Ultrasound-guided ilioinguinal/iliohypogastric nerve blocks versus caudal block for postoperative analgesia in children undergoing unilateral groin surgery

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ABSTRACT

Context: Ultrasound (US) guidance is strongly recommended when performing peripheral nerve blocks in infants and children. **Aims:** To assess whether US-guided ilioinguinal/iliohypogastric (II/IH) nerve blocks with local anesthetic (LA) would provide comparable postoperative analgesia to blind technique caudal block with LA following pediatric unilateral groin surgery. Secondary endpoints included analgesic consumption, parental satisfaction, and postoperative complications. **Settings and Design:** Prospective, crossover randomized controlled trial performed on children undergoing unilateral groin surgery. **Methods:** Fifty children aged 1-6 years scheduled for unilateral groin surgery were included in the study. After induction of general anesthesia and prior to surgical incision, patients were prospectively randomized into one of two groups: Group B received US-guided II/IH nerve blocks with 0.1 ml.kg^{-1} of 0.25% bupivacaine and Group C received a caudal blockade with 0.7 ml.kg^{-1} of 0.25% bupivacaine. Patients were assessed in the recovery room, the day-stay unit and for 24 h at home for pain score, analgesic consumption, and parental satisfaction. **Statistical Analysis:** Arithmetic mean and standard deviation values were calculated and statistical analyses were performed for each group. Independent sample *t*-test was used to compare continuous variables exhibiting normal distribution, and Chi-squared test or Fisher exact test for non-continuous variables. $P<0.05$ was considered significant. **Results:** The average pain scores during hospital stay were $1.82 \pm 1.71$and 1.52 ± 1.41 for group C and group B respectively ($P>0.05$). The average time to first rescue analgesia was longer in group B 253 ± 102.6 min as compared to 219.6 ± 48.4 min in group C. In recovery room, four patients in group C required pain rescue medication compared to five patients in group B ($P>0.05$). Similarly eight patients in the group C and six patients in group B required pain rescue medication at day-stay unit or at home ($P>0.05$). Group C received 0.74 pain rescue medication doses (range 0-8), while group B received 0.65 pain rescue medication doses (range 0-6) at hospital and at home ($P>0.05$). **Conclusions:** US-guided II/IH nerve blocks is an ideal postoperative analgesic for unilateral groin surgery in children, particularly hernia repairs and is as effective as caudal block, with a lower volume of local anesthetics.

Key words: *Analgesia, caudal block, children, ilioinguinal/iliohypogastric nerve block (II/IH), local anesthetic hernia repair, ultrasound guidance*

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INTRODUCTION

Infants and children undergo a variety of groin procedures that can cause a significant degree of discomfort postoperatively. Caudal analgesia with local analgesics alone is effective but is often short-lived and associated with undesired motor blockade and other complications.[1]

Ilioinguinal/iliohypogastric (II/IH) nerve blockade is one of the most common peripheral nerve block techniques in paediatric anesthesia and has been shown to be equally effective compared with caudal blockade for inguinal hernia repair.[2] An ultrasound (US)-guided technique for II/IH has been described with significantly better block qualities compared with the landmark-based technique.[3]

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According to this new technique, the needle tip will be placed in close proximity to the two nerves in the correct anatomical plane between the internal oblique and the transverse abdominis muscles. Therefore, intramuscular and intraperitoneal injection of LA is safely avoided. In contrast, the performance of landmark-based II/IH nerve blocks is associated with multiple administration of LA in adjacent anatomical structures, particularly is muscle tissue.[4] Although caudal block could be performed under US guidance the caudal block in our study was done using the standardized blind technique.

The present study has been carried out to assess whether US- guided II/IH nerve blocks with LA would provide comparable postoperative analgesia to blind technique caudal block with LA following pediatric unilateral groin surgery. Secondary endpoints included analgesic consumption, parental satisfaction, and postoperative complications.

METHODS

The study was approved by the institutional human ethics committee (Menoufiya University hospital, Menoufiya city, Egypt) and written informed parental consent was obtained. Over one year, 50 children (American Society of Anesthesiologists class I or II) aged 1-6 years, scheduled to undergo unilateral inguinal hernia repair, hydrocelectomy, or orchidopexy, were enrolled in this double blind, randomized prospective controlled study.

Patients with known allergy to amide-type local anaesthetics, a history of clinically important renal, hepatic, cardiac, or neurological conditions, severe diaper rash, and those with the presence of a sacral dimple were excluded from the study.

