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Review Article

Systematic review of the systemic concentrations of local anaesthetic after transversus abdominis plane block and rectus sheath block

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Abstract

Background. Safe and efficacious modalities of perioperative analgesia are essential for enhanced recovery after surgery. Truncal nerve blocks are one potential adjunct for analgesia of the abdominal wall, and in recent years their popularity has increased. Transversus abdominis plane block (TAPB) and rectus sheath block (RSB) have been shown to reduce morphine consumption and improve pain relief after abdominal surgery. These blocks typically require large volumes of local anaesthetic (LA). We aimed to synthesize studies evaluating systemic concentrations of LA after perioperative TAP and RSB to enhance our understanding of systemic LA absorption and the risk of systemic toxicity.

Methods. An independent literature review was performed in accordance with the methods outlined in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement. An electronic search of four databases (MEDLINE, EMBASE, Cochrane Central Register of Controlled Trials, and PubMed) was conducted. Primary articles measuring systemic concentrations of LA after single-shot bolus TAPB or RSB were included.

Results. Fifteen studies met the inclusion criteria. Rapid systemic LA absorption was observed in all studies. Of a total of 381 patients, mean peak concentrations of LA exceeded toxic thresholds in 33 patients, of whom three reported mild adverse effects. The addition of epinephrine reduced systemic absorption of LA. No instances of seizure or cardiac instability were observed.

Conclusions. Local anaesthetic in TAPB and RSB can lead to detectable systemic concentrations that exceed commonly accepted thresholds of LA systemic toxicity. Our study highlights that these techniques are relatively safe with regard to LA systemic toxicity.

Key words: anaesthetics, local; drug toxicity; nerve block

Safe and effective modalities of perioperative analgesia are essential for enhancing recovery after surgery. Optimal regimens of analgesia seek to improve patient comfort and mobilization whilst minimizing the risk of complications that may inhibit postoperative recovery.[1] Severe pain after open and laparoscopic abdominal surgery remains a significant clinical

problem. As surgical techniques change and length of inpatient stay decreases, it is important to offer safe and reliable methods of analgesia that may be delivered in both hospital and outpatient settings.

Regional anaesthesia has become an important addition to multimodal regimens of analgesia for postoperative pain. The block of pain impulses by local anaesthetic (LA) provides effective pain relief for abdominal surgery, either on its own or as part of a multimodal analgesic regimen.[2] With the development of ultrasound imaging techniques that enable precise target identification, truncal blocks, such as transversus abdominis plane block (TAPB) or rectus sheath block (RBS), are becoming popular after abdominal surgery.[3 4] Previous clinical trials have shown that the addition of truncal blocks to multimodal regimens of analgesia significantly reduces pain and opioid consumption after surgery.[5–7] Transversus abdominis plane block and RSB are compartmental blocks, which require large volumes of LA to optimize the spread within a fascial plane towards a target nerve or group of nerves.[8]

Despite the increasing interest in truncal blocks, little is known about systemic concentrations of LA after truncal nerve block. The large doses of LA required raise the potential issue of LA systemic toxicity. Local anaesthetic systemic toxicity is characterized by central nervous system and cardiac instability ranging from dizziness to seizures, and from mild arrhythmia to cardiovascular collapse and death, respectively.[9 10] Systemic concentrations of LA are correlated with the vascularity of the tissue, LA pharmacodynamic properties and effects of potential additives, and patient conditions such as pregnancy or sepsis.[11] After a single bolus injection of LA, peak concentrations are greatest after intrapleural or intercostal administration followed in decreasing order by caudal, epidural, brachial plexus, and lower limb blocks.[12] The systemic absorption of LA after epidural and brachial plexus applications has been well characterized and discussed in the literature.[13 14] The aim of this review was to synthesize data from studies assessing perioperative LA systemic concentrations after single bolus TAPB and RSB and define the plasma concentrations to be expected.

Methods

A systematic review was performed in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement where possible.[15] Two authors (J.R., J.T.) independently performed a series of electronic searches of four databases (MEDLINE, EMBASE, Cochrane Central Register of Controlled Trials, and PubMed). With the assistance of a subject librarian, the first author (J.R.) collated a list of keywords and search terms to incorporate into strategies adapted for each database. The search terms combined local anaesthetics, anterior abdominal wall blocks, systemic concentrations, and pharmacokinetics of local anaesthetics. Language limitation was not applied. Truncated search terms were used to increase the hit rate. Search results were downloaded and managed with RefWorks citation management software (ProQuest LLC, Ann Arbor, MI, USA).

Study selection

Abstracts were screened and full-text papers obtained to identify primary research studies reporting serum concentrations of LA agents used in ultrasound-guided (USG) anterior abdominal wall blocks (TAPB and RSB) in adult patients for any indication. The primary outcome of interest was serum concentrations of LA agents in the first 24 h after surgery. All human clinical trials, whether randomized, quasi-randomized, or non-randomized, that primarily evaluated serum concentrations of LA agents after TAPB or RSB were included. Exclusion criteria included studies that did not evaluate serum concentrations of LA agents, studies on infants and children (<18 yr of age), and those articles for which full-text publications were not available (e.g. conference abstracts). Two reviewers (J.R., J.T.) independently performed the searches and examined titles and abstracts to exclude irrelevant reports and produce a list of studies for full-text review in an iterative process. Any disagreement over inclusion or exclusion was discussed with the senior author (A.G.H.) and a consensus reached. Additional articles and abstracts were retrieved by manually examining reference lists of relevant publications. The last search was performed on July 16, 2016.

Data abstraction

Data extraction was performed independently by the first author and entered in predesigned electronic tables. Tables recorded patient characteristics, operative characteristics, LA dose and type, and LA serum concentrations, including pharmacokinetic parameters (C_{max} and T_{max}), where C_{max} refers to the maximal serum concentration that a drug achieves and T_{max} refers to the time at which C_{max} is observed. Data were reported as the mean (SD) where possible, and only recorded if stated in the text, tables, graphs, or figures of the articles. The median score was used as an estimate of the mean where the latter was not reported. Standard deviation measures were attempted based on the methods described in the Cochrane Handbook of Systematic Reviews of Interventions, where attempts to contact authors for clarification were unsuccessful (up to two emails).[16] Variations in the timing of outcome measures, procedure type, and study cohorts limited meaningful synthesis of the data. Pharmacokinetic modelling was not attempted because of study heterogeneity and differences in LA detection method and anaesthetic regimens. The data are therefore presented as a narrative review.

Assessment of risk of bias

Two reviewers (J.R., J.T.) independently applied the Newcastle–Ottawa Scale (NOS), which assesses the methodological quality of non-randomized aspects of study design, including patient selection, comparability of study groups, and assessment of outcomes.[17] The tool uses a scoring system with a maximum of nine stars, and studies that achieve five or more stars are considered high quality.

Results

The literature search identified 206 records in the initial database search. A PRISMA flow diagram for the systematic review is presented in Fig. 1. Fifteen clinical studies met the inclusion criteria and were included in the review.[18–32] Three studies were excluded, where two studies were abstracts from conference proceedings, and multiple LA applications were used in the remaining study (Table 3). The majority of the included studies used ropivacaine as their chosen LA agent.[18–23 26 28–31] One study used lidocaine,[24] and three studies used levobupivacaine.[25 27 32] Among 381 participants included for analysis in all 15 studies, there were 33 reported instances where systemic LA concentrations exceeded toxic threshold parameters (as defined