Ilio inguinal block: do we know the correct dose?

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Introduction
Although Ilio-inguinal nerve blocks are commonly used, the dose advocated varies between 0.3-0.5ml/kg. Despite these doses a failure rate of up to 20-30% has been described using the standard technique. These failures may be due to inadequate understanding of the anatomy, faulty technique, or incorrect placement of local anaesthetic. Ultrasound guided nerve blocks permit the precise placement of local anaesthetic. In a previous study an ultrasound-guided ilio-inguinal block was found to be more effective than the standard "fascial click" method. In that study the injection of local anaesthetic was stopped when the target nerve was seen to be surrounded by local anaesthetic. Significantly lower volumes of 0.25% levobupivacaine were required in the ultrasound-guided group than in the "fascial click" group (0.19±0.05ml/kg vs. 0.3ml/kg; $p<0.0001$). Despite these lower volumes of 0.25% levobupivacaine, a better quality of analgesia was achieved. These findings stimulated a further study using an ultrasound-guided technique to determine whether a further reduction in the volume of 0.25% levobupivacaine was possible without loss of efficacy.

Objective
To determine the lowest effective dose of local anaesthetic for ilio-inguinal block using ultrasound guidance.

Methods
Following ethical approval, 40 consecutive ASA I children aged 1-8 years scheduled for elective unilateral inguinal surgery were enrolled in this prospective study. Informed consent was obtained from the parents of all children and where appropriate, assent was obtained from the child. Exclusion criteria included any contraindication to ilio-inguinal block, parental or patient refusal, or allergy to amide local anaesthetics.

After oral premedication with midazolam 0,5mg/kg, general anaesthesia was induced with sevoflurane. After establishing venous access, a laryngeal mask was placed and anaesthesia was maintained with 1 MAC halothane in nitrous oxide: oxygen 40:60 and spontaneous ventilation. Intraoperative monitoring included ECG, heart rate, pulse oximetry, non-invasive blood pressure and end-tidal carbon dioxide concentration.

A SonoSite 180+ portable ultrasound unit (SonoSiteô, Bothell, WA, USA) and a 5-10 MHz linear hockey stick probe were used to identify the target nerves. Adjustments (depth, probe frequency, low and far gain) were made to obtain optimal ultrasonographic images of the nerves and the surrounding anatomical structures (muscles layers, peritoneum). Following aseptic preparation of the puncture site and the ultrasound probe, the nerve block was performed using an insulated 22-gauge 40mm needle (Pajunkô, Geisingen, Germany) under ultrasound guidance After identifying the target nerves (ilio-inguinal and ilio-hypogastric nerve), the needle was positioned using real time ultrasound imaging. Once the needle was correctly positioned, and following a negative aspiration test, a predetermined volume of 0.25% levobupivacaine was injected.

Using a step down approach, with 10 children in each study group, 0,2ml/kg levobupivacaine 0.25% was used as the starting dose. Results were analysed after each group of 10 patients. If all blocks were successful and satisfactory analgesia was achieved, the volume of local anaesthetic was halved and a further 10 patients were enrolled into the study. After each group of 10 patients, the results were analysed. A further 50% reduction was planned if all blocks were successful. Failure to achieve a 100% success in the whole group instigated an increase of half the previous volume reduction to be used in the subsequent group. For example, if after reducing the dose from 0.2ml/kg to 0.1ml/kg, and any of the 10 blocks failed, the next group would receive 0.15ml/kg 0.25% levobupivacaine.

In all patients skin incision was performed at least 15min after placement of the ilio-inguinal nerve block. An increase in heart rate of more than 15% during operation was defined as a failed block and rescue analgesia using fentanyl 1µg/kg was given. The efficacy of postoperative analgesia was documented using the objective pain score (OPS). If OPS score was <11, the block was also considered a failure and the child received rescue analgesia and 30mg/kg paracetamol. The children were monitored hourly for four hours postoperatively, i.e. the usual length of stay before discharge from the outpatient surgical unit. The children were discharged home after 4 hours, when they were pain free and when there was no other medical reason to admit them to a surgical ward. The children were discharged with an oral paracetamol suspension (30mg/kg) for subsequent analgesia, to be administered by their parents or care providers, who were also asked to report immediately to Red Cross Childrenís Hospital in the event of difficulty in pain management.

Demographic data were compared by ANOVA. The incidence of failed or inadequate block was compared by chi-square test between the four groups. $P < 0.05$ was considered statistically significant.

