

Background: Peripheral nerve blocks have become an increasingly popular form of anesthesia. Preemptive analgesia reduces central sensitization, postoperative pain, and analgesic consumption. Different additive has been used to prolong regional blockade and improve postoperative analgesia. Aim: This study was conducted to evaluate whether preemptive ankle block using combination of ropivacaine and dexamethasone would succeed in improving the postoperative analgesia after foot surgery in patients receiving general anesthesia. Study Design: Randomized double-blind clinical trial. Patients and Methods: The study was done on forty American Society of Anesthesiologists physical Status I and II, patients undergoing elective forefoot and midfoot surgery under general anesthesia after written informed consent and Ethical Committee approval, general anesthesia was induced as usual, the patients were breathing spontaneously, laryngeal mask airway was inserted, and anesthesia was maintained using inhalational anesthetic. Ankle block was performed before surgery using 20 ml containing 18 ml ropivacaine 0.75% and 2 ml containing 8 mg dexamethasone in Group I and 20 ml containing 18 ropivacaine 0.75% plus 2 ml normal saline in Group II. Evaluation of ankle block was performed by testing the motor response to electric nerve stimulation of both the posterior tibial nerve and the deep peroneal nerve. The absence of any motor responses indicated success of the block. Surgery was started in 30 min after the block. After recovery from anesthesia, the following was measured, visual analog score at 1, 4, 6, 12, and 24 h, the time to the first rescue analgesic, the analgesic requirements, and any side effects. Statistical Analysis: Data were presented as means (standard deviation). Mann–Whitney U-test were used for continuous data. Student’s t-test was used for normal distributed data. Results: Patients were similar as regard to demographic data, type, and duration of surgery. Pain intensity was significantly lower in dexamethasone group ($P < 0.05$). Time to first rescue analgesic was prolonged in dexamethasone group (110 ± 3.3 min vs. 66 ± 7.9 min; $P = 0.001$) The analgesic consumption was significantly lower in dexamethasone group. The complication was minor and self-controlled in both groups. Conclusion: The addition of dexamethasone to ropivacaine improved preemptive ankle block analgesia by decreasing postoperative pain intensity and analgesic consumption with minimal postoperative complication.

Keywords: Ankle block, dexamethasone, preemptive analgesia, ropivacaine

Introduction

Local anesthesia (LA) offers many benefits either performed under monitored anesthetic care or general anesthesia. LA provides patients safety and analgesia, control intraoperative and postoperative pain, and decrease demand of intravenous sedation.\(^1\) Preemptive analgesia is defined as a treatment that is initiated before surgery to prevent the establishment of central sensitization evoked by the incisional and inflammatory injuries occurring during surgery and in the early postoperative period.\(^2\) As a consequence, preemptive analgesia can reduce immediate postoperative pain and also prevent the development of chronic pain by decreasing the altered central sensory processing.\(^3\) Local anesthetic adjuncts such as opioid, tramadol, clonidine, and neostigmine have been studied previously in an attempt to prolong the duration of analgesia after peripheral nerve block with varying degree of success.\(^4-6\) A preliminary human studies investigating the analgesic efficacy of dexamethasone added to local anesthetic agent has been encouraging.\(^7,8\) We hypothesized that the addition of dexamethasone 8 mg to ropivacaine would prolong the duration of analgesia and decrease postoperative nausea.

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and vomiting after ankle block in patients undergoing foot surgery.

Patients and Methods

This study was performed at university hospitals from June 2015 to December 2015 after approval from the local Institutional Ethical Committee and obtaining written informed consent form the patients. Forty patients American Society of Anesthesiologists physical Status I and II undergoing elective foot surgery were involved in this study. The exclusion criteria were uncontrolled diabetes, liver and renal diseases, peptic ulcer, circulatory instability, hemostatic disorders, infection or edema at the site of block, and hypersensitivity to local anesthetics. Patients were randomly divided using the closed envelope technique into two groups, twenty patients each. Group assignment was performed by a nurse who did not share in the study. Observation and follow-up of the groups were performed by blinded specialists. Group I (ropivacaine group) received local injection of 20 ml of ropivacaine 0.75% (18 ml) and 2 ml normal saline, and Group II (dexamethasone group) received local injection of 18 ml of ropivacaine 0.75% plus 2 ml of 8 mg dexamethasone. On arrival to the operating room, an intravenous line was inserted, intravenous Ringer solution was infused, and routine patients’ monitors were attached in the form of pulse oximetry, electrocardiogram, and noninvasive blood pressure. Because a great number of our patients refused any awake needle injection, all patients received the same technique of general anesthesia. Laryngeal mask airway was inserted under the deep plane of anesthesia without the use of muscle relaxant and the patients were left to breathe spontaneously. Anesthesia was maintained using inhalational anesthetic and increments of fentanyl 50 μg to keep stable hemodynamics and optimum depth of anesthesia. The entire foot was cleaned with disinfectant, and block of the two deep nerves was started first because subcutaneous injection of superficial nerves deforms the anatomy. The block was done as following:

