Epidural analgesia is superior to local infiltration analgesia in children with cerebral palsy undergoing unilateral hip reconstruction

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Background and purpose — Treatment of postoperative pain in children with cerebral palsy (CP) is a major challenge. We investigated the effect of epidural analgesia, high-volume local infiltration analgesia (LIA), and an approximated placebo control on early postoperative pain in children with CP who were undergoing unilateral hip reconstruction.

Patients and methods — Between 2009 and 2014, we included 18 children with CP. The first part of the study was a randomized double-blind trial with allocation to either LIA or placebo for postoperative pain management, in addition to intravenous or oral analgesia. In the second part of the study, the children were consecutively included for postoperative pain management with epidural analgesia in addition to intravenous or oral analgesia. The primary outcome was postoperative pain 4 h postoperatively using 2 pain assessment tools (r-FLACC and VAS-OBS) ranging from 0 to 10. The secondary outcome was opioid consumption over the 21-h study period.

Results — The mean level of pain 4 h postoperatively was lower in the epidural group (r-FLACC: 0.7; VAS-OBS: 0.6) than in both the LIA group (r-FLACC: 4.8, p = 0.01; VAS-OBS: 5.2, p = 0.02) and the placebo group (r-FLACC: 5.2, p = 0.01; VAS-OBS: 6.5, p < 0.001). Corrected for body weight, the mean opioid consumption was lower in the epidural group than in the LIA group and the placebo group (both p < 0.001).

Interpretation — Epidural analgesia is superior to local infiltration analgesia for early postoperative pain management in children with cerebral palsy who undergo unilateral hip reconstruction.

Many children with severe cerebral palsy (CP) undergo hip reconstruction. Treatment of postoperative pain in these often cognitively impaired children is a major challenge, mainly because they cannot adequately self-report their pain (Long et al. 2009).

Treatment of postoperative pain after femoral and pelvic osteotomies is especially difficult, as these procedures may require a postoperative casting or bracing. Postoperative pain, muscle stretching due to fixed position of the legs and the surgical trauma can cause an increase in painful muscle spasms, creating a vicious circle (Nolan et al. 2000, Lubicky 2003, Koman et al. 2004). A variety of different pain management strategies have been used, most often epidural analgesia. However, there are several concerns regarding the use of epidural analgesia. Firstly, epidural analgesia is associated with undesired side effects such as urinary retention and unevenly distributed motor block in the right and left leg, causing inadequate analgesia, hypotension, nausea, sedation, and pruritus (Brenn et al. 1998). Secondly, children with CP often have intrathecal baclofen pumps for the management of severe spasticity of the lower extremities, and whether it is safe to insert an epidural catheter in such patients is a controversial issue. Thirdly, children with CP often have varying degrees of scoliosis, which might make insertion of an epidural catheter difficult. Finally, it is difficult to monitor for serious adverse events such as epidural hematoma or infection (Ali Sakr Esa et al. 2009, Muthusamy et al. 2010, Ganapathy 2012, Rawal 2012). In spite of the disadvantages of epidural analgesia, it is often the first choice in postoperative pain management in children with CP due to a seemingly good effect on both pain and spasticity (Nolan et al. 2000). Nevertheless, only a few

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studies have systematically investigated this issue. One study (Moore et al. 2013) investigated children with CP after selective dorsal rhizotomy and found lower pain scores in the epidural analgesia group than in a systemic fentanyl and diazepam group.

Kerr and Kohan (2008) documented the positive effect of high-volume local infiltration analgesia (LIA) in adults after hip or knee replacement. A mixture of ropivacaine, ketorolac, and adrenaline was infiltrated around all structures subject to surgical trauma, followed by postoperative bolus injections through a small catheter. This method of postoperative pain management has since gained widespread use, primarily in adults (Andersen et al. 2007, 2010, Essving et al. 2010, Leelanukrom et al. 2012). LIA has been investigated for postoperative pain management in children and infants mainly undergoing abdominal surgery (Leelanukrom et al. 2012), but never in children with CP or children undergoing orthopedic surgery.

We tested the efficacy of epidural analgesia and LIA for the management of early postoperative pain in children with CP using both a randomized, double-blind, placebo-controlled design and a prospective consecutive cohort. The primary outcome was early postoperative pain at 4 h assessed using the revised "face, legs, activity, cry, and consolability" pain score (r-FLACC) and the observational visual analog scale (VAS-OBS). The secondary outcomes were opioid consumption during the 21-hour study period and postoperative pain at 9 and 21 hours.

