Case Report

Pericapsular Nerves Group (PENG) Block in Children under Five Years of Age for Analgesia in Surgery for Hip Dysplasia: Case Report

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Pericapsular Nerves Group (PENG) Block in Children under Five Years of Age for Analgesia in Surgery for Hip Dysplasia: Case Report

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Abstract: Introduction: The Pericapsular Nerve Group (PENG) block is a novel technique that allows for analgesia of the anterior hip capsule via the articular branches of the accessory obturator nerve and femoral nerve, which have a significant role in the innervation of the hip capsule. PENG blockade is effective in both adult and pediatric patients. However, there are no studies in the available literature on patients under five years of age. Herein, we describe our experience with two pediatric patients with hip dysplasia. **Purpose:** This study aimed to evaluate the analgesic effect of the pericapsular nerves group (PENG) in small children undergoing hip surgery. **Patients and methods:** This study included two patients, aged 2 and 4 years old, who qualified for hip surgery. General or spinal anesthesia with the addition of a PENG block was performed. During the procedure, the basic hemodynamic parameters were monitored. After the surgery, the patients received 15mg/kg^{-1} iv paracetamol every 6 hours to prevent rebound pain. The pain was assessed using the FALCC score. The 15mg/kg^{-1} metamizole was administered if the FLACC score was 3. In the FLACC score 4, the application of 0,2mg/kg^{-1} Nalpain was ordered. **Results:** The patient's hemodynamic parameters were stable and within normal range. FLACC scores from all patients ranged from 0 and 3 in the first 24 h period. One patient required metamizole 12 hours after surgery. No evidence of block complications was observed. **Conclusions:** This case series showed that PENG block provided adequate postoperative analgesia and assured opioid-free pain management. However, we are convinced that future randomized, controlled trials are needed in this field.

Keywords: pain; myelomeningocele; paralytic dislocation of the hip; congenital dislocation of the hip; Dega transiliac osteotomy

Introduction

The use of local anesthesia for perioperative analgesia in hip surgery is a widespread practice that has been shown to reduce pain, perioperative complications, and postoperative opioid use [1]. In pediatric anesthesia, regional techniques are the mainstay of perioperative analgesia, either alone or as part of a multimodal analgesia strategy. Perioperative pain management is paramount after pediatric hip surgery. Inadequate analgesia can lead to patient and parent dissatisfaction, longer recovery, and extended hospital stays [2]. Local anesthesia is beneficial because it provides adequate pain relief while reducing opioid side effects [3,4].

Neural axis technology reduces pain scores in pediatric patients undergoing hip replacement surgery. However, positioning requirements, bilateral sensory and motor block, and urinary retention limit their use. Caudal and lumbar plexus blocks are the most common regional blocs, which are advanced techniques. However, many anesthesiologists are reluctant to use this occlusion because of the risk of complications such as colonic and renal puncture and total obstruction [5]. Our institutional practice includes the administration of spinal anesthesia with propofol sedation or

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general anesthesia with propofol and remifentanil, both regimens combined with an epidural catheter for children undergoing unilateral or bilateral hip surgery. This type of anesthesia effectively blocks nerves that innervate the hip. However, sometimes the analgesia is insufficient due to epidural catheter dislodgement or migration [6]. The use of an epidural catheter is also limited due to the need for continuous hemodynamic monitoring during postoperative analgesia [7].

Pericapsular Nerve Group (PENG) block was first described in 2018 by Girón-Arango et al. [8] for perioperative analgesia in hip fracture patients. This block was confirmed by a cadaveric dye study [9] that exhibited the pericapsular spread targeting only the sensory branches of the anterior hip capsule with a motor-sparing effect. PENG block extensively blocks innervation of the anterior hip capsule. This advanced ultrasound-guided technology numbs the obturator, paraobturator, and capsular sensory branches of the femoral nerve [9,10].

Unfortunately, there are no studies in the available literature on patients under five years of age. Therefore, we present the utilization of the PENG block for perioperative pain management in 2 pediatric patients undergoing unilateral surgery for pediatric hip dysplasia.

Material and Methods

Written informed consent was obtained from the parent for this scientific contribution.

Patients admitted to the W. Dega Orthopedic and Rehabilitation Clinical Hospital of Poznan University of Medical Sciences with a hip pathology as a part of a multidisciplinary care pathway

Upon discussion with the surgical team, the goals of care included a 2-day admission for postoperative pain control and complete avoidance of motor blockade. In addition, we offered a PENG block for postoperative pain management instead epidural catheter. In both cases, after the induction of anesthesia, the PENG block was performed (Figures 1–2).

