ORIGINAL STUDIES

EFFICIENCY OF ULTRASOUND GUIDED LOWER LIMB PERIPHERAL NERVE BLOCKS IN PERIOPERATIVE PAIN MANAGEMENT FOR KNEE ARTHROSCOPY IN CHILDREN. A RANDOMIZED STUDY

Dragan MARINKOVIĆ1,2, Jovana M. SIMIN2, Biljana DRAŠKOVIĆ1,2, Ivana M. KVRIĆ2 and Marina PANDUROV2

Summary

Introduction. Ultrasound guided lower limb peripheral nerve blocks are efficient for perioperative pain treatment in children. The aim was to see if lower limb peripheral nerve blocks reduced the amount of propofol and opioid analogs used intraoperatively, as well as the level of pain and consumption of systemic analogs postoperatively.

Material and Methods. A randomized, prospective clinical trial was carried out. It included 60 children between 11 and 18 years of age scheduled for elective knee arthroscopy. The patients were divided into two groups. Group A received general anesthesia, group B received lower limb peripheral nerve blocks with sedation or general anesthesia. Postoperative level of pain was assessed using visual analogue scale. Results. Less propofol and fentanyl was used to induce and maintain anesthesia in group B (p<0.001). The level of postoperative pain was significantly lower in group B (p<0.001), as well as the postoperative consumption of analogs (p<0.001). As many as 47% of the patients were discharged without receiving any analgesics postoperatively. The average duration of peripheral nerve blocks was 468 minutes. Conclusions. Ultrasound guided lower limb peripheral nerve blocks are an efficient technique of regional anesthesia in children. They reduce the amount of general anesthetics and opioid analogs needed intraoperatively as well as the level of postoperative pain and consumption of analogs postoperatively.

Key words: Nerve Block; Ultrasonography, Interventional; Peripheral Nerves; Lower Extremity; Arthroscopy; Knee Joint; Perioperative Care; Pain Management; Pain Measurement; Child; Anesthetics; Analgesia; Anesthesia, Conduction; Anesthesia, General

Original study

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in increased precision and reduced complications. In addition, it reduces the unpleasant feeling associated with the landmark-nerve stimulator technique and therefore increases the patient’s satisfaction. Furthermore, this technique reduces the time needed to perform PNB and the time to its onset; it increases the intensity and duration of sensory block, and last but not least, it reduces the amount of the LA used and the cost of treatment. US guided PNB also reduce the need for general anesthetics and analgesics, their adverse reactions and complications, leading to faster postoperative recovery and shorter hospital stay [3, 4].

The aim of the research was to see whether US guided lower limb PNB reduced the amount of propofol and opioid analgesics used intraoperatively as well as the intensity of pain and consumption of systemic analgesics postoperatively.

Material and Methods

This randomized prospective clinical research was carried out at the Clinic for Pediatric Surgery, at the Institute for Child and Youth Healthcare of Vojvodina, in Novi Sad. Sixty patients admitted for scheduled knee arthroscopy, between 11 and 18 years of age, were randomized into two groups by flipping a coin. Group A received general anesthesia, while group B patients were given US guided lower limb PNBs with general anesthesia or sedation. Some group B patients received femoral nerve block with obturator or ischiadic nerve block, or both of them.

All patients admitted for elective knee arthroscopy during the observed period of time were included in the study. The exclusion criteria were parents’ objection, allergy to a local anesthetic, hemorrhagic diathesis, and neurological deficit of the lower limb on which PNB was supposed to be performed.

All children underwent preoperative and psychological preparation one day before the surgery, accompanied by a parent. All patients were ASA I and ASA II category according to the American Society of Anesthesiologist (ASA). After premedication with oral midazolam (Dormicum®, Rosche) 0,5 mg/kg (maximum dose 15 mg) 45 minutes before the operation, the peripheral venous cannula was placed.

Group A underwent standard monitoring (pulse oximetry, electrocardiography, non-invasive arterial pressure and capnography) and general anesthesia was induced with continuous infusion of propofol (6-10 mg/kg/h), along with bolus doses of fentanyl (1 µg/kg) and rocuronium (0, 15 mg/kg) and inhalation of air/O₂ mixture (FiO₂ 50%). The lungs were mechanically ventilated using a pressure-controlled mode to maintain EtCO₂ between 4.7 and 5.3 kPa.