Patients and methods

Patients

18 children were enrolled at the Department of Children's Orthopedics at Aarhus University Hospital from September 2009 to November 2014. No changes in the surgical or postoperative treatment protocols were made during the study period. Originally, 24 children had been screened for eligibility during the first study period; 5 did not meet the inclusion criteria, 5 declined participation, and 2 were not included for other reasons. The CONSORT 2010 Guidelines were used in the screening. Thus, 12 children (aged 3–13 years, 7 boys) with CP with varying levels of cognitive impairment were included for the first study period and randomized to either LIA or placebo. In the second study period, 6 children (aged 5–11 years, 3 boys) who met the inclusion criteria were consecutively included for epidural analgesia postoperatively. Written informed consent was obtained from both parents before inclusion. Demographic and surgical variables were similar in the 3 groups (Table 1). Gross Motor Function Classification System (GMFCS) score was assessed by chart review. All children had preoperative radiographic evaluation including assessment of the acetabular index (AI) and migration percentage (MP) on the side of surgery and in the contralateral hip (Table 1). 5 children had severe bilateral pathology with an MP of the contralateral hip of > 40%. The radiographic measurements of 12 hips (4 from each group) were re-assessed after a period of 2 weeks and the average coefficient of variation (CoV) showed very good reproducibility of the measurements (CoV MP: 0.025; CoV AI: 0.025). Inclusion criteria were planned unilateral femoral and pelvic osteotomy, planned postoperative hip spica casting, and age < 18 years. Exclusion criteria were previous surgical interventions in the same anatomical region, multiple-level surgery, known allergy to or intolerance of study drugs, or implanted intrathecal baclofen pump.

Table 1. Baseline demographics and surgical data. Most values are median (range). There were no significant differences between groups

	LIA (n = 5)	Epidural (n = 6)	Placebo (n = 6)
Demographic data			
Age, years	8 (5–13)	7.5 (5–11)	6.5 (3–10)
Weight, kg	20 (15–33)	20 (16–25)	16 (14–25)
Sex (M/F)	2/3	3/3	4/2
GMFCS (no. of patients)	IV:4; V:1	III:1; IV:2; V:3	IV:4; V:2
MP – side of surgery, %	65 (41–82)	59 (42–100)	58 (29–100)
MP – contralateral hip, %	31 (0–84)	24 (08–85)	26 (13–47)
AI – side of surgery	31 (19–35)	27 (22–39)	32 (24–36)
AI – contralateral hip	30 (5.2–37)	20 (12–33)	24 (13–31)
Surgical data			
Side of surgery (right/left)	3/2	4/2	3/3
Blood loss, mL	300 (216–950)	250 (150–450)	350 (225–430)
Duration of surgery, min	190 (165–245)	228 (179–290)	233 (175–245)
Duration of anesthesia, min	300 (260–355)	325 (285–435)	323 (290–435)
Temperature (°C) [a]	36.9 (36.0–37.2)	36.9 (36.5–37.5)	37.5 (35.5–38.5)

[a] At the end of anesthesia.
GMFCS: gross motor function classification system;
MP: preoperative migration percentage.
AI: preoperative acetabular index;

Design

The first part of the study was designed as a prospective, randomized controlled trial. All the children included were randomized to receive either local infiltration analgesia or placebo for postoperative pain management. In addition, all the children received intravenous or oral analgesia and subsequent bolus administration of the randomized treatment at 8 and 20 h postoperatively. In the second part of the study, the children were consecutively included for postoperative pain management with epidural analgesia in addition to intravenous or oral analgesia.

For all 3 groups, the study period ended 21 h postoperatively and pain assessments were made at 4 h, 9 h, and 21 h

postoperatively. Opioid consumption was assessed in the total period of anesthesia, the last 30 min of anesthesia, during the first 4 postoperative hours, from 4–9 hours, and from 9–21 hours. For the LIA and placebo group, an algorithm was set up for deciding if the postoperative pain management should be supplemented with epidural analgesia. The decision was made at the bedside, by the primary investigator (LKP). If 2 of the 3 following items could be answered affirmatively at any time during the study period, the pain management was supplemented with epidural analgesia and the child was excluded from further analysis: (1) pain ≥ 5 using the VAS-OBS (assessed by parents or primary caregivers), (2) pain ≥ 5 using the r-FLACC (assessed at the bedside by the investigator), and (3) a sufficient amount of opioids had been administered. After the 21-h study period, the children in the LIA and placebo groups were switched to epidural analgesia and the children in the epidural group continued with epidural analgesia.