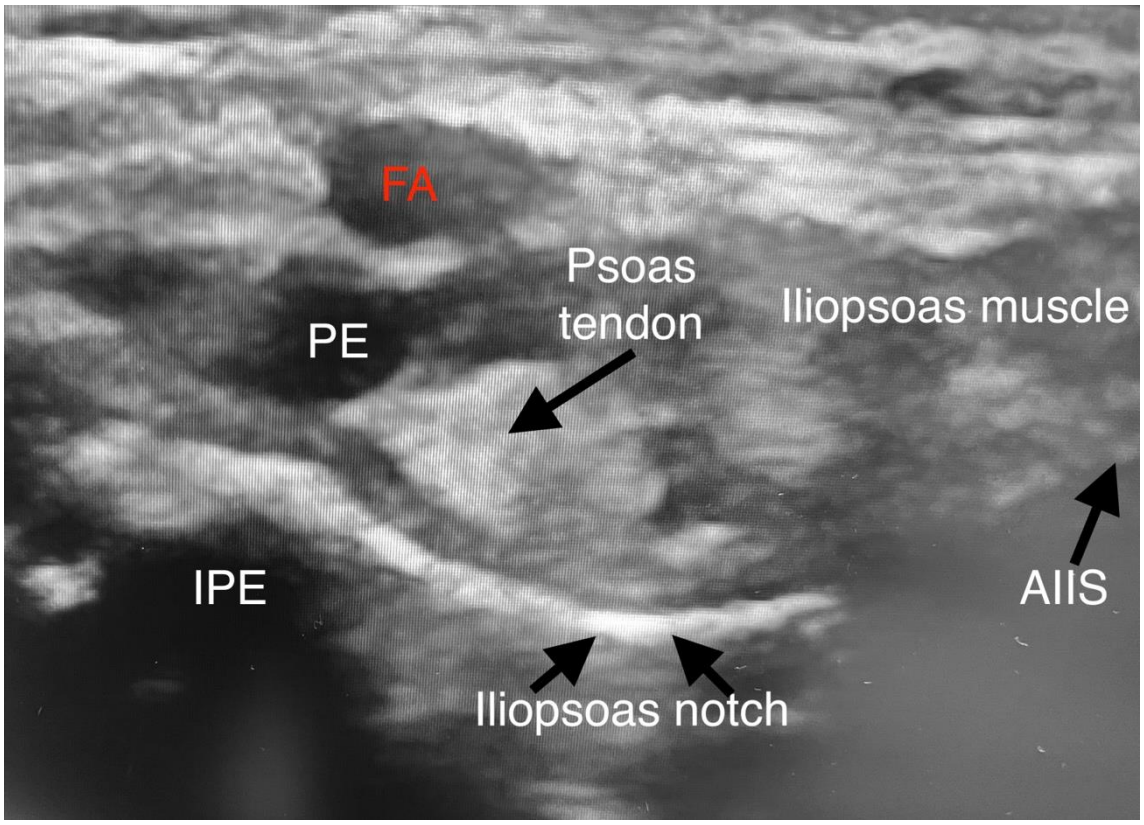

Figure 1. Sonoanatomy of PENG.

