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Safety of ultrasound in pediatric regional anesthesia: are we on the right track?

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Key points

The use of ultrasound for pediatric regional anesthesia and pediatric intensive care is relatively new, however interest in this application is grawing rapidily. Published reports of ultrasound guided regional anesthesia have largely focused on the safety and efficacy in pediatric patients. Anyway, we must remember that a training is always necessary and that only experienced pediatric anesthesiologists can perform these techniques. A number of serious neurologic complications have been recently described. it is very likely that the use of ultrasound could not avoid these complications, for these reasons, we must always take every precaution before performing pediatric regional blocks even if we consider them simple.

Over the last few years many things have changed in anesthesia and pediatric intensive care. All that was applied to adults can be performed to children, neonates and preterms. Today we can affirm that the ultrasound-guided anesthetic techniques have allowed us to improve the anesthetic procedures and achieve a level of safety extraordinarily high. The availability of ultrasound machines with very high resolution and sophisticated software, the application of robotics techniques to anesthesia, the realization of new and innovative needles and probes have improved the quality standards. That's why we encourage and recommend the use of ultrasound in pediatric anesthesia and pediatric intensive care. In children the anatomical structures, vascular and nerve are extremely close and the placement of needles with blind techniques poses many risks of accidental vascular puncture or injury to parenchymatous organs such as the liver, spleen and lungs. A wide literature has been published all reassuring on this topic with particular reference to the newborn or preterm infant. Recently Alten (1) has shown that about one hundred fifteen neonates real-time ultrasound technique facilitates placement of femoral vein central venous line in critically ill neonates with cardiac disease at a higher rate of success with fewer attempts and lower occurrence of complications when compared with the landmark technique.

In another study Froelich (2) enrolled two groups of patients to determine whether ultrasound increased successful placement of central venous catheter, decreased site attempts and decreased complications. Ninety-three patients were enrolled into the landmark group and 119 into the ultrasound group. Ultrasound-guided placement in children were associated with decreased number of anatomical sites attempted and decreased the number of attempts to gain placement.

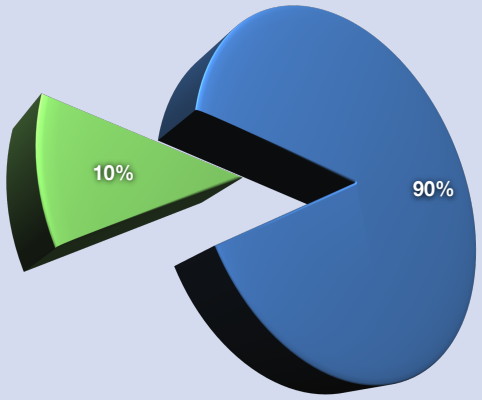
Time to placement by residents was decreased with ultrasound but not the time to placement by other operators. Ultrasound guidance increased the use of internal jugular catheter placement and decreased the accidental artery punctures. Anyway, the ultrosound guidance did not improve success rates.

The use of sonography in children has also made possible to achieve very high levels of specialization to solve problems of particular clinical complexity. A case report to be taken as an example is the percutaneous ultrasound-guided stellate ganglion nerve block performed by Boe to suppress recurrent ventricular fibrillation in an infant awaiting heart transplant (3).

With regard to the safety and effectiveness of ultrasound regional guided techniques the study of Polaner conducted in United States of America is certainly of great importance (4). The Pediatric Regional Anesthesia Network (PRAN) was formed to obtain highly audited data on practice patterns and complications and to facilitate collaborative research in regional anesthetic techniques in infants and children. The results of this research, recently published, showed that regional anesthesia in children as commonly performed in the United States has a very low rate of complications, comparable to that seen in Europe. The use of ultrasound demonstrated to Increase the number of peripheral nerve blocks. Polaner et al accrued a total of 14,917 regional blocks, performed on 13,725 patients in 3 years. There were no deaths or complications with sequelae lasting >3 months (95% CI 0–2:10,000). Single- shot blocks had fewer adverse events than continuous blocks, although the most frequent events (33% of all events) in the latter group were correlated to the catheters (dislodgment, occlusion).