Surgery and anesthesia

On the ileum, the osteotomy was either the innominate osteotomy of Pemberton or Salter (Pemberton 1965, Salter 1966) using a modified Smith-Peterson approach combined with a shelf augmentation. The femoral osteotomy was made just below the trochanter minor through a standard lateral incision and the necessary shortening, derotation, and varisation was performed. All patients underwent additional adductor release through a small medial groin incision, rectus femoris release through the modified Smith-Peterson incision at the ileum, and iliopsoas release at the level of the trochanter minor through the lateral femoral incision after femoral osteotomy was performed. All surgeries were performed by 2 surgeons (OR and BMM).

Surgery was performed with the child under general anesthesia using propofol and/or sevoflourane, and remifentanil. In all 3 groups, an epidural catheter was inserted and tested for correct placement. During the anesthesia and postoperatively, the epidural group received continuous epidural analgesia with bupivacaine (2.5 mg per m), which was maintained for the first 2–3 days (even though the study period ended 21 h postoperatively). The LIA and placebo group only received epidural analgesia during the 21-h study period if it was found necessary as rescue analgesia, according to the algorithm described above. After the end of the study, epidural infusion was initiated and maintained for the first 2–3 days. All children were transferred to the intensive care unit (ICU) postoperatively, where the pain treatment consisted of paracetamol (15 mg/kg × 4 p.o. or rectally), fentanyl (0.5–1 μg/kg i.v.), or morphine (0.05–0.1 mg/kg i.v.) administered when needed, as assessed by the ICU nurse monitoring the child.

Randomization and blinding

In the first part of the study, the children were assigned to 2 groups using a block randomization procedure with a block size of 6, i.e. 6 children in the LIA group and 6 children in the placebo group. The randomization envelope was opened and the dosage of ropivacaine or saline was calculated by a anesthetist nurse not involved in the ongoing surgery or in later care of the child, thus keeping the investigator and the surgeons blinded. Ropivacaine and saline are clear fluids of similar viscosity, so it was not possible for the surgeon to guess the content of the syringe when infiltrating. In the second part of the study, all the children received epidural analgesia.

Local infiltration analgesia

Both the LIA group and the placebo group received intraoperative infiltration and boluses 8 h and 20 h postoperatively. The dosage for the LIA group was ropivacaine (2 mg/kg) and epinephrine (5 μg/mL) as infiltration and ropivacaine (0.5 mg/kg) as bolus. The concentration of the ropivacaine used was 2 mg/ml, which for a child of 30 kg amounts to a volume of 30 mL to be infiltrated and a volume of 7.5 mL to be given as bolus. Identical volumes of isotonic saline were used in the placebo group.

All infiltrations were performed by the same surgeon (OR) using the "moving needle" technique described by Kerr and Kohan (2008). The total infiltration was divided according to a standardized distribution algorithm. One-third of the total volume was injected in relation to the femoral osteotomy and distributed evenly in the vastus lateralis. Two-thirds of the total volume was distributed adjacent to the pelvic osteotomy with 20% in the area where the lateral femoral cutaneous nerve exits the pelvis, 40% in the gluteal muscle, and 40% in the most proximal part of the femoral quadriceps muscle. The infiltration was done just before wound closure. 2 catheters for postoperative bolus injections were inserted in close proximity to each osteotomy, and with exits proximal to the wound by subcutaneous tunneling.

Assessment of pain

2 methods were used for objective postoperative pain assessment. Firstly, the r-FLACC score (range 0–10) was assessed by using a 2-min video recording of the child (Malviya et al. 2006). Secondly, the VAS-OBS score (range 0–10) was used at the bedside, where the parents or primary caregivers estimated the pain intensity in the child at the same time as the video recording (Dijk et al. 2002). All recordings were performed in a standardized manner at 4, 9, and 21 h after the child was awakened from anesthesia. The 2-min observation time was chosen in accordance with a study on clinical feasibility of the r-FLACC score, in which nurses were able to complete the r-FLACC score in less than 1 min (Crosta et al. 2013). After the end of the study period, the video recordings were viewed by a registered nurse experienced in the care and pain management of children with CP, in order to assign an r-FLACC score to be used in the subsequent data analysis. The recordings were reviewed in random order, and the registered nurse was blinded to the treatment allocation.

