HOT TOPIC

SHOULD THE USE OF ULTRASOUND (U/S) BE ROUTINE PRACTICE WHEN PERFORMING CAUDAL BLOCKS?

SUMMARY OF KEY POINTS:

- Caudal epidurals make up 40% of all regional blocks in paediatric anaesthesia
- Traditional landmark-based techniques have a low complication rate
- U/S may prove particularly beneficial where landmark palpation is difficult (obesity, neonates and infants) and in the context of conditions associated with congenital vertebral malformations

REVIEW OF EVIDENCE

Background:

Regional anaesthesia based techniques are integral to a multi-modal analgesic profile. In paediatrics, regional anaesthesia is routinely performed under general anaesthesia (GA) or deep sedation, with patients unable to express paraesthesia related discomfort. Fortunately, this does not seem to increase the risk of complications[1]. The American Society of Regional Anaesthesia and Pain Medicine (ASRA) and European Society of Regional Anaesthesia and Pain Therapy (ESRA) committees consider paediatric regional under GA or deep sedation the standard technique.

Caudal epidurals make up 40% of all regional blocks in paediatrics. They are often used with the objective of minimizing exposure to peri-operative opiates (and their potential side effects) in infraumbilical surgery. Traditional landmark-based techniques rely on palpation of bony anatomy, with success rates of up to 96% and complication rates of 1.9% [2]. Peripheral regional nerve blockade is now almost exclusively performed using U/S guidance to increase success rate and decrease the complication profile. Advocates have claimed similar benefits for U/S guided neuraxial techniques, including caudals. But despite some of the claimed merits, U/S is currently used in just 3% of caudal blocks[3]. Is it time to adopt U/S guided caudals into routine practice?

Anatomic considerations

A commonly adopted landmark technique for identifying the sacral hiatus is by palpation of the posterior superior iliac spines (PSISs). It is assumed that a line between these spines forms the base of an equilateral triangle, where its apex lies over the sacral hiatus between the sacral cornua. But palpation may be more challenging in obesity or previous spinal surgery. In a study of 1,100 patients aged 7 years or younger, it was reported that identification of the sacral hiatus by palpation was difficult in 11% of cases and was more common in those <10 kg[4]. A study by Kim et al.[5] found that locating the sacral hiatus by the equilateral triangle method was inaccurate in children less than 6 years of age. The authors argue that U/S is useful for identifying the anatomical landmarks required for block performance.

U/S can be used to visualise the sacral hiatus, sacrococcygeal ligament, dura mater and epidural space. It is worth noting that anatomical anomalies of the sacral canal roof are

observed in 5% of patients. The depth of the dural sac is variable and unpredictable, so puncture without U/S guidance potentially risks dural injury.
In the neonate there is incomplete ossification of the posterior vertebral elements, which can make identification of the sacrococcygeal membrane more challenging. In a comparative study of 26 infants Mirajali et al.[6] were able to easily palpate the PSISs but found difficulty in palpating 15% of sacral cornua and thus the sacral hiatus. Use of U/S allowed identification of these landmarks. Consequently, they make an argument for pre-scanning with U/S in this age group, where landmark-based techniques may prove difficult.
Pre-scanning with U/S is a useful diagnostic tool for infants with sacral dimples and urogenital anomalies, who may have a higher incidence of spinal dysraphism or bony defects which would contraindicate neuraxial techniques.

Visualising the needle (real-time scanning using U/S)
A potential cause for block failure is the misplacement of the block needle. Adler et al.[7] prospectively examined 109 caudals and whether caudal needles were accurately placed using a landmark technique, with a separate sonographer subsequently scanning with U/S to check needle position. They found correct needle placement in just 78.9% of cases and argue that that we may significantly misjudge needle placement using landmarks alone.

An argument for U/S guided blocks is that visualisation of the regional needle and adjacent structures might potentially increase success rates. However, the caudal needle cannot always be visualised with ultrasound. Ahiskalioglu et al.[8] used a transverse out-of-plane approach and were able to visualise the needle in just 60% of cases. Compiled data from a recent meta-analysis[9], including transverse out-of-plane and longitudinal in-plane approaches, showed that the needle was visualised in 82.1% of cases. It is important to acknowledge that real-time needle visualization, while efficacious, is technically challenging[9]. Dural displacement from the spread of local anaesthetic is more commonly seen and can be used as confirmation of appropriate needle placement.

