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Pain Management for Pediatric Hip Surgery with Lumbar Erector Spinae Plane Block: A Case Series

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Abstract

Background: Multimodal strategies are frequently used to manage postoperative pain after pediatric hip surgery, including spinal and epidural techniques. The lumbar erector spinae plane (ESP) block is a novel, less invasive regional anesthesia option that may offer improved postoperative analgesia in this population.

Methods: This retrospective case series included 11 pediatric patients who underwent Pemberton osteotomy surgery and received lumbar ESP block(s). Intraoperative block medications, anesthetic techniques, surgical characteristics, postoperative observational pain scores, opioid consumption, length of stay, and side effects were recorded.

Results: The mean intraoperative total opioid consumption consisted of fentanyl 2.1 ± 1.6 mcg/kg and morphine 0.05 ± 0.06 mg/kg. The mean postoperative pain scores (scale 1-10) were 0.4 ± 0.5; maximum pain scores were 2.0 ± 2.4. The mean length of stay was 30.2 ± 10.3 hrs. Postoperative nausea was observed in 36% of patients; none had respiratory depression or urinary retention. The ESP block medications included ropivacaine or bupivacaine with one or more duration-prolonging adjuvants.

Conclusions: Lumbar ESP blocks provide effective analgesia for the management of pediatric pain after hip surgery, and potentially mitigate some of the risks associated with spinal and epidural techniques.

Keywords: Hip; Pelvic osteotomy; Nerve block; Erector spinae plane block; Pediatric

Introduction

Pemberton osteotomy is a surgical procedure used to treat moderate to severe congenital hip dysplasia in children. This method involves creating a wedge-shaped pelvic osteotomy and inserting an iliac bone graft to allow for realignment of the hip socket [1]. Postoperative pain management is accomplished using multimodal strategies that include non-opioid and opioid analgesics, as well as regional anesthesia.

Opioids analgesics have well-described side effects such as sedation, respiratory depression, nausea, and urinary retention. Another common approach to pain relief after this surgery is to perform a continuous epidural or single-injection spinal anesthetic. These techniques, however, usually involve administering neuraxial opioids, which provide effective pain relief, but also have opioid-related side effects [2]. Additionally, neuraxial local anesthetics can cause motor weakness impairing postoperative examination.

A novel regional anesthesia technique called the erector spinae plane (ESP) block was first described in 2016 for the treatment of thoracic neuropathic pain [3] and has since been used for a variety of indications. When performing an ESP block, a large volume of dilute local anesthetic is injected into the fascial plane between the vertebral transverse process and the overlying erector spinae muscle group. This local anesthetic spreads to dorsal and, potentially, ventral rami through the paravertebral space. At the lumbar level, the ESP block may provide similar sensory coverage to a lumbar plexus block. In pediatrics the ESP block has been primarily studied in abdominal and thoracic surgery [4]; in the adult literature the lumbar ESP block has demonstrated its analgesic effectiveness for hip and proximal femoral surgery [5].

In 2019 we began performing the ultrasound-guided lumbar ESP block for Pemberton osteotomy surgery. This retrospective, consecutive case series details our initial experience with single-injection lumbar ESP blocks, with a specific focus on intraoperative opioid consumption, postoperative opioid consumption, hospital length of stay, postoperative pain scores, and side effect incidence. Additionally we report our lumbar ESP block technique, including local anesthetic and adjuvant agents employed.

Materials and Methods

After approval was granted for this investigation by the WGC IRB on Jan 31, 2022 (Study No. NCA2125R), we conducted a retrospective reviewed of the charts of all patients who underwent Pemberton pelvic osteotomy procedures and received a lumbar ESP block injection between January 2016 and September 2021. We identified 11 charts for data query, which included patient demographics, medication administration records, operative details, pain scores, and hospital length of stay. Hospital length of stay was defined as the time period from end-surgical time to time of discharge from the hospital. The post-operative period refers to the time subsequent to post-anesthesia care unit (PACU) discharge and concludes with discharge from hospital. Nurse-reported 1-10 observational pain scores were used, which included the assessment of consolability, muscle tension, facial expression, crying, and activity. Means and standard deviations were calculated for all quantitative variables.