The r-FLACC score consists of 5 subgroups (face, legs, activity, cry, and consolability) in which the child can be assigned 0, 1, or 2 points related to specific pain reactions. In the video recording a close-up of the face, the legs and the full body of the child was taken. Preoperatively, the parents or primary caregivers completed a questionnaire regarding the individual pain behavior of the child relating to each subgroup of the r-FLACC score. These answers were added to the r-FLACC score before the r-FLACC score assignment by the registered nurse. The r-FLACC score had previously been translated into Danish by the same research group using the international guideline set up by the Translation and Cultural Adaptation Group (TCA) – Principles of Good Practice (PGP) (Wild et al. 2005).

Statistics

Data analysis was performed using STATA version 11. Before the statistical analysis, all continuous data were plotted to assess normal distribution (QQ plots, SD test). Analyses of the r-FLACC scores, the VAS-OBS scores, and the opioid consumption were carried out using the 2-sample Student t-test with equal variances (unpaired) for normally distributed data. Any p-value of < 0.05 was considered to be significant.

A sample size calculation for the first part of the study was based on an expected difference between the LIA group and the placebo group of 5 points on the r-FLACC score (SD 3) 4 h postoperatively. With 80% power, the significance level (α) at 0.05, and the risk of type-II error (β) at 0.2, a total sample size of 12 children would be required. In the second part of the study, identical assumptions were made for the epidural group and the LIA group, resulting in an equal sample size of 12 children in total.

Ethics

The study was approved by the Committee on Health Research Ethics, Central Denmark Region (M-20080207), the Danish Medicines Agency (EudraCT. no 2008-006913-26), and the Danish Data Protection Agency, and was conducted in accordance with the Helsinki Declaration. It was registered at clinicaltrials.gov (NCT00964639), conducted in accordance with the guidelines for Good Clinical Practice (GCP), and monitored by the GCP unit of Aarhus University Hospital.

Results

A lower level of pain at 4 h postoperatively was found in the epidural group than in both the LIA group and the placebo group, as assessed by both r-FLACC ($p = 0.01$ and $p = 0.01$, respectively), and VAS-OBS ($p = 0.02$ and $p < 0.001$). In addition, statistically significantly lower values were found in 4 subgroups of the r-FLACC score (legs, activity, cry, and consolability) in the epidural group than in the LIA group. Significantly lower values in all 5 subgroups of the r-FLACC score were found in the epidural group than in the placebo group. No significant differences between the LIA group and the placebo group were found at 4 h postoperatively (Table 2).

Regarding the level of pain, there were lower r-FLACC and VAS-OBS scores 9 h and 21 h postoperatively in the epidural group than in both the LIA group and the placebo group (Table 2). 2 of 5 children in the LIA group met the criteria for supplementary epidural analgesia and 5 of 6 children in the placebo group met the criteria for supplementary epidural analgesia.

A secondary outcome was the mean opioid consumption perioperatively, during the first 4 postoperative hours, from 4 to 9 hours, and from 9 to 21 hours, corrected for body weight (fentanyl equivalent dosages per kg). Perioperatively, the total mean opioid consumption and the mean opioid consumption during the last 30 min of anesthesia were lower in the epidural group than in the LIA group ($p = 0.01$ and $p = 0.3$, respectively) and the placebo group ($p = 0.09$ and $p = 0.03$). No significant differences in perioperative opioid consumption between the LIA group and the placebo group were found. At both 4 h and 9 h postoperatively, the mean opioid consumption was lower in the epidural group than in both the LIA group ($p < 0.001$ and $p < 0.001$, respectively) and the placebo group ($p < 0.001$ and $p < 0.001$) (Table 2).

1 child in the LIA group received epidural analgesia though not needing it, and was excluded from data analysis. The parents of 1 child in the epidural group were not able to use the VAS-OBS score, which led us to exclude VAS-OBS data for that patient. Complete pain questionnaires for the r-FLACC were returned for 16 children. No serious adverse effects from LIA or epidural analgesia were observed during the study period or the remaining hospital stay. After the end of the study period, 4 patients accidently removed the epidural catheter but reinsertion was not found to be necessary.

Discussion

To our knowledge, this is the first randomized, controlled double-blind trial to focus on LIA in children with CP who undergo major orthopedic surgery. We found that epidural analgesia is superior to LIA for early postoperative pain management in children with CP who are undergoing unilateral hip reconstruction.