All patients were premedicated with 0.5 mg. kg^{-1} of oral midazolam approximately 30 minutes before induction of anesthesia. Parental presence was allowed if requested for the induction of anesthesia. General anesthesia was induced with 8% sevoflurane in 70% nitrous oxide and 30% oxygen, via a facemask. After establishing a venous access, a classic disposable laryngeal mask airway (LMA) was placed after the patient was noted to be in an adequate plane of anesthesia. No additional sedatives or analgesics were administered at the time of the insertion of the LMA. Anesthesia was maintained with at least 1.2 MAC of sevoflurane in nitrous oxide and oxygen. Intraoperative monitoring included ECG, heart rate, pulse oximetry, non-invasive blood pressure and end-tidal carbon dioxide concentration.

Block technique and randomization

The patients were then randomized to one of two groups using a computer-generated randomization table. II/IH nerve block group (Group B) received US-guided II/IH nerve blocks with 0.1 $ml.kg^{-1}$ of 0.25% bupivacaine and caudal block group (Group C) received a blind technique caudal blockade with 0.7 $ml.kg^{-1}$ of 0.25% bupivacaine. All the surgical procedures were performed by the same surgeons, and all blocks were performed by the same anaesthetist who has a good experience in US–guided nerve block in children.

In group C, patients were placed in the left lateral position. The block site, which was mainly at the sacral hiatus, was sterilized with betadine, and the sacral hiatus between the sacral conru was palpated. Then a 23-G short needle injection was used with the bevel toward the abdomen to puncture the sacral surface at a 45-degree angle. When the sacrococcygeal ligament seemed to have punctured, the needle was tilted more toward the skin surface and the needle was inserted 2-3-mm deeper. The needle was aspired to check for blood and cerebral spinal fluid extravasations. The loss of resistance was confirmed with air-infusion. Then 0.25% bupivacaine 0.7 $ml.kg^{-1}$ was injected.

In group B, a SonoSite 180 plus portable US unit (SonoSite, Bothell, WA, USA) and a 5-10 MHz linear probe were used to identify the targeted nerves and surrounding anatomical structures. Adjustments (depth, probe frequency, low and far gain) were performed in order to achieve optimal ultrasonographic figures of the nerves and the surrounding anatomical structures (muscles, peritoneum). After aseptic preparation of both the puncture site and the ultrasound probe, the block was then performed using "in-plane technique" and an insulated 22-G 40-mm needle with a facette tip and an injection line (PajunkTM, Geisingen, Germany). Under direct visualization of the tip of the needle which was placed lateral to the nerve structures between the internal oblique and transverse abdominis muscles. The distribution of LA was monitored under real-time ultrasonography, and in case of a misdistribution of the LA, the needle would have been repositioned. Misdistribution was defined as when the LA did not surround the nerve structures [Figure 1].

Intraoperative management

Skin incision was permitted 15 minutes after performance of the block. Increases in HR or RR of 20% above the baseline, or patient movement at skin incision or during the intraoperative period, were considered signs of a failed block or inadequate analgesia. In this case, fentanyl 1 $\mu g.kg^{-1}$ was given intravenously, but the postoperative data were not included in the statistical analysis. Vital signs

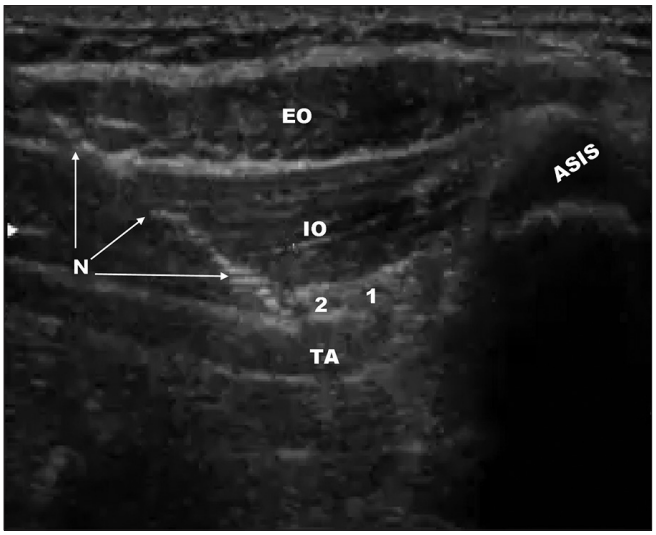

Figure 1: US image of the II/IH nerve in the plane between the internal oblique and the transversus abdominis muscle. Arrows illustrate the position of the needle adjacent to the nerves. ASIS – Anterior superior iliac spine; EO – External oblique muscle; IO – Internal oblique muscle; TA – Transversus abdominis muscle; N – Needle 1: Ilioinguinal nerve 2: Iliohypogastric nerve

were recorded every 5 minutes for 30 minutes after the block to ensure the adequacy of the blockade especially after surgical incision.