All patients were managed with a standard anesthetic regimen. After inhalational induction of general anesthesia, intravascular access placement, and endotracheal intubation, unilateral or bilateral ESP blocks were performed in accordance with the operative side(s). The blocks were performed by a small team of attending pediatric anesthesiologists with extensive experience with ultrasound-guided peripheral nerve blocks. Patients were positioned prone, and ultrasound visualization was achieved using a small linear probe in sagittal orientation, beginning at the level of the iliac crests to identify the L3 and L4 lumbar vertebrae (Figure 1).

Figure 1: Patient positioning and set-up for lumbar ESP Block. Image courtesy of https://www.baby-blocks.com/block-detail/lumbar-erector-spinae-plane-block.

Transverse processes were identified by sliding the probe from medial to lateral, and then an echogenic needle was advanced to touch down on the transverse process just deep to the erector spinae muscle group. Correct fascial plane entry was confirmed by hydro-dissection with normal saline, following which local anesthetic was injected (Figure 2) with weight-adjusted volume ranging from 10mL to 15mL. Local anesthetic type and the addition of block-prolonging adjuvants were chosen by the anesthesiologist.

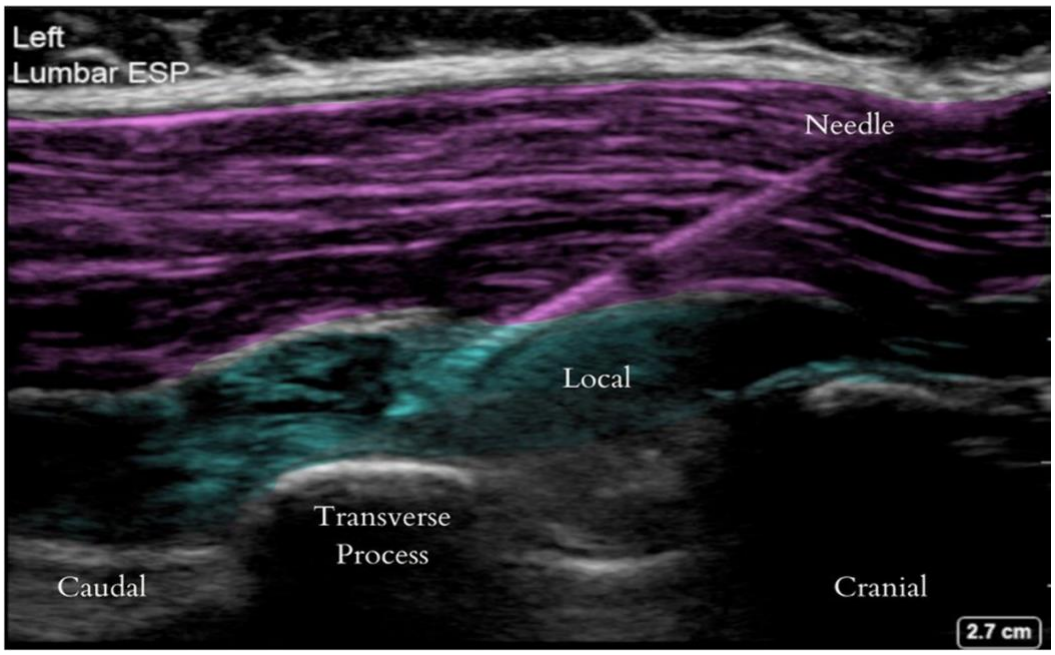

Figure 2: Ultrasound-guided placement of local anesthetic in the fascial plane between the erector spinea muscle group and the lumbar transverse processes. Image courtesy of https://www.baby-blocks.com/block-detail/lumbar-erector-spinae-plane-block.

Surgery then proceeded with a Pemberton osteotomy in all cases following the technique as originally described utilizing a curvilinear cut through both inner and outer tables of the ilium extending to the posterior limb of the triradiate cartilage [1]. As a reshaping osteotomy, the acetabulum was then hinged on the triradiate cartilage to improve acetabular coverage both anteriorly and laterally. In this series, trapezoid allograft was used to maintain the correction without further stabilizing implants. A spica cast was placed based on surgeon preference. No additional local anesthetic was administered by the surgeons.

Intraoperative anesthetic maintenance consisted of inhalational anesthesia with sevoflurane. Patients were administered multimodal pain medications, including intraoperative opioids, at the anesthesiologist's discretion. All patients were extubated at the end of the procedure without complication.