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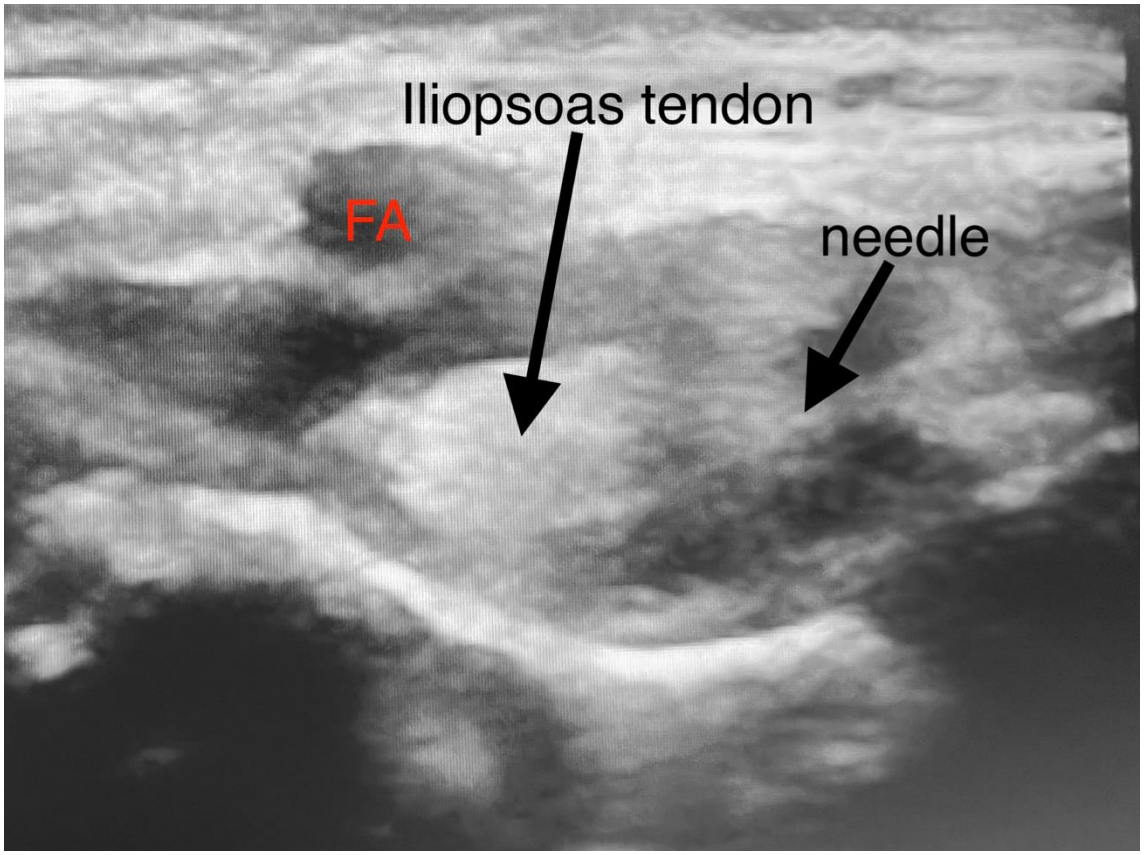

Figure 2. Injection technique of PENG block.

The patients were kept supine during the focal block. A low-frequency linear transducer (2–5 MHz) was placed in a transverse plane along the left inferior anterior iliac spine (AIIS) to identify the iliopsoas muscle, femoral artery (FA), and femoral nerve. The probe was then rotated counterclockwise to align with the pubic ramus to visualize the AIIS, iliopsoas prominence (IPE), FA, iliopsoas, and iliopsoas notch. Under direct vision, a 22-gauge 50 mm echo needle was advanced in the lateral-medial plane between the psoas tendon and the pubic ramus until the needle touched the IPE. The needle was withdrawn, and after negative aspiration, 0,2% ropivacaine was injected in incremental doses. Preparation and surgical positioning allowed for maximal time for block onset.

The basic hemodynamic parameters were monitored during the procedure and the first 24 hours postoperatively. After the surgery, the patients received 15mg/kg^{-1} iv paracetamol every 6 hours to prevent rebound pain. The pain was measured every 2 hours in a FLACC score. The 15mg/kg^{-1} metamizole was administered if the FLACC score was 3. In the FLACC score ≥4, the application of 0,2mg/kg^{-1} Nalpain was ordered. The evidence of block complications, like mobility disorders, bleeding, neuropathy, or systemic toxicity from local anesthetic deposition, was observed. Muscle weakness or mobility of the hip joint was difficult to observe due to the plaster cast.

1st Case Report

A 4-year-old, 14,3kg, the boy with developmental dysplasia due to myelomeningocele, and paralytic dislocation of the left hip joint, with no other co-morbidities (table 1). He was walking independently and did not require urine catheterization. Apart from the primary disease, he was not hospitalized. The boy did not take the medications permanently. He had no drug allergies and no history of convulsions. Due to his primary disease, he was under the care of an orthopedic, rehabilitation, and urological clinic. In June 2020, he underwent surgery for meningomyelocele, and in October 2020, he had an Achilles tenotomy on the left side. The course of the procedures and anesthesia without complications. His neurological development was expected according to age. He has qualified for Dega transiliac osteotomy with femoral subtrochanteric osteotomy combined with Mustard iliopsoas transfer. The ASA physical status classification was 3. An hour before the planned

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surgery, 7,5mg Midazolam p.o. and 4mg Dexamethasone i.v., were administered. In addition, 200mg of Paracetamol was given intravenously before surgery. General anesthesia was performed with a continuous infusion of propofol and remifentanil in doses, ensuring BIS within 40-60 limits and airway potency was maintained using a laryngeal mask. The lung-sparing mechanical ventilation with Air/O_2 mixture was used, under the control of SpO_2 >94% and pCO2, within the 35-45 mmHg range (Getinge, FlowC, Maquet Critical Care AB, Sweden). After the induction of general anesthesia, the PENG block was performed with 7,5mL of 0,2% Ropivacaine (Table 1). During the procedure, the hemodynamic parameters (MX550, Philips Medizin Systeme Beoblingen GmbH Hewlett-Packard-Str. 2, Germany) and the remifentanil dosage were monitored. Paracetamol was administered every six hours after surgery.

