Pediatric regional anesthesia – update

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Purpose of review
New topics in pediatric regional anesthesia are discussed.
Recent findings
Continuous peripheral nerve blocks, new local anesthetics and the performance of regional blocks with ultrasonography guidance are summarized.
Summary
Prolonged analgesia with continuous peripheral nerve blocks in the treatment of pediatric postoperative limb pain, sometimes with patient-controlled regional analgesia, should be preferred instead of continuous epidural analgesia. Levobupivacaine and ropivacaine display the same pharmacokinetic profile as racemic bupivacaine with less cardiac toxicity. Conversely, continuous infusion of these new local anesthetics offers the safest therapeutic index, especially in infants. Many adjuvants have been used, but clonidine offers clear advantages. Ultrasonography guidance blocks will probably become the reference technique for local anesthetics injection and regional anesthesia catheter placement; new training in this field should be available.

Keywords
continuous peripheral nerve blocks, local anesthetics, regional anesthesia, ultrasonography guidance block

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Introduction

During the last decade, pediatric regional anesthesia has been shown to be safe and effective. Many studies of individual techniques and the daily clinical practice of pediatric regional anesthesia have confirmed its safety and value for perioperative pain control in children. Therefore, new aspects of regional anesthesia have been reported, especially continuous peripheral nerve blocks, new local anesthetics and ultrasonography guidance block.

Continuous peripheral nerve blocks

Single-shot peripheral blocks are nowadays widely used in children, but they can provide analgesia only for a few hours. These blocks are even safer than central ones, but few studies describe this technique in children, except recently for infraclavicular block [1] and sciatic block [2•,3]. The indications to place a catheter for continuous peripheral nerve blocks are severe pain, long intraoperative time requiring redosing and pain control necessary for many days. Otherwise, painful rehabilitation and physiotherapy are probably the main indications, because only if pain is under control can good rehabilitation be performed. Indeed, in adults, it has become daily clinical practice supported by a large quantity of data, providing effective analgesia and allowing active physiotherapy, essential to reach optimal functional recovery. Catheters can be maintained in position for several days and even if so far there are only reports from adults being sent home with a catheter infusion, in the future this method will be applied also in children. A recent study has reported the efficacy of continuous peripheral nerve blocks with elastomeric disposable pumps associated with initial Bier blocks for the treatment of recurrent complex regional pain syndrome in children [4]. All the studies published so far underline the efficacy and safety of analgesia via a peripheral catheter, and no complications or side effects linked to the long-term infusions have been described, with only a few accidental removals and some drug leakage [5]. They are at least as efficient as epidural analgesia, but produce fewer side effects [2•]. Sometimes a combination of peripheral blocks as a continuous sciatic block with a single-shot three-in-one block for tourniquet pain and light general anesthesia provides good intraoperative conditions for leg and foot surgery and adequate postoperative pain relief. Additional sedation to minimize the discomfort of a cast may be a consideration in the first 24 h [6]. As continuous regional analgesia is considered a safe and efficacious technique for postoperative pain relief in children after lower limb surgery,

the feasibility of patient-controlled regional analgesia in a similar acute pain situation was recently evaluated. Both techniques are efficacious and satisfactory; however, patient-controlled regional analgesia with ropivacaine 0.2% can provide adequate postoperative analgesia for pediatric orthopedic procedures with smaller doses of ropivacaine and lower total plasma concentrations of ropivacaine than with continuous regional analgesia [7•]. Finally, continuous regional anesthesia should be the first choice of the anesthesiologist involved in the treatment of pediatric postoperative limb pain.