Postoperatively, all patients received weight-based acetaminophen every 4-6 hours and ketorolac every 6 hours. Opioids were ordered at the discretion of the anesthesia service while patients were in the PACU and by the surgical service for the remainder of the hospitalization. Patients were discharged home after their pain was controlled on oral analgesics.

Results

During the study period 11 patients received ESP blocks for Pemberton osteotomy surgery, all of whom were included in the analysis. Six of the patients were male and five were female, with a mean age of 6.3 ± 1.4 years. All patients were classified as ASA 1 or 2. The mean surgical duration was 2.7 hours with 27% of cases being bilateral and 27% including additional femoral surgery. Thirty-six percent of patients were placed into a spica cast at the conclusion of the case. (Table 1). The majority of ESP blocks utilized ropivacaine with one or more of the perineural adjuvants to prolong block duration: clonidine, buprenorphine, and dexmedetomidine. Bupivacaine combined with liposomal bupivacaine (Exparel®) was used in 18% of cases (Table 2).

Table 1: Patient Demographic and Surgical Characteristics.

Patient	Age (yr)	Sex	Weight (kg)	ASA Class	Surgery Duration (hr)	Bilateral Surgery	Femoral-Sided Surgery	Spica Cast Applied
1	9	F	20.7	1	3.2		Femoral osteotomy	Double leg
2	8	M	26.3	1	2.1		None	Single leg
3	5	M	15.6	1	3.5	+	Hardware removal	None
4	7	M	26.3	1	2.0		None	None
5	7	F	24	1	1.9		None	None
6	6	M	18.1	1	2.2		None	None
7	5	M	15.6	2	1.8		None	None
8	4	F	17.2	1	3.6	+	None	Double leg
9	6	F	22.4	1	3.1		Guided growth	None
10	6	F	23.9	1	2.3		None	Single leg
11	6	M	18.6	1	4.1	+	None	None
Mean	6.3		20.8		2.7			
SD	1.4		4.0		0.8			
Range	5-9		15.6-26.3		1.8-4.1			

Abbreviations: SD: Standard deviation; **F:** Female; **M:** Male; **ASA Class:** American Society of Anesthesiology Classification.

Table 2: Intraoperative Anesthetic Characteristics.

Patient	ESP Block Local Anesthetic Type	ESP Block Additive Medication(s)	Fentanyl IV (mcg/kg)	Morphine IV (mg/kg)	Acetamin-ophen IV	Ketorolac IV	Ketamine IV
1	Ropivacaine 0.2%	Clonidine	1.8	0.0	+	+	
2	Ropivacaine 0.2%	Buprin	0.0	0.1	+	+	+
3	Ropivacaine 0.25%	Buprin	3.2	0.0	+	+	+
4	Ropivacaine 0.2%	Buprin + Dex	2.9	0.1	+	+	
5	Ropivacaine 0.2%	Buprin + Dex	2.1	0.0		+	
6	Ropivacaine 0.2%	Buprin + Dex	0.0	0.0		+	
7	Ropivacaine 0.2%	Buprin + Dex	3.8	0.1	+	+	
8	Ropivacaine 0.2%	Buprin + Dex	1.7	0.0	+	+	
9	Ropivacaine 0.2%	Buprin + Dex	4.5	0.0	+	+	+
10	Bupivacaine 0.25%	Exparel 1.3%	3.1	0.1	+	+	
11	Bupivacaine 0.25%	Exparel 1.3%	0.0	0.2	+	+	
Mean			2.1	0.05			
SD			1.6	0.06			
Range			0-4.5	0-0.2			

Abbreviations: ESP: Erector spinea plane; **Buprin:** Buprenorphine; **Dex:** dexmedetomidine.

Intraoperatively, all patients received ketorolac and ondansetron, with the majority also receiving IV acetaminophen (81%) and dexamethasone (90%). The mean intraoperative IV fentanyl consumption was 2.1 ± 1.6 mcg/kg. Long-acting intraoperative IV opioid consumption consisted of morphine at a mean dose of 0.05 ± 0.06 mg/kg. Ketamine was administered to 27% of patients (Table 2).