Results

Patient demographics were similar in all groups (gender, weight and height). In the 0.1ml/kg group there was a difference in the median age of the children compared to the other groups, but this difference was not significant. The same surgeon performed all surgical procedures and all blocks were performed by anaesthetists experienced in ultrasound-guided regional anaesthesia in children. The ilio-inguinal and the iliohypogastric nerve could be visualized in all cases. There were no surgical or anaesthetic complications.

There was no significant difference in heart rate at skin incision in the 0.2ml/kg or 0.1ml/kg or 0. 075ml.kg 0.25% levobupivacaine groups ($p< 0.05$). In the 0,05ml/kg group, 3 out of 10 children (30%) received rescue analgesia (fentanyl) in response to an increase in heart rate of more than 15% on incision. The rest of the group showed no increase in heart rate on skin incision. With regard to postoperative pain, there was no significant difference in the OPS levels in the 0.2ml/kg, 0.1ml/kg and 0.075ml.kg 0.25% levobupivacaine groups. No parent or child from these groups requested additional analgesia. However there was a significant increase in OPS levels after one hour in the 0.05ml/kg group compared to the 0.2ml/kg and 0.1ml/kg groups. Four children in the 0.05ml/kg group who had an OPS Score $\leq$11 were treated with paracetamol. Three of these had received fentanyl intra-operatively

In accordance with the protocol, in view of the 30% failure in the 0.05ml/kg group, a volume of 0.075ml/kg was used in the subsequent group. There were no failures in the 0.075ml/kg 0.25% levo-bupivacaine group; No statistically significant difference in the heart rate at skin incision or in the postoperative OPS pain scores could be detected when the 0.75ml.kg and the 0.2ml/kg or 0.1ml/kg groups were compared. No additional analgesia was required in the 0.075ml/kg group.

Discussion

The major advantage of ultrasound guided nerve blocks is that the nerves can be ''visualised'' using real time imaging. The local anaesthetic solution can be seen as it is injected into the correct tissue plane and seen to surround the nerve. If not, the position of the needle can be adjusted. With experience the exact location of the needle in relation to the nerve can be determined.

Reducing the volume of local anaesthetic has several advantages. Firstly the risk of toxicity is diminished. This is particularly relevant after ilio-inguinal nerve blocks in infants and small children. In a recent pharmacokinetic study, Ala-Kokko et al demonstrated high plasma concentrations of bupivacaine following ilioinguinal nerve blocks that were performed using the traditional ''fascial click'' method in children aged 2-10years. The median venous plasma concentration was 2.2μg/ml bupivacaine (0.9-4.9), a level considered by some to be close to the maximum tolerated. Smith et al also reported unexpected high bupivacaine plasma levels (up to 4mg.L) in children between 10-15kg (1.5±0.9mg.L range 0.43-4.0mg.L) compared with a group of children with 15-30kg (0.9±0.3mg.L range 0.35-1.34mg.L)

Secondly a reduction in volume potentially reduces unwanted side effects. Transient femoral nerve palsy is a well described side effect of ilio-inguinal nerve block in children which may delay ambulation and be disturbing to the child and parents. The femoral nerve palsy is thought to be volume related and occurs as a result of spread of local anaesthetic between the muscle layers to the femoral nerve, or when incorrect landmarks are used.

Conversely the volume of local anaesthetic should not be reduced to such an extent that efficacy is lost. Studies using ultrasound guidance have suggested that more accurate placement of smaller amounts of local anaesthetic does not reduce the efficacy. However, there must be a point at which the reduction of local anaesthetic volume, for a given concentration, is no longer as effective In this study successful blocks were achieved using 0.2ml/kg, 0.1ml/kg and 0.075ml/kg of 0.25% levo-bupivacaine without compromising the quality of analgesia Stated differently the quality of analgesia does not improve when larger volumes of local anaesthetic are administered.

Four of the 10 children in the 0.05ml/kg group required additional analgesia; either fentanyl (3) intra-operatively in response to the increase in heart rate, or paracetamol (4 of which 3 had previously received fentanyl) postoperatively in response to inadequate analgesia based on the OPS score. Some initial analgesia was provided for the children in the first 60 min in the 0.05ml.kg group since they had similar OPS scores as the other groups. After 60 min the OPS levels were significantly higher than those in the other groups. This suggests that some of the ilio-inguinal blocks may have been effective initially, or that the rescue analgesia (fentanyl 1ug.kg) had some initial analgesic effect.

Conclusion

This study demonstrates that much lower volumes of local anaesthetic can be used to perform successful ilioinguinal nerve blocks in children than previously recommended. The lowest effective dose was 0.075 ml/kg 0.25% levo-bupivacaine when performed under ultrasound guidance. This volume was as effective as 0.1ml/kg or 0.2ml/kg although pain assessment was limited to first 4 postoperative hours.