Dahl and Rasmussen (2012) introduced a 3-arm study design to compare the efficacy of a new intervention and an established intervention, and named the third arm an "approximated placebo control". Our study incorporated this 3-arm study design, with the placebo group being an "approximated placebo control" given basic oral or intravenous analgesia (paracetamol, opioids), both routinely and when needed. This approach increases assay sensitivity as well as improving the detection of clinically relevant differences. A limitation of the second part of the study was that the epidural group and the LIA group were compared as 2 cohorts and not as random-

Table 2. Postoperative pain and opioid consumption. Values are mean (SD)

	LIA	p-value [a]	Epidural	p-value [b]	Placebo	p-value [c]
Perioperatively						
No. of patients	4 [d]		6		6	
Total opioid consumption, µg/kg/min	0.63 (0.15)	0.01	0.31 (0.17)	0.09	0.66 (0.42)	0.9
30-min opioid consumption, µg/kg/min [e]	0.33 (0.18)	0.3	0.20 (0.16)	0.03	0.50 (0.25)	0.3
Epidural analgesia (n) [f]	0		6		0	
4 hours postoperatively						
No. of patients	5		6		6	
Opioid consumption, µg/kg	6.3 (2.8)	< 0.001	0.5 (0.7)	0.00	7.8 (3.1)	0.4
r-FLACC score, range 0–10	4.8 (3.0)	0.01	0.7 (0.8)	0.01	5.2 (3.3)	0.9
VAS-OBS score, range 0–10 [g]	5.2 (3.3)	0.02	0.6 (0.9)	0.00	6.5 (2.4)	0.5
Rescue epidural analgesia (n) [f]	0		6		0	
9 hours postoperatively						
No. of patients	4		6		4	
Opioid consumption, µg/kg	3.1 (0.3)	< 0.001	0.2 (0.3)	0.01	3.5 (1.3)	0.8
r-FLACC score, range 0–10	3.8 (2.2)	0.3	2.2 (2.0)	0.8	2.8 (2.0)	0.7
VAS-OBS score, range 0-10 [g]	3.3 (1.9)	0.2	1.4 (1.9)	0.05	5.3 (1.9)	0.3
Rescue epidural analgesia (n) [f]	1		6		2	
21 hours postoperatively						
No. of patients	3		6		1	
Opioid consumption, µg/kg	2.6 (1.0)		1.4 (2.3)		0	
r-FLACC score, range 0–10	0.7 (1.2)		1.8 (2.1)		0	
VAS-OBS score, range 0–10 [g]	1 (1)		0.8 (1.8)		4	
Rescue epidural analgesia (n) [f]	2		6		5	

[a] Between LIA and epidural values.
[b] Between epidural and placebo values.
[c] Between placebo and LIA values.
[d] 1 patient was excluded immediately after surgery and 1 patient had missing perioperative opioid consumption data.
[e] 30-min opioid consumption: opioid consumption during the last 30 min of anesthesia.
[f] The epidural group received epidural analgesia perioperatively and during the study period. The LIA and placebo groups did not receive epidural unless it was needed as rescue analgesia.
[g] The parents of 1 patient were not able to use the VAS-OBS.

ized controlled groups, thus reducing the strength and level of evidence. On the other hand, we found the results to be so unequivocal that they compensated for the lower level of evidence. If a randomized controlled trial between LIA and epidural were to be set up, it would be a comparison between 2 established treatments—with a power calculation showing the need for a large study population. Due to the heterogeneity of the study population, we assumed that this would be impossible to achieve in a reasonable time frame. Our initial hypothesis was that LIA would adequately manage early postoperative pain in children with CP who undergo unilateral hip reconstruction. We therefore chose to design the first part of the study as a randomized controlled trial between LIA and an approximated placebo. Other possible limitations of the study were the small numbers of patients and the long inclusion time, although the patient number was based on a power calculation that called for 6 patients in each group, and no changes in the surgical or postoperative treatment protocols were made during the period of the study. In addition, at the start of the study period the 2 surgeons who performed all the operations were already experienced in the procedure, so there was no additional learning curve during the study period.