Postoperative management

After surgery, patients were transferred to the recovery room for continuous monitoring of vital signs and assessment of pain. The children were monitored every 15 minutes during the first hour in PACU and every 30 minutes for the next 3 hours in day-stay unit until discharge from the hospital. Postoperative analgesia was measured using a modified Children's Hospital of Eastern Ontario Pain Scale (CHEOPS).[5] Patients with modified CHEOPS score >6 were given rescue analgesia with 15 mg.kg^{-1} paracetamol intravenously. Those with modified CHEOPS score of 4-5 were given paracetamol 15 mg.kg^{-1} as suppository. Pain scores were recorded every 5 minutes after administration of rescue analgesia to evaluate pain relief or need for further rescue analgesia. We recorded the number of children who needed postoperative rescue analgesics and the duration of analgesia that was taken at the time when an analgesic was required. Presence of significant muscle weakness was assessed at 3 hours after the block using four P's (push, pull, pinch, punt) method described by Neal.[6]

Patients were discharged from the hospital 4 hours after surgery when they were pain free and there was no other medical reason to admit them to a surgical ward. The parents were actively involved in the clinical trial and invited to complete a postoperative chart with a simple pain scale (0 = no pain/child calm; 1 = minimum pain/child irritable; 2 = mild pain/child consolable; and 3 = severe pain/child inconsolable). Parents were instructed to give 15 mg.kg^{-1} rectal paracetamol when pain scores were 2 or 3, and not more frequently than every 6 hours. If 1 hour after giving paracetamol, parents assessed their child to be still in pain, oral ibuprofen 10 mg.kg^{-1} was administered every 8 hours as required.

Data collection

The patient's primary recovery nurse recorded recovery room pain score, time to first rescue analgesia, pain and vomiting rescues medications. The primary day-stay unit nurse recorded the pain score in the day-stay unit and the requirement for supplemental analgesia. Parents were contacted by the anesthesiologist not involved in the study on the day following discharge from the hospital, and were asked about the number of rescue analgesic administrations given, and whether there were any other complications such as nausea or vomiting. They were also asked if they had been satisfied with the analgesic care of their children. All data collection was considered blinded.

Statistical analysis

Distribution of baseline variables was assessed by the Shapiro-Wilk W tests. A power analysis estimated a sample size of 50 patients would have an 80% power at the 0.05 level of significance to detect a 50% reduction in number of the patients requiring rescue analgesia between the II/ IH nerve block and the caudal block groups. By using SPSS software for Windows, version 11 (SPSS Inc, Chicago, IL, USA), arithmetic mean and standard deviation values for different variables were calculated and statistical analyses were performed for each group. Independent sample *t*-test was used to compare continuous variables exhibiting normal distribution, and Chi-squared or Fisher exact test for non-continuous variables. $P<0.05$ is considered significant.

RESULTS

Additional fentanyl on skin incision was deemed necessary in one child (4%) in group C compared with two children (8%) in group B ($P>0.05$) due to increased heart rate, these patients were excluded from the study.

Patients characteristics were equally distributed in the two study groups. There was no statistically significant difference in the type of surgeries or duration of anesthesia. All anesthetic procedures were uneventful [Table 1].

The average pain score during hospital stay for group C was 1.82±1.71 compared to 1.52±1.41 in group B, with no statistically significant difference between groups.

The average time to first rescue analgesia was longer and

the duration of analgesia was more variable in group B (253±102.6 minutes) as compared to (219.6±48.4 minutes) in group C.

In recovery room, four patients in group C required pain rescue medication compared to five patients in group B (P>0.05). Similarly eight patients in the group C and six patients in group B required pain rescue medication at day-stay unit or at home (P>0.05).

Group C received 0.74 pain rescue medication doses (range 0-8), while group B received 0.65 pain rescue medication doses (range 0-6) at hospital and at home. The difference between groups in the average number of pain rescue medication was not statistically significant [Table 2].

Only one patient in group C and two patients in group B were reported to have vomiting and receive nausea vomiting rescue medications. This difference was not significant (P>0.05).

None of the patients of either group had any motor weakness at 3 hours. Similarly no significant difference was found in the acceptance of both techniques by parents and children.

Table 1: Patients' criteria and anesthetic details

	Group C (24)	Group B (23)	*P* value
Age (months)	3.64±1.76	3.47±1.54	NS (0.7188)
Weight (kg)	15.8±3.71	16.2±3.27	NS (0.6055)
Sex (M/F)	22/2	20/3	NS (0.601)
Type of surgery			
Hernia repair	18 (75%)	16 (69.5%)	
Orchidopexy	2 (8.33%)	3 (13.04%)	NS (0.862)
Hydrocele repair	4 (16.7%)	4 (14%)	
Duration of anesthesia (min)	72.1±11.7	76.3±13.5	NS (0.2589)

