HOT TOPIC

SHOULD ULTRASOUND GUIDED ARTERIAL LINE PLACEMENT BE THE 1ST LINE TECHNIQUE IN CHILDREN?

SUMMARY OF KEY POINTS:

- Arterial line insertion is a common technique for haemodynamic monitoring and blood sampling in children undergoing major surgery or in the intensive care unit.
- The traditional palpation method of arterial line insertion has a low complication rate but can be challenging even for experienced Paediatric Anaesthetists.
- The use of ultrasound for arterial line insertion may improve the likelihood of successful first pass cannulation, and reduce the number of attempts, the time taken for successful insertion and complications.

REVIEW OF EVIDENCE

Background

The insertion of an arterial line is a common procedure for children undergoing major surgery and those critically unwell on the intensive care unit where close haemodynamic monitoring or frequent arterial blood gas sampling is desirable[1]. Traditionally this has been performed using a palpation or doppler technique whereby the chosen artery (typically the radial artery) is palpated or a doppler probe is used to detect the maximum noise signal to locate the artery[1,2]. Whilst commonly practiced this technique can be highly challenging even for experienced Paediatric Anaesthetists especially in infants and neonates.

It has been suggested that the use of ultrasound for arterial line placement may improve the rates of first pass success, time taken to successful cannulation, and the number of required attempts, which may reduce the rate of complications in children[1].

First Attempt Success Rate

A Cochrane review published in 2019, analysed 4 randomised control trials (RCTs; a total of 404 participants) comparing ultrasound guided vs palpation/doppler technique placed arterial lines. The review found a relative risk (RR) of 1.96 (1.34-2.85, CI 95%) for 1st attempt success with ultrasound[1]. The studies included in this review suggested the chances of 1st time successful cannulation appear to be greater for ultrasound vs doppler by non-expert operators (33% vs 15%, p=0.039, median age 6 months)[2] and for ultrasound vs palpation in experienced practitioners (67% vs 20%, p<0.05, median age 28 months)[3]. Higher likelihood of 1st success was also observed in children undergoing cardiac surgery[4] (76.3% vs 35.6%, p<0.001, median age 18.4 months). However, this benefit was not found in one study among older children (mean age 99 months, n=152), observing respective 1st pass success rates of 13.9% vs 13.8% for ultrasound vs palpation techniques, when performed by novice practitioners (less then 5 previous successful ultrasound guided arterial line insertions)[5].

Time to Successful Cannulation

Several studies have investigated the time to successful arterial cannulation with ultrasound vs palpation. Ultrasound appears to be faster in the elective surgery setting with expert operators; Schwemmer et al, 64.5 (± 54.2) vs 150.8 (± 130.2) seconds ($p<0.05$)[3]. Although two studies from North America with inexperienced operators have produced conflicting findings: Tan et al, demonstrated times of 7.8 minutes vs 12.7 minutes favouring ultrasound for success within three attempts[6] whereas Ganesh et al, found no statistical difference between groups[5]. In addition, ultrasound appears to be faster for arterial canulation in children in the ICU setting[7] and for arterial identification in children undergoing elective cardiac surgery[4].

Number of attempts

Additionally, ultrasound appears to be superior in reducing the number of attempts for successful cannulation, potentially the most important factor in reducing the rate of mechanical complications. Schwemmer, demonstrated a mean number of attempts of successful cannulation 1.3 ± 0.5 with ultrasound in comparison to the palpation group mean attempts of 2.3 ± 0.9 ($p<0.05$, 30 line insertions)[3]. A group from Japan reported similar benefits with a median number of attempts with ultrasound of 1 (IQR 1-1) vs 2 (IQR 1-2) in a group using the traditional palpation technique ($p=0.001$, 118 line insertions)[4].

Frequency of Complications

A large retrospect study has reported the frequency of major complications of arterial line insertion in children undergoing surgery as 0.2%, where younger age was shown to be a strong predictive risk factor for complications[8]. No large study has assessed how the use of ultrasound may affect the rate of arterial line related complications in children. Of all the studies already described, none has reported major complications. A recent meta-analysis[9] combining 6 studies, suggested the rate of perivascular haematoma was significantly lower when ultrasound was utilised with a RR = 0.19 (95% CI 0.10-0.35, $p<0.00001$).

Conclusions

The use of ultrasound appears to improve several important clinical metrics as regards to arterial line insertion, of which we believe the most important are the rates of first pass success and the number of attempts to successful cannulation. In addition, it seems intuitive that this may limit the chances of complications particularly those that are mechanical in nature (haematoma formation and vasospasm), although this warrants further research. Furthermore, the use of ultrasound does not appear to have any appreciable downsides, including the time taken for successful line insertion. It is worth noting that many of the studies are deemed to present moderate quality evidence by a Cochrane review, with potential performance bias and the lack of blinding to the study intervention being common weaknesses to all the studies[1]. However, despite this we argue that ultrasound is likely to be superior to palpation/doppler guided arterial line insertion and should be considered as the first line technique in children.

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