U/S can be used to visualise distribution of local anaesthetic within the epidural space, and this affects the block success significantly. In the Jain et al[9] meta-analysis U/S was able to visualise sacral canal distention with saline or local anaesthetic in 97.5% of cases, confirming correct needle placement. A further proclaimed safety advantage is that turbulent flow seen on U/S eliminates the possibility of an intravascular injection.

First puncture success and overall success rate
Some comparative studies have tried to address whether U/S improves the chances of caudal success. However, success has been variably defined within different studies which makes comparison difficult. Success was most commonly taken as an absence of haemodynamic response to surgical stimulus. Ashiskalioglu et al. and Karaca et al.[10]

claimed higher overall success rate with U/S vs landmarks techniques. (97% vs 93% and 96.2% vs 94.7% respectively). In contrast, Wang et al.[11] had higher success rates with the landmark technique (92.8% vs.95.7%). Pooled analysis of 5 trials, showed no significant difference in overall success between the two groups[9].
However, there were significant differences reported in 1st puncture success rates. Riaz et al.[12] found higher 1st puncture success rate of 95% vs 70.83% in the U/S group. Ahiskalioglu et al. Wang et al .and Karaca et al. also recorded higher first puncture success in U/S groups - 80% vs 63%, 92.8% vs 50% and 90.2% vs 60.2% respectively.

Safety and complication rate

Paediatric regional anaesthesia has a low incidence of adverse events. This is supported by large prospective studies from the Paediatric Regional Anaesthesia Network (PRAN) database[13] in the US and from the French-Language Society of Paediatric Anaesthesiologists (ADARPEF)[14]. ADARPEF found that complications from central neuraxial blocks, including caudals, were 6 times higher than those of peripheral blocks. In 2015 an observational study of 18,650 caudals using prospective data from the PRAN database, found an incidence of complications of 1.9%, with a peak in children younger than 6 months[3]. Additionally, the use of indwelling catheters increases complication rates.
Major complications such as local anaesthetic toxicity or lasting neurological injury have very low incidences and have not been reported in comparative studies. Minor complications such as vascular puncture and subcutaneous injections have been compared with the two methods.
Ahiskalioglu et al. (12%), Roberts et al. (10.6%)[15], and Wang et al. (18.6%) observed higher vascular punctures rates with landmark techniques compared to U/S guided blocks (1.4%, 5.3% and 5.7% respectively).
However, there is some conflict in opinions. The analysis from ADARPEF was unable to detect a beneficial role in the use of ultrasound to minimise complications. The Guay et al. 2019[16] Cochrane review reported at the time that there was little or no difference in the risk of vascular puncture, citing low-quality evidence. But subsequent Jain et al. 2021 meta-analysis supports a significantly reduced risk of vascular puncture (risk ratio 0.15) and subcutaneous injection (risk ratio 0.06) in the U/S group compared with the landmark technique. It has been suggested that visualisation of the sacral venous plexus (which may extend to S4) and minimised needle redirections decrease the potential for vascular punctures.

Block performance time

There have been several landmark vs U/S comparative trials looking at the time taken to perform caudals. The evidence for impact of U/S on block performance time is mixed. Wang et al. reported shorter block performance time with U/S at 145s compared with 164s. Riaz et al. noted a longer time for U/S (110s vs 63s) and Ashikalioglu et al found no significant difference (109.9s vs 110.8s). The Jain et al. pooled data did not reveal any

significant difference in block performance time between the two techniques. Notably the time taken for probe preparation and scan time was not measured in any of the studies. When taken into consideration, this would likely increase the overall time spent on caudal insertion.

Conclusion

Whilst ultrasound does not improve the overall success of paediatric caudal insertion, it may offer some benefits. Key advantages include visualisation of anatomic structures and spread of local anaesthetic, as well as improved first puncture success rate. As yet, no large-scale prospective studies confirm whether U/S results in improved morbidity or mortality. But there is some evidence to support a reduced risk of some complications, including vascular puncture and subcutaneous injection.

The use of U/S may prove particularly beneficial where landmark palpation is difficult (obesity, neonates and infants), when there is a suspicion of spinal dysraphism or where a caudal catheter is planned. Future studies in these patient groups would be of particular interest. Block performance time using U/S will improve with operator experience and should not be a deterrent to use.

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