Data are presented as Mean±SD, number or percent; P<0.05 is significant

Table 2: Outcome data

	Group C (24)	Group B (23)	*P* value
CHEOPS pain score	1.82±1.71	1.52±1.41	NS (0.516)
Duration of analgesia (min)	219.6±48.4	253±102.6	NS (0.1576)
Patient receiving pain rescue medications at PACU	4 (16.6%)	5 (21.74%)	NS (0.659)
Patient receiving pain rescue medication in hospital and post discharge	8 (33.3%)	6 (20.08%)	NS (0.587)
Pain rescue medication (number)	0.74	0.65	NS (0.219)
PONV number	1 (4.16%)	2 (8.69%)	NS (0.525)
Acceptance of the techniques by parents	22 (91.6%)	22 (95.6%)	NS (0.576)

Data are presented as Mean±SD, number or percent; P<0.05 is significant

DISCUSSION

Caudal anesthetics usually provide analgesia for approximately 4-6 hours. However, its complications do exist such as bone marrow puncture, intestinal damage and the danger of an increase of the blood concentration, and these complications can lead to systemic toxicity. Central nervous disorders, spinal deformities, inflammation of the block site and coagulation disorders are counter-indications for caudal anesthesia, so it is necessary to find a substitute to control pain.[7,8]

The II/IH blocks can provide approximately similar duration of analgesia as a caudal anesthetic with less LA solution administered especially when performing these block with US guidance.[2,9]

Despite its popularity, when conventional methods are used, the II/IH nerve block only has a success rate of 70-80% in some published series.[10] Several complications such as colonic or small bowel puncture[11,12] pelvic hematoma,[13] femoral nerve palsy and quadriceps muscle paresis[14,15] have been described.

In this study the precise administration of lower volumes of LA under US guidance resulted in effective II/IH nerve blocks in children, with a reduced failure rate of 4% and no complications. By post injection US control Weintraud *et al.*[4] were able to show that the use of the classic landmark-based approach resulted in only 14% of the injections being made at the correct anatomical location. Not surprisingly the overall success rate of the II/IH was found to be only 61% in this study.

In a prospective randomized study by Willschke and coworkers[16] the use of an US- guided II/IH was compared with the landmark-based approach concerning efficacy of the two techniques. It was clearly demonstrated that the use of the US-guided technique was associated with a significantly higher success rate, as evidenced by a reduced hemodynamic reaction to skin incision (4 vs. 24%) and a considerable reduction in the number of patients needing supplemental analgesia in the recovery room (6 vs. 40%).

In a further study by the same authors they showed that a substantial reduction in the volume of LA (traditionally recommended volume 0.3-0.5 ml.kg^{-1}) is possible when using US-guidance. Using a modified up–down technique they found that an effective II/IH nerve blocks can be achieved using a volume of LA as low as 0.075 ml.kg^{-1} when using US-guidance.[3] This was approximately the volume that we used for our II/IH nerve blocks.

Our study showed that the mean duration of analgesia is longer with the US II/IH nerve block as compared to caudal block with 0.25% bupivacaine. This can be expected as uptake of drug is faster from the epidural space. Hannallah *et al*.[9] proved that there are no differences in the postoperative analgesic effects between caudal blocks and ilioinguinal-iliohypogastric nerve blocks postorchiorrhaphy. Bhatpara *et al*.[17] concluded that simplified II/IH nerve blocks in combination with small volume LA wound infiltration offers longer mean duration of analgesia and better safety margin to start oral analgesics than caudal block with LA alone in children undergoing herniotomy.

Our study demonstrated a decrease in pain scores in the immediate postoperative period in group that received the II/IH nerve blocks as compared to the caudal block group with no statistically significant difference between both groups.

In II/IH nerve block group, patients who underwent inguinal hernia repair (n=16) showed decreased pain scores, and the time to first rescue analgesia was administered much later than the patients who underwent other groin procedures e.g. orchidopexy. This difference may be because of the stimulation of higher dermatomes in children undergoing orchidopexies because the ilioinguinal nerve block is a sensory division of the L1 dermatome, which may not provide higher dermatomal coverage needed for orchidopexy. This difference could also be explained by lack of blockade of the genitofemoral nerve (L1-2), which provides sensory analgesia to the scrotum.

There was no difference in the doses of postoperative pain rescue medication administered to the studied groups in the PACU or at home.

The side effects were not different in both groups in our study. None of the patients of either group had any motor weakness at 3 hours. Similarly, parental acceptability of the technique was similar in both the groups.

One weakness of the study was the lack of standardization of the procedures. The variety of groin procedures, including inguinal hernia repairs and orchidopexies may have lead to a variety of visceral pain manifestations that may have translated to either increased or decreased pain scores. Another weak point is that compared to currently new developed ultrasound machine, SonoSite S-180 machine does not have the highest resolution capacity.

In conclusion, US II/IH nerve blocks is an ideal postoperative analgesic for unilateral groin surgery in children, particularly hernia repairs, this block can be as effective as caudal block, with a lower volume of LA.

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