The study used 2 different independent (and validated) pain scores—with the advantage that they both range from 0–10, making them comparable. The 2 pain scores complement each other and have different advantages and disadvantages. The VAS-OBS score is assessed by the parents whereas the r-FLACC score is assessed by a registered nurse. Furthermore, the time span that the parents VAS-OBS score is based on might be longer than the fixed 2 min of video recording that is the basis of the r-FLACC score. The VAS-OBS score is assessed at the bedside, whereas the r-FLACC score is based on a video recording. The advantages of using a video recording for the r-FLACC scoring are the possibility of testing intra- and inter-rater reliability, the standardized set-up, and the objectiveness of the person rating the video. One could argue that for the patients treated with epidural analgesia, assessment of leg movements in the "leg" subgroup of the r-FLACC score is difficult, due to possible motor block. However, movements of the legs were documented in several of the patients in the epidural group. In addition, it is noteworthy that for the individual patients in the epidural group, several of the children had a score of 1 (range 0–2) in the "legs" subgroup. If there was marked affection from the epidural block, one would have expected all the children in the epidural group to have scored 0 in the "leg" subgroup. We are convinced that the epidural block did not affect the total r-FLACC score in a significant way.

Our study benefited from having a randomized and double-blind design, and substantiates the idea that epidural analgesia is superior to LIA for early postoperative pain management in children with CP who undergo unilateral hip reconstruction. In addition, a high proportion of patients in the LIA group—and especially in the placebo group—had to be switched to epidural analgesia for adequate pain management.

There has been a lack of well-designed and executed trials regarding the dosage of ropivacaine for LIA in children. A higher dosage of ropivacaine than used in our study would most likely be safe and more efficient, though no consensus has been reached internationally regarding safe dosages for children. A limitation of the LIA technique in children undergoing multiple site infiltration is the lower dose of ropivacaine per site, since the total dose used is based on the patient's body weight. In addition, we did not infiltrate the site of the medial adductor release with ropivacaine, which might have affected the level of pain. On the other hand, the amount of pain arising from the medial tendon release may be of minor importance compared to the extensive bony and soft tissue procedures performed on the ileum and femur.

LIA has mainly been studied in relation to hip and knee replacement surgery in adults (Rawal 2011, Lubicky 2003, Lunn et al. 2011). Several randomized controlled trials have investigated the effect of local infiltration analgesia in adults, but unfortunately using different study designs and modifications from the original LIA technique (Andersen et al. 2007, Essving et al. 2010). The discussion of local infiltration analgesia has continued in a number of reviews on the topic (Kehlet and Andersen 2011, Rawal 2011). Postoperative pain management with epidural analgesia is commonly considered to be the standard treatment in both adults and children. Nolan et al. (2000) discussed the beneficial effects of epidural analgesia in children with CP regarding spasticity, since an excellent epidural block will prevent muscle spasms caused by a pain-induced spinal reflex. We found a significantly lower level of pain in the children treated with epidural analgesia than in those treated with LIA, which was most likely due to both the sensory block and the reduced level of muscle spasms prevented by the epidural analgesia. Thus, the higher level of pain in the LIA group might be partly attributable to the lack of muscle spasm inhibition. Brenn et al. (1998) concluded that children with CP have considerable pain and spasms after orthopedic surgery, and that epidural infusion provides good analgesia with few side effects. As the level of muscle spasms in children with CP can increase in relation to pain, an increase in muscle spasms might also be present due to immobilization in a cast. We argue that muscle spasms in children casted in a hip spica will increase the level of pain, so epidural analgesia as postoperative pain management appears to be more effective than LIA. Lubicky et al. (2003) investigated the complications related to casting in children with CP. Contrary to our point of view, they argued that casting may not increase spasms and consequently pain. The effect of casting on pain and muscle spasms in children with CP needs further investigation. In addition, the casting confines of the hip joints limit movements which might eliminate some degrees of postoperative pain. This limits the generalizability to patients who are not postoperatively casted in a hip spica.

Regarding future investigations, it would be advantageous to test the effect of both epidural analgesia and LIA in children with CP in relation to an objective quantifiable measure of the level of muscle spasms. Furthermore, for future pain management after orthopedic surgery, it would be beneficial to assess the effect of casting on the postoperative level of muscle spasms and pain.

In conclusion, epidural analgesia is superior for early postoperative pain management in children with CP who undergo unilateral hip reconstruction. This may be generalizable to bilateral surgery and other lower extremity surgery. Even considering the known side effects of epidural analgesia, it may be looked upon as a first choice for pain management in children with CP due to the substantial reduction in pain and opioid consumption.

Design of the protocol: LKP, LN, OR, and BMM. Enrollment of the patients: LKP. Surgery: OR and BMM. Local infiltration analgesia: OR. Anesthesis procedures: BUD and LN. Data collection: LKP. Data analysis: LKP. Preparation of the manuscript: LKP, LN, OR, BUD, and BMM.

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