In group B, US guided lower limb PNBs were performed with sedation or under general anesthesia, depending on the child’s age and the level of cooperation. For sedation, 0.1 mg/kg intravenous midazolam (Dormicum® Rosche, 15 mg/ml) was used. In the patients requiring general anesthesia it was conducted in the same manner as in group A, without the administration of muscle relaxants. After the orientation and visualization of nerve structures, 0.25% or 0.33% levobupivacaine (Chirocaine 5 mg/ml, Abbott) 1 ml/kg (2.5-3 mg/kg) was administered under direct ultrasonographic guidance with ‘in-plane’ technique and a 22G (Stimuplex®D, Braun) needle. The puncture area and the ultrasound probe were prepared in a sterile manner. The puncture site was protected and the operation began 20 minutes later (Figure 1).

Vital parameters as well as the overall consumption of anesthetics and opioid analgesics were recorded during the operation. The level of postoperative pain was assessed using Wong Baker FACES scale or visual-
analogue scale (VAS) right after the operation and 2, 6 and 12 hours after the operation. The pain level was marked with 0 to 10 grades, 0 being the lowest and 10 the highest pain level (Figure 2). The time to the first dose of systemic analgesic, overall analgesic consumption and adverse events was also recorded.

Statistical analysis was done using SPSS package 13.0 for Windows. The statistical significance between the average values of parametric data was tested using Student’s t-test, and χ² test was used for non-parametric data. P value below 0.05 was considered statistically significant.

Results

Sixty patients were included in the study, thirty in each group. No statistically significant differences were calculated between the study groups regarding the age, weight, sex or the duration of surgery (Table 1).

Some of the group B patients received general anesthesia in addition to the PNB, while others were sedated (Graph 1).

During the performance of PNB, 80% of patients were sedated, while the rest were under general anesthesia. In 47% of cases, the US guided lower limb PNB was conducted without the addition of nerve stimulator.

The average PNB duration was defined as the time from the administration of PNB to the administration of the first dose of systemic analgesic given to relieve the pain. The average length of PNB was 468 minutes (100-1290 minutes).

The pain level assessed at different time points is presented in Table 4. Whereas all group A patients needed analgesics postoperatively, only 47% of group B.

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**Table 1.** Patients’ characteristics in both groups. Data are presented as mean values (SD).

<table>
<thead>
<tr>
<th></th>
<th>Group A/Grupa A</th>
<th>Group B/Grupa B</th>
<th>p value/p-vrednost</th>
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</thead>
<tbody>
<tr>
<td>Age (years)/Starost (godine)</td>
<td>14.53 (3.19)</td>
<td>15.2 (1.57)</td>
<td>p&gt;0.001</td>
</tr>
<tr>
<td>Weight/Masa (kg)</td>
<td>61.55 (17.93)</td>
<td>64.35 (16.15)</td>
<td>p&gt;0.001</td>
</tr>
<tr>
<td>Duration of operation/Trajanje operacije (min)</td>
<td>64.5 (21.66)</td>
<td>63.66 (21.53)</td>
<td>p&gt;0.001</td>
</tr>
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</table>

**Table 2.** Intraoperative consumption of propofol and fentanyl, mean (SD)

<table>
<thead>
<tr>
<th></th>
<th>Group A/Grupa A</th>
<th>Group B/Grupa B</th>
<th>p value/p-vrednost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Induction propofol/Propofol za uvod (mg/kg)</td>
<td>2.26 (0.33)</td>
<td>1.59 (0.97)</td>
<td>p&lt;0.001</td>
</tr>
<tr>
<td>Maintenance propofol/Propofol za održavanje (mg/kg/h)</td>
<td>6.45 (1.81)</td>
<td>4.18 (1.20)</td>
<td>p&lt;0.001</td>
</tr>
<tr>
<td>Fentanyl/Fentanil (μg/kg/h)</td>
<td>2.12 (0.68)</td>
<td>1.13 (0.53)</td>
<td>p&lt;0.001</td>
</tr>
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</table>

**Table 3.** Types of PNBs performed

<table>
<thead>
<tr>
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<th>Number of patients/Broj pacijenata (%)</th>
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</thead>
<tbody>
<tr>
<td>Femoral, obturator, ischiadic/Femoralni, opturatorni, išijadični</td>
<td>13 (43.33)</td>
</tr>
<tr>
<td>Femoral, obturator/Femoralni, opturatorni</td>
<td>10 (33.33)</td>
</tr>
<tr>
<td>Femoral, ischiadic/Femoralni, išijadični</td>
<td>7 (23.33)</td>
</tr>
</tbody>
</table>
B patients required postoperative analgesia. Others were discharged without receiving any analgesics postoperatively. The average postoperative analgesics demand is presented in Graph 2. No side-effects related to anesthesia technique were recorded.