1. Deep peroneal nerve block: A finger was positioned in the groove just lateral to extensor hallucis longus, the needle was inserted under the skin and advanced until stopped by bone, at this point, the needle was withdrawn back 1–2 cm and 3–4 ml of solution were injected
2. The posterior tibial nerve was anesthetized by injection just behind the medial malleolus. The needle was inserted in the groove behind the medial malleolus and advanced until contacted the bone, then withdrawn 1–2 cm and 3–4 ml of solution were injected
3. The three superficial nerves (superficial peroneal, sural, and saphenous nerves) were blocked using simple circumferential injection of solution subcutaneously. The three nerves are cutaneous extensions of the sciatic and femoral nerves. Because they are positioned superficially to the deep fascia, an injection of local anesthetic in the territory through which they descend to the distal foot is adequate to achieve their blockade. To block the saphenous nerve, a 1.5 inch, 25-gauge needle was inserted at the level of medial malleolus and a “ring” of local anesthetic is raised from the point of needle entry to the Achilles tendon and anteriorly to the tibial ridge. This was performed with one or two needles insertion; 4 ml of local anesthetic suffices. To block the superficial peroneal nerve, the needle was inserted at the tibial ridge and extended toward the lateral malleolus. Four millilitre of local anesthetic were injected subcutaneously. To block the sural nerve, the needle was inserted at the level of the lateral malleolus, and the local anesthetic was injected toward the Achilles tendon. Four milliliter of local anesthetic was deposited in a circular fashion to raise a skin “wheat.”

Evaluation of the nerve block under anesthesia depends on eliciting the motor response to electric nerve stimulation, and this was present here in stimulation of the posterior tibial nerve and the deep peroneal nerves which have sensory and motor fibers. The tibial nerve is located posterior to the posterior tibial artery at the level of the medial malleolus. The artery was palpated, and the needle was inserted posterior to the artery. The deep peroneal nerve runs lateral to the dorsalis pedis artery at the level of the foot, the needle was inserted lateral to the artery and nerve stimulation was performed with an electric current of 0.5 mA of 2 Hz frequency and 100 ms pulse width. The absence of all motor responses to electric nerve stimulation indicated success of the block.

Surgery was started in 30 min after the block. After recovery from anesthesia and shift to the recovery room, patient-controlled analgesia was started when the patient was fully awake; it was in the form of 1 mg morphine delivered in response to the patient request with a lockout time of 15 min without background morphine infusion. No other rescue analgesics were given. The following were measured by an observer who was blinded to the group of patients and material used:

- Visual analog score at 1, 2, 4, 12, and 24 h
- The time to first rescue analgesic
- The analgesic requirements (total dose of morphine was calculated at 2, 4, 6, 12, and 24 h)
- Side effects (nausea, vomiting, numbness, tingling, and bruising) were recorded.

Statistical analysis

It was performed using (SPSS, version 15, SPSS Inc., Chicago, USA). Data were presented as means (standard deviation). Mann–Whitney U-test were used for continuous data. Student’s t-test are used for normal distributed data. In all cases, $P<0.05$ was considered statistically significant.

Epi Info program (Opensource.org, version 3.03a, Emory University, Atlanta, USA) was used for sample size calculation using the analgesic consumption as the primary outcome of this study. The α-error level was fixed at 0.05, and power was
set at 80% while the expected change to be detected was 20%. A number of twenty patients were found to be necessary.

**Results**

Patient’s demographics were similar between groups and differences were not statistically significant. Surgical duration was almost similar in both groups, and difference was statistically not significant ($P > 0.05$) [Table 1].

There was no significant difference in the 1st h follow-up period between the two groups regarding pain intensity ($P = 0.708$) [Table 2].

The pain score was significantly lower in dexamethasone group compared to ropivacaine group at 4, 6, and 12 h during follow-up period ($P = 0.006, 0.008, 0.010$), and continued to be lower at 24 h but without any statistical significance ($P = 0.105$) [Table 2].

The time of first rescue analgesic dose was significantly prolonged in dexamethasone group ($110 ± 3.3$ min) compared with ropivacaine group ($66 ± 7.9$ min; $P = 0.001$) [Table 3].

Analgesic requirements were almost similar between groups at the 1st h of follow-up period ($P = 0.844$) but at 4, 6, and 12 h follow-up period analgesic consumption was significantly lower in the dexamethasone group ($P = 0.019, 0.031, 0.039$), and continued to be lower up to 24 h follow-up period without significance ($P = 0.159$) [Table 4].

Postoperatively, a nonsignificant more number of patients in ropivacaine group (three patients) experienced nausea in the first 12 h compared to dexamethasone group (two patients) ($P = 0.633$). In addition, vomiting was nonstatistically more in ropivacaine group than dexamethasone (four patients to three patients) ($P = 0.677$). Other reported complications were numbness and bruising, and there was no significant difference between groups ($P > 0.05$) [Table 5].