In the first 24 hours, postoperatively patient's hemodynamic parameters were stable and within the normal range according to age. After the surgery, the pain was measured every 2 hours in a FLACC score. The 15mg/kg^{-1} metamizole was administered if the FLACC score was 3. In the FLACC score ≥4, the application of 0,2mg/kg^{-1} Nalpain was ordered. There was no evidence of block complications, like mobility disorders, bleeding, neuropathy, or systemic toxicity from local anesthetic deposition. Muscle weakness or mobility of the hip joint was difficult to observe due to the plaster cast. However, parents and caregivers did not observe any mobility or sensory disturbances.

2nd Case Report

A 22-month-old, 18kg girl with congenital hip joint dislocation with no other co-morbidities. She was walking independently and was not hospitalized apart from the primary disease. The girl did not take the medications permanently. She had no drug allergies and no history of convulsions. She was under the care of an orthopedic and rehabilitation due to her primary disease. In August 2022, she underwent hip arthrography, closed repositioning of the hip, and placement of a tooth cast. In September 2020, chronic instability of the left hip joint and burns in the places of skin folds in the groin was found in the operating room conditions. The plaster cast was removed, and it was decided that surgery was necessary. After seven days, an open reposition of the hip joint with K-wire stabilization was performed. In October 2020, the K-wire was removed, and in November, the plaster cast was cut through, and a Frejka pillow was adjusted. The course of the procedures and anesthesia without complications. His neurological development was expected according to age. The girl was qualified for transiliac osteotomy with femoral subtrochanteric osteotomy. The ASA physical status classification was 2 (Table 1). An hour before the planned surgery, 7,5mg Midazolam p.o. and 4mg Dexamethasone i.v. were given. In addition, 250mg of Paracetamol was given intravenously before surgery. Sedation was performed with continuous propofol infusion at a dose of 5mg/kg/hour. Spontaneous ventilation was maintained with an oxygen mask 2L/min. Spinal anesthesia (L3/4, PAJUNK, sprotte needle 27G, 70mm) with 1,5 ml of 0,5% heavy spinal Bupivacaine. After the spinal anesthesia, the PENG block was performed with 5mL of 0,2% Ropivacaine (Table 1). Paracetamol was administered every six hours after surgery to prevent rebound pain.

In the first 24 hours, postoperatively patient's hemodynamic parameters (MX550, Philips Medizin Systeme Beoblingen GmbH Hewlett-Packard-Str. 2, Germany) were stable and within the normal range. After the surgery, the pain was measured every 2 hours in a FLACC score. The 15mg/kg^{-1} metamizole was administered if the FLACC score was 3. In the FLACC score ≥4, the application of 0,2mg/kg^{-1} Nalpain was ordered. There was no evidence of block complications, like mobility disorders, bleeding, neuropathy, or systemic toxicity from local anesthetic deposition. Muscle weakness or mobility of the hip joint was difficult to observe due to the plaster cast. However, parents and caregivers did not observe any mobility or sensory disturbances.

Table 1. Characteristics of Patients.

	1st	2nd
Sex	M	F
Age	4 years	22 months
Weight	14,3 kg	18kg
ASA	3	2

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Comorbidities	myelomeningocele	obesity
Hip pathology	paralytic dislocation of the left hip joint	congenital dislocation of the left hip joint
Type of Surgery	Dega transiliac osteotomy with femoral subtrochanteric osteotomy combined with iliopsoas transfer, according to Mustard	Traniliac osteotomy with femoral subtrochanteric osteotomy
Type of Anesthesia	General anesthesia Propofol 0,2mg/kg/min Remifentanil 0,1ug/kg/min	Spinal anesthesia 1,5mL heavy, spinal Bupivacaine Propofol 0,06mg/kg/min
Type and Volume of Local Anesthetic used for PENG block	7,5mL of 0,2% ropivacaine	5mL of 0,2% Ropivacaine

Results

The patient's hemodynamic parameters were stable and within normal range. During the surgery, both patients did not require extra doses of opioids. The time of the procedure was 105 and 75 minutes, the difference was due to the technique of the surgery, and the blood loss was 200ml and 170ml (Table 2).

Table 2. Surgery and postoperative course.