New local anesthetics and adjuvants

Ropivacaine is one of the new local anesthetics. This long-acting local anesthetic causes less cardiovascular changes than bupivacaine. Indeed, the outcome of these inadvertent intravascular administrations was favorable. Levobupivacaine may represent an alternative – this is a pure enantiomer (similar to ropivacaine) with the same beneficial properties as ropivacaine [8,9]. Levobupivacaine is an effective agent for caudal anesthesia in children at a recommended dose of 2.5 mg/kg. The rapidity of onset was suitable for establishment of surgical anesthesia and postoperative analgesia was achieved in greater than 97.5% of patients. It appears to be of equivalent potency to racemic bupivacaine in children requiring lower abdominal surgery [10]. Ropivacaine and levobupivacaine are effective for peripheral nerve, caudal and lumbar/thoracic epidural blocks. It produces less motor blockade than bupivacaine after caudal administration [10,11]. In addition, isobaric 5 mg/ml ropivacaine intrathecal anesthesia has been successfully reported with 0.5 up to 20 ml/kg in 1 to 17-year-old children [12]. Block performance of intrathecal isobaric ropivacaine in children is similar to that obtained in adults, but the safety of the larger dose used in children warrants further studies.

Pharmacokinetic data have recently been provided by a study on continuous epidural infusion. Epidural infusions (0.2–0.4 mg/kg/h ropivacaine) provided satisfactory pain relief in neonates and infants under 1 year old. As plasma concentrations of unbound ropivacaine were not influenced by the duration of the infusion, ropivacaine can be safely used for postoperative epidural infusion for 48–72 h [13]. Levels of unbound ropivacaine were higher in the neonates than in the infants, but were below threshold concentrations for central nervous system toxicity in adults (0.35 mg/l or greater). This should not preclude the use of ropivacaine infusions in neonates, but suggests a need for caution during the first weeks of life. Indeed, size and post-natal age are the major contributors to levobupivacaine clearance variability in children. These covariates should be considered when establishing safe epidural infusion regimens. Reduced clearance and slower absorption half-time contribute to delayed T_{max} in neonates and young infants [14•]. In addition, 2 mg/kg of 0.5% levobupivacaine has been recommended for blockade of the ilioinguinal and iliohypogastric nerves in pediatric patients undergoing inguinal surgery. Bupivacaine concentrations from a study with a similar protocol were used as historical controls for comparison. The comparison has shown that levobupivacaine and bupivacaine are equally absorbed to similar maximum concentrations [15].

Due to the pharmacodynamic and pharmacokinetic advantages, ropivacaine and levobupivacaine should be used instead of bupivacaine in 2007.

Many adjuvants have been used, but it has been recently reported that clonidine offers clear advantages in central blocks. Using a dose-ranging design in children undergoing elective inguinal hernia repair, the addition of 2 μg/kg clonidine to a caudal block with 0.125% bupivacaine increased the duration of postoperative analgesia without any respiratory or hemodynamic side-effects [16]. No advantages have been found by adding clonidine in ilioinguinal/iliohypogastric nerve block [17].

Ultrasonography guidance and regional blocks

The use of ultrasound as an aid for accurate placement of local anesthetics is gaining in popularity for regional anesthesia over conventional landmark-based techniques and neurostimulation [18••,19••]. Ultrasonography allows noninvasive real-time imaging of the relevant anatomical structures while the needle is placed under direct vision [20]. Ultrasonography-guided block techniques are superior to blind techniques relying on subtle sensations, which may be unreliable even in experienced hands. Lower limb surgery commonly requires the use of multiple nerve blocks. Thus, a central block is often chosen as each peripheral block has a potential for failure and the local anesthetic dose available is limited. The use of ultrasonography allows the volume of local anesthetic per block to be decreased by 30–50%, making it is easy to remain within maximum doses when performing multiple blocks while still achieving success.

Many blocks have been recently studied with ultrasonography. For peripheral nerve blocks, paraumbilical block and ilioinguinal block have been revised by the use of ultrasonography. The bilateral placement of levobupivacaine 0.25% 0.1 ml/kg in the space between the posterior aspect of the rectus sheath and the rectus abdominis muscle under real-time ultrasonographic guidance provides sufficient analgesia for umbilical hernia repair [21]. The unpredictable depth of the posterior rectus sheath in children is a good argument for the use of ultrasonography in this regional anesthetic technique. Local anesthetic volumes for ilioinguinal block have been