The mean length of stay was 30.2 ± 10.3 hours. Observational pain scores were consistently 0 throughout the postoperative hospital stay in 55% of patients. The mean and maximum postoperative pain scores are displayed for each patient in Table 3. Only one patient required a single dose of hydromorphone in PACU, otherwise no other patients required PACU opioids. During the remainder of the post-operative period, 45% of patients required no opioids, while 27% required only one dose of oral oxycodone. The mean total oxycodone administered was 0.12 ± 0.15 mg/kg. Breakthrough IV pain medications were ordered on an as-needed basis; however, no patient required them.

Anti-emetic medication was administered to 36% of patients during their postoperative hospital course. No patients required treatment for respiratory depression. No patients required treatment for urinary retention (Table 3).

Table 3: Postoperative Characteristics.

Patient	LOS (hr)	Mean Obs Pain Score (1-10)	Max Obs Pain Score (1-10)	Oxycodone Scheduled or PRN	# of Doses Oxycodone Given	Total Oxycodone Given (mg/kg)	Side Effects (N, RD, U)
1	24.6	1.4	5	Scheduled	4	0.33	N
2	27.3	0	0	PRN	0	0.00	
3	27.2	0	0	PRN	0	0.00	N
4	49.7	0	0	PRN	0	0.00	
5	25.1	0	0	PRN	1	0.08	N
6	52	1	5	PRN	4	0.38	
7	26.6	0	0	PRN	0	0.00	N
8	24.2	0.6	5	PRN	1	0.09	
9	26.1	0.3	2	PRN	0	0.00	
10	25.2	0	0	Scheduled	4	0.33	
11	23.7	0.6	5	PRN	1	0.10	
Mean	30.2	0.4	2.0		1.4	0.12	
SD	10.3	0.5	2.4		1.7	0.15	
Range	23.7-52.0	0-1.4	0-5		0-4	0-0.38	

Abbreviations: LOS: Length of stay; **Obs:** Observational; **Max:** Maximum; **PRN:** Pro re nata indicating "as needed"; **N:** Nausea requiring antiemetic therapy; **RD:** Respiratory depression requiring naloxone therapy; **U:** Urinary retention requiring catheterization.

Discussion

In our retrospective case series, lumbar ESP blocks provided effective analgesia for pediatric patients undergoing Pemberton osteotomy surgery for developmental hip dysplasia. Nearly half of the patients required no opioids postoperatively and the majority were discharged on post-operative day one. Single-injection ESP blocks may be a reasonable alternative to the more commonly utilized single-injection spinal or continuous epidural techniques, which carry significant side-effects and require additional postoperative monitoring and resources. Urinary retention is a known complication of neuraxial anesthetics, often requiring maintenance of urinary catheters. There were no patients in our case series with urinary catheters in the post-operative period and no patients needed treatment for urinary retention. Moreover, continuous postoperative cardio-respiratory monitoring was not required as no neuraxial opioids or continuous infusions of local anesthetics were administered. Furthermore, ESP blocks provided the additional benefit of allowing for postoperative motor examination.

Studies utilizing the lumber ESP block for pediatric hip surgery are limited to two case reports [6,7] and one randomized controlled trial by Abdualla et al [8]. These studies highlight the lumbar ESP block's potential for providing effective intraoperative and postoperative analgesia. Our study is consistent with these findings and adds to the current body of literature. In reviewing our cases for side effects we encountered a higher rate of postoperative nausea than expected. This is usually a rare occurrence in the pediatric population and may be attributed to our off-label addition of duration-prolonging additive medications to standard local anesthetics [9]. Buprenorphine, in particular, can extend block duration by up to 8 hours, however it has the known side effect of nausea [10].

Four of our 11 cases experienced nausea requiring a single dose of antiemetic and three of these four patients received buprenorphine as an additive block medication. Liposomal bupivacaine, an extended-release formulation of bupivacaine, was approved for use in pediatric patients age ≥ 6 years in March, 2021 and may provide up to 72 hours of analgesia. Two of the cases in our series received liposomal bupivacaine as an additive medication in their ESP blocks. Neither of these patients required antiemetic therapy postoperatively, though our sample size is too small to draw any associated conclusions.

Limitations of our investigation include its small sample size and its retrospective nature. Nonetheless, our consecutive case series shows that the lumbar ESP block may be an effective technique for the management of pain for pediatric hip surgery. Further studies with larger sample sizes and randomized controlled trials are warranted to confirm these findings.

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