**Discussion**

Regional anesthesia, especially PNBs, is increasingly used in the perioperative pain treatment [1]. The introduction of the US guided technique is responsible for the increasing use of PNB in pediatric population [2]. In our country this technique was not used in everyday clinical practice until a couple of years ago. Our Clinic is one of the first institutions where it gained significant popularity.

In our study the precise administration of local anesthetic under the ultrasound guidance to group B patients resulted in efficient lower limb PNB, with no complications recorded. Knee arthroscopy was done under sedation only in as many as 37% of these patients. By reducing the need for general anesthesia, one can expect better hemodynamic stability, reduction of perioperative stress response and fewer complications [5, 6].

The amount of propofol given intraoperatively to induce and maintain anesthesia was significantly lower in group B patients who received the combination of PNB and general anesthesia. This is of utmost importance since there is growing and convincing evidence that the exposure to anesthetics in common clinical practice can be neurotoxic to the developing brain and lead to long-term neurological sequelae [7–9].

There was significantly lower intraoperative demand for opioid analgesics in group B, meaning that the lower limb PNB provided the adequate intraoperative analgesia. The reduced need for opioids leads to its reduced side-effects such as postoperative nausea and vomiting, pruritus and respiratory depression. Our results are in accordance with other studies which examined the efficacy of PNBs in knee surgery [10–13].

Muscle relaxant, rocuronium, was used only in group A patients since PNB provided adequate muscle relaxation in group B. The reduced need for muscle relaxants decreases the possibility of adverse drug reactions, such as histamine liberation or allergic reactions, ranging from rash to anaphylaxis [14–16].

During the performance of PNB, 80% of patients were sedated, while others were under general anesthesia, which is in accordance with the findings of other authors [2].

In 47% of cases, the US guided PNB was conducted without the addition of a nerve stimulator, which made the overall experience of administration of local anesthetic much less unpleasant. Marhofer et al. stressed the importance of the US guided technique in the reduction of pain sensation caused by muscle contractions and repeated needle positioning [1, 2]. Due to the precise needle visualization there is no need for multiple needle adjustments and hence the sensation of pain is reduced.

The average PNB duration was defined as the time from the administration of PNB to the administration of the first dose of systemic analgesic given to relieve the pain, as found in the literature [2, 17]. The average length of lower limb PNB was 468 minutes (100–1290 minutes), which is in accordance with the results of Marhofer [2] and Oberndorfer et al. [17].

In our study, 0.25% and 0.33% levobupivacaine was used for lower limb PNBs, the average dose being 1.75 mg/kg. These results are in accordance with the findings of other authors who have proved that lower doses can be used for PNB due to precise visualization of the needle and the spreading of the LA [17–24]. This is particularly relevant for neonates and infants who are at risk of local anesthetic toxicity and higher free plasma concentrations of local anesthetic agents in view of their lower plasma concentration of the binding protein alpha-lacid glycoprotein [25].

The level of postoperative pain assessed with Wong Backer FACES scale and VAS was significantly lower in group B. Consequently, the average number of doses of systemic analgesics administered postoperatively was significantly lower in this group of patients. It is interesting to point out that

<table>
<thead>
<tr>
<th>Pain level/Nivo b]a</th>
<th>Group A/Grupa A</th>
<th>Group B/Grupa B</th>
<th>p value/p vrednost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initially/Na početku</td>
<td>2.8 (1.34)</td>
<td>0.4 (0.81)</td>
<td>p&lt;0.001</td>
</tr>
<tr>
<td>After 2 h/Posle 2 h</td>
<td>4.73 (1.52)</td>
<td>0.66 (1.32)</td>
<td>p&lt;0.001</td>
</tr>
<tr>
<td>After 6 h/Posle 6 h</td>
<td>.73 (0.69)</td>
<td>.20 (1.78)</td>
<td>p&lt;0.001</td>
</tr>
<tr>
<td>After 12 h/Posle 12 h</td>
<td>5.93 (0.36)</td>
<td>1.90 (2.00)</td>
<td>p&lt;0.001</td>
</tr>
</tbody>
</table>
as many as 47% of these patients were discharged without the need for any analgesics postoperatively. The results of these studies have suggested that PNB are a good technique for postoperative pain management for knee arthroscopy. No complications were recorded either during PNB performance or postoperatively in our study. The use of US reduces the incidence of possible complications associated with PNB performed using a landmark and nerve stimulator technique [25, 28].

Conclusion

The ultrasound guided peripheral nerve block is a safe technique of regional anesthesia in children. The combination of regional and general anesthesia reduces the consumption of general anesthetics, opioid analgesics and muscle relaxants, and hence their side effects and possible complications. In addition, the ultrasound guided peripheral nerve blocks reduce the level of postoperative pain and consumption of analgesics postoperatively.

Reference