Catheter dislodgment and occlusions were more frequently observed for thoracic and lumbar blocks and much less for those caudal. Moreover, is quite interesting to observe that one of the most frequent complications described was represented by the abandonment of the caudal block for inability to place the block or block failure. We believe that the use of ultrasound for caudal block (performed only in 3% of patients) could significantly increase the success rate. In our institution we are conducting a retrospective research in which the use of color doppler flow (CDF) allowed us to see the spread of local anesthetic in 75 neonates and infants undergoing caudal anesthesia. In 90% of patients both CDF and traditional ultrasound (US) allowed to observe the spread of the local anesthetic into the caudal space. In 10% of patients only CDF allowed us to observe the spread (Figure 1). It is clear that the caudal block is not always so easy to perform as usually stated and that ultrasound and color

FIGURE 1. COLOR DOPPLER FLOW (CDF) AND ULTRASOUND (US) EVALUATION OF LOCAL ANESTHETIC SPREAD DURING CAUDAL ANESTHESIA



75 neonates and infants (0-6 monts, 2.1-8.4 kg)

CDF and US allowed to see the spread (90%)

Only CDF allowed to see the spread (10%)

doppler flow can help to obtain the best results (5, 6, 7, 8, 9, 10).

The PRAN has also demonstrated that ninety-five percent of blocks were placed with the little patients under general anesthesia. Single-shot caudal blocks were the most frequently regional anesthesia techniques applied (40%). Anyway, peripheral nerve blocks were also frequently used (35%), thanks to the increasingly application of ultrasound (83% of upper extremity and 69% of lower extremity).

Among the regional ultrasound blocks is widely developing the transversus abdominis plane block (TAP). The ultrasound TAP block is a relatively simple technique that provides myocutaneous anesthesia that may be useful in the prevention and treatment of postoperative parietal pain. Initial experience with ultrasound TAP block demonstrated efficacy of the technique in different echoguided procedures such as cesarean section, appendicectomy, laparoscopic cholecystectomy and infra umbilical surgery in adult patients. Clinical trials recently published suggest that TAP block may represents an effective alternative to epidural anesthesia also in pediatric and neonatal patients. In some cases it may be particularly useful in preterms and infants especially if they are suffering from diseases with a high risk of general anesthesia or postoperative apnea. The use of ultrasound allows to perform the blockade safely avoiding the accidental puncture of liver and spleen observed with the blind technique through the Petit's triangle (11,12,13).

Although locoregional anesthesia has been shown to be safe in pediatric patients, Meyer (14) has recently published an interesting article on 4 clinical cases of severe neurological damage following epidural anesthesia. Anesthesia were performed correctly following all procedures by experienced anesthetists in pediatric regional anesthesia. This did not prevent the consequences that were disastrous with permanent or long-term neurological damage. Remain many questions about the pathogenetic mechanisms of these complications but the problem should not be underestimated. In all 4 cases there were no compression by hematomas or abscesses or direct needle damage but probable vascular injuries from anterior spinal artery syndrome (ASAS) or other alteration in cord blood flow. Infact magnetic resonance imaging revealed ischemia of the conus medullaris. Another mechanism may have been due to the effects of the hydrostatic pressure created by the injection of the local anesthetic into the epidural space resulting in decreased cord perfusion. It must also be taken into account that in pediatric patients there is already a physiological lower spinal cord perfusion pressures that can be increased by the anesthetic solution administered also through repeted repeated bolus, high infusion volumes following prolonged surgery. The addition of epinephrine for the test dose can determine vasoconstriction that could play a role in creating an ASAS.

Those who have described are just a few examples and simple considerations about the safety and efficacy of ultrasound in pediatric regional anesthesia. Anyway, we cannot affirm that the use of ultrasound would have been able to avoid the neurological damages described by Meyer.

It is likely that an ultrasound prescanning can help to analyze the neuraxial structures before performing an anesthetic block but it's very difficult to avoid, if the whole procedure is correctly performed as described by Meyer, the complications that are still fortunately very rare and which may relate to particular unrecognized clinical condition.

An increasing number of pediatric anesthesiologists are using ultrasound for many clinical applications. We want to encourage and recommend its use, but this should be done only after an appropriate training, in experienced hands and by experienced pediatric anesthesiologists.

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