**Discussion**

The results of this study demonstrated that the addition of dexamethasone to ropivacaine during preemptive ankle block gave a longer duration of analgesia and decreased intensity of pain for 24 h postoperatively period in foot surgery. The duration of pain relief and pain intensity was markedly prolonged in dexamethasone group. These results were similar and in agreement with Shrestha and coworkers,[11] who reported that addition of dexamethasone for brachial plexus block prolongs the duration of analgesia without any unwanted effects. Another study done by Vieira et al.[6] showed that the addition of dexamethasone to bupivacaine increased the duration of analgesia, but there was no evaluation for intensity of pain and analgesic dose after surgery.

The mechanism of action of corticosteroid in prolonging peripheral nerve blockade is not completely understood. There are several theories to explain this effect, among those

### Table 1: Patients characteristics and surgery duration in both group

|                | Group I (n=20) | Group II (n=20) | P      |
|----------------|---------------|-----------------|--------|
| Age (years)    | 56±17         | 48±14           | 0.113  |
| Male/female    | 11/9          | 8/12            | 0.342  |
| Surgery duration (min) | 57±19         | 55±22           | 0.759  |
| Site of surgery |               |                 |        |
| Fore foot/mid foot | 15/5          | 13/7            | 0.490  |

Data are presented as mean (SD) or number of patients. Group I=Ropivacaine group, Group II=Dexamethasone group, SD=Standard deviation

### Table 2: Pain score after recovery during follow-up period for both groups

| Time (h) | Group I (n=20) | Group II (n=20) | P      |
|----------|----------------|-----------------|--------|
| 1        | 3.6±5.3        | 2.8±7.9         | 0.708  |
| 4        | 7.4±5.2        | 3.9±1.2         | 0.006* |
| 6        | 6.7±2.9        | 4.6±1.7         | 0.008* |
| 12       | 5.9±2.3        | 4.3±1.3         | 0.010* |
| 24       | 4.6±3.1        | 3.1±2.6         | 0.105  |

*Significance ($P < 0.05$). Data are presented as mean (SD). Group I=Ropivacaine group, Group II=Dexamethasone group, SD=Standard deviation

### Table 3: Time to the first rescue analgesic (min)

| Time (min) | Group I | Group II | P      |
|------------|---------|----------|--------|
| 1          | 66±7.9  | 110±3.3* | 0.001* |

*Significance ($P < 0.05$). Data are presented as mean (SD). Group I=Ropivacaine group, Group II=Dexamethasone group, SD=Standard deviation

### Table 4: Postoperation analgesic morphine consumption

| Time (h) | Group I | Group II | P      |
|----------|---------|----------|--------|
| 2        | 3.1±1.1 | 2.8±6.7  | 0.844  |
| 4        | 8±6.5   | 4.1±2.9  | 0.019* |
| 6        | 7.9±4.1 | 5.3±3.2  | 0.031* |
| 12       | 6.5±3.6 | 4.6±1.7  | 0.039* |
| 24       | 4.8±2.1 | 3.8±2.3  | 0.159  |

*Significance ($P < 0.05$). Data are presented as mean (SD). Group I=Ropivacaine group, Group II=Dexamethasone group, SD=Standard deviation

### Table 5: Postprocedure side affects

|                | Group I | Group II | P      |
|----------------|---------|----------|--------|
| Nausea         | 3       | 2        | 0.633  |
| Vomiting       | 4       | 3        | 0.677  |
| Numbness/tingling | 3      | 2        | 0.633  |
| Bruising at injection site | 2 | 1 | 0.548  |

Data are presented as number of patients. Group I=Ropivacaine group, Group II=Dexamethasone group

theory is upregulation of K+ channels in excitable cell and local action on nociceptor C-fiber mediated by glucocorticoid
Another theory refers to anti-inflammatory action of dexamethasone and blocking transmission on nociceptive fiber.[13]

In contrast to our study and to the previous studies that showed beneficial effect of dexamethasone in prolongation of postoperative analgesia when added to local anesthetic, Parrington et al.[14] in a study done to evaluate adding dexamethasone to mepivacaine in supraclavicular brachial plexus block, they were unable to demonstrate augmentation or prolongation of postoperative analgesia, this difference may be attributed to difference in the study methodology, type of local anesthetic, and volume of local anesthetic. For the purpose of our study, we did not use epinephrine because of its intermediate duration of action, which would likely mask any pharmacodynamics effect of adjunctive dexamethasone.[15]

The present study showed that the addition of dexamethasone to ropivacaine reduced overall pain scores and analgesic requirement in postoperative period without any serious adverse effects. Adverse effects with a single dose of dexamethasone are rare and minor in nature and the previous studies have demonstrated that short-term use of dexamethasone is safe.[16,17] Dexamethasone is also known to reduce postoperative nausea and vomiting, and its antiemetic is due to anti-inflammatory property of dexamethasone which are in agreement with our study. In this study, a nonsignificant incidence of side effects was observed in the two studied groups.

**Limitation**

The limitation of this study may be the nonuse of sonar-guided nerve block.

**Conclusion**

The addition of dexamethasone to ropivacaine in LA infiltration prolonged the postoperative analgesia and reduced postoperative analgesic consumption; furthermore, it could be used as a substitution to epinephrine to prolong the duration of analgesia in patients with ischemic heart disease and patients with lower limb ischemia.

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**Conflicts of interest**

There are no conflicts of interest.

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