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Research Article

Intra-articular versus intravenous magnesium-sulfate as adjuvant to femoral nerve block in arthroscopic knee surgery under general anesthesia: Randomized controlled trial

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KEYWORDS

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Abstract *Background:* The combined use of intra-articular (IA) or intravenous (IV) magnesium-sulfate (mgso4) with femoral nerve block might be associated with additive effects on the duration and quality of postoperative analgesia in arthroscopic knee surgery.
Patients and methods: This randomized controlled double-blind study included 90 patients. Femoral nerve block was performed in all patients using 20 ml 0.25% bupivacaine before induction of general anesthesia. At the end of surgery patients were randomly allocated into: Group-IA (intra-articular 1 g $MgSO_4$ in 20 ml), Group-IV (intravenous 1 g $MgSO_4$ in 20 ml), and Group-P (20 ml intra-articular and 20 ml intravenous normal saline). 20 ml normal saline was given IV in IA group and IA in IV group. Visual analogue pain score (VAS) at rest, with movement, time to first post-operative rescue analgesia, total postoperative diclofenac consumption, and the number of meperidine rescue doses during the first 24 h postoperatively were measured.
Results: Pain scores were comparable in the three groups at 2 and 4 h and were significantly higher in the control group at 6 h and over 24 h. Group IA had the lowest pain scores. Duration of analgesia was significantly higher [11.6 (4.5) h] in IA group compared to [7.5 (3.6) h] in IV group and [5.2 (2.3) h] in control group ($p < 0.01$). Total Diclofenac over 24 h was significantly lower in IA group [73.8 (50.9) mg] versus [138.4 (51.6) mg] in IV group and [186.0 (43.9) mg] in the control group ($p < 0.01$).

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Conclusion: The combined use of femoral nerve block with IA or IV $MgSO_4$ is associated with significant reduction of the intensity and duration of postoperative pain and postoperative analgesic requirements in patients undergoing arthroscopic knee surgery with the IA $MgSO_4$ being superior to IV route of administration.

1. Introduction

Acute pain from anterior cruciate ligament (ACL) reconstruction surgery has three major components: tissue injury, nociceptor sensitization, and activation of a central pathway [1,2]. Good-quality postoperative analgesia is essential for early rehabilitation after arthroscopic knee surgery [3]. Local anesthetics [4,5], opioids [6], alpha-2 adrenoceptor agonists [7,8], and magnesium sulfate $MgSO_4$ [9,10] have all been tried intra-articularly either as sole agents or in combination, to provide effective postoperative analgesia [3]. However, there is increasing evidence of a potential toxic effect of local anesthetic agents to chondrocytes within the articular cartilage [11]. In contrast, several reports have confirmed the safety of intra-articular $MgSO_4$ at the chondrocyte level [12,13]. Furthermore, intra-articular $MgSO_4$ appears to have protective effects on chondrocytes when co-administered with local anesthetics [12].

It has been reported that intra-operative intravenous $MgSO_4$ reduces analgesic requirements and improves postoperative analgesia [14]. Although the majority of studies have concluded that magnesium sulfate has a positive analgesic effect, some have produced negative results [15]. The mechanism underlying the analgesic effect of magnesium is unclear. Magnesium acts as an antagonist at N-methyl-D-aspartate (NMDA) type glutamate receptors [15]. Block of NMDA receptors is known to inhibit the induction and maintenance of central sensitization to nociceptive stimuli [15]. N-methyl-D-aspartate receptors are present in the peripheral terminal of articular primary afferent fibers and on cellular elements within the knee joint [14].

Femoral nerve block provides a superior analgesic effect for patients undergoing ACL reconstruction surgery than placebo [2]. However, when applied alone, femoral nerve block does not facilitate early recovery [2]. The outcome with continuous femoral nerve block has been shown to be better than "single shot" femoral nerve block (SFNB) and continuous epidural anesthesia [16]. Nevertheless, continuous femoral nerve block for postoperative analgesia induces a frequent rate of catheter colonization [17]. The concomitant use of single-shot femoral nerve block and intravenous or intra-articular adjuvants appears to be a logical alternative to continuous catheter techniques.

This study was designed to investigate the potential analgesic effect of intra-articular or intravenous $MgSO_4$ as adjuvant to femoral nerve block in adult patients undergoing arthroscopic ACL reconstruction under general anesthesia.

2. Patients and methods

Ninety patients with ASA physical statuses I and II aging from 18 to 60 years scheduled for arthroscopic ACL reconstruction were enrolled in this randomized controlled double-blinded study. The study was approved by the Institutional Ethics Committee and written informed consent was obtained from each patient and is registered in the Pan African Clinical Trial Registry with an identification number (PACTR201503001053196). The study was conducted in the Orthopedic Surgical Theatre in Cairo University Hospitals. Online randomization program (http://www.randomizer.org/) and the sealed envelope method were used to allocate patient in the three study groups and to conceal this allocation.

Patients with hepatic, renal, cardiac, hematological, or respiratory impairment, diabetic patients, morbidly obese and pregnant patients with history of neuropathy, myopathy and neuromuscular diseases, patients with prior treatment with corticosteroids, calcium channel blockers, and opioids and patients with cognitive dysfunction that may interfere with the patient ability to provide reliable information about their postoperative pain all were excluded from the study.

No premedication was given to allow for reliable assessment of the femoral nerve block. Standard monitoring was applied. Femoral nerve block was performed using 20 ml bupivacaine 0.25% before induction of general anesthesia. A peripheral nerve stimulator (STIMUPLEX HNS12, B Braun, Germany) was used to localize the femoral nerve. A 22-gauge, 5-cm Contiplex® D fully insulated atraumatic needle (B Braun, Germany), was used for bupivacaine injection. Over a period of 30 min after injection of peri-neural bupivacaine and prior to induction of anesthesia, a blinded investigator assessed sensory block by testing the pinprick sensation along the medial aspect of the leg. The sensory block was graded as follows: grade 0, normal sharpness sensation (compared with the contralateral side); grade I, reduced sharpness or a non-sharp sensation (touch or pressure); and grade II, unable to recognize pinprick sensation. For motor block assessment, the patient's knee was fully flexed, and the patient was then asked to extend it. The motor block was classified as follows: grade 0, normal muscle power; grade I, motor weakness; and grade II, complete motor paralysis [9]. At the end of the 30 min assessment period, patients with inadequate femoral nerve block were excluded from the study.

After adequate assessment of femoral nerve block, general anesthesia was induced using fentanyl 2 μg/kg and propofol 2 mg/kg. An appropriately sized laryngeal mask airway (LMA) was inserted and patients were allowed to breathe spontaneously and the tidal volume was augmented with the use of pressure support ventilation mode. Anesthesia was maintained using isoflurane 2–3% end-tidal concentration in oxygen adjusted to maintain the heart rate and mean arterial blood pressure within ± 10% of their baseline values. No other analgesics were given intraoperatively.

At the conclusion of surgery, patients were randomized to one of three equal groups (n = 30): Group-IA received 20 ml intra-articular $MgSO_4$ (10 ml 10% $MgSO_4$ "1 g" diluted in