	1st	2nd
Total operating time	105 minutes	75 minutes
Complications	no	no
Estimated blood loss	200ml	170ml
Highest FLACC score	3	2
Pain medications	200mg Paracetamol every 6 hours	250mg Paracetamol every 6 hours
Interventional pain drugs	200mg Metamizole iv.	no
Breakthrough opioids or muscle relaxants	no	no

Postoperatively, the patients appeared comfortable with numeric pain scores of 2/3 of 10. Paracetamol was administered every six hours. Over the night, both patients did not require breakthrough opioids or muscle relaxants. After 12 hours postoperatively, 200mg of metamizole iv was administered to the male patient due to a 3 in FLACC score. Later, FLACC and subjective pain scores were 0-1/10 for the next 24 hours, and the parents did not report poor pain control (Table 2). On the first postoperative day, the patients could participate in physical therapy.

The patients were discharged on the evening of day one with as-needed diazepam for muscle spasms and acetaminophen-opioid preparation for pain control. There was no evidence of block complications, like mobility disorders, bleeding, neuropathy, or systemic toxicity from large-volume local anesthetic deposition [11].

Discussion

Effective management and control of intraoperative and postoperative pain are essential in perioperative hip disease to minimize opioid use and its side effects. In our facility, most pediatric hip surgeries are performed under spinal anesthesia and propofol sedation [12], with preserved spontaneous ventilation. However, the 4-year-old boy had general anesthesia due to the myelomeningocele [13,14]. In addition, spinal and epidural anesthesia is inappropriate for patients with spinal malformations [15].

One of the difficulties in controlling hip pain using adequate topical analgesia is the complex innervation of the joint by multiple nerves. The most common local anesthesia and analgesia techniques for hip surgery are the lumbar plexus block, lumbar epidurals, femoral nerve blocks,

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sciatic nerve blocks, fascia iliac blocks, and pericapsular injections. However, they may provide only partial analgesia or lower extremity weakness, hypotension, and related side effects, especially in patients with congenital and acquired musculoskeletal system defects [15].

The single-shot PENG block has recently been described in the cadaveric study [16,17] and in the literature for perioperative analgesia in hip surgery by blocking the articular branches of the femoral nerve (FN), accessory obturator nerve (AON), and obturator nerve (ON) [8,18–20].

The technical simplicity of imaging in traction-fixed patients and no need for multiple punctures made this blockage ideal for the young pediatric patient [10]. Unfortunately, there are no studies regarding PENG block in patients younger than five years old, like in our case report.

Similar to our study, the pediatric case reports of older children showed the opioid-sparing effect of PENG block in the first 24 hours postoperatively [8,18,19]. In our study, parents and caregivers did not observe muscle weakness, as reported in other studies [9,21,22], which is of particular importance in the case of children with myelomeningocele and other neuromuscular, neurodegenerative or other congenital nerve diseases [23].

A significant drawback of single-shot peripheral nerve blocks is the limited time window of analgesic effect. In addition, the possibility of rebound hyperalgesia after a single-shot nerve block from 12 at 24h has been described [24,25]. In our study, children were given acetaminophen before surgery to avoid rebound pain.

Several additives, such as dexamethasone and alpha-2-adrenergic receptor agonists, have been shown to prolong analgesia following peripheral nerve blocks with single doses and give the potential extent for pain beyond the provision of a single-shot nerve block [26]. Therefore, in our study, we decided to use dexamethasone with the best-proven effectiveness [27,28].

Also, some studies [29–31] have reported that few patients experience pain in the lateral femoral cutaneous nerve region after hip surgery. However, we did not observe it in our study.

In 2021, Morrison et al. [32] published a systematic review of studies describing PENG blockade in adults and pediatrics to treat hip pain caused by either fracture or surgery. They found 20 studies that met the inclusion criteria for both the PENG blockade alone and the PENG blockade in combination with other topical analgesic techniques. They concluded that PENG blockade is a promising topical analgesic technique. We achieved similar results in terms of analgesic efficacy and reduced opioid consumption.

Conclusions

Consistent with the literature, our experience demonstrated exercise-preserving and opioid-sparing analgesia using PENG blocks in patients under five. Therefore, we settled on a safe and well-tolerated pediatric range of ropivacaine 0,3-0,5mL 0,2% Ropivacaine [2]. We recognize that the efficacy of PENG blocks has yet to be demonstrated in prospective clinical trials in the pediatric population. Nevertheless, our observations were encouraging, but future studies of PENG efficacy and safety in the pediatric population are warranted.

Supplementary: The following supporting information can be downloaded at the website of this paper posted on Preprints.org. Figure 1. Sonoanatomy of PENG. Figure 2. PENG block. Table 1. Characteristics of Patients. Table 2. Surgery and postoperative course.

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