The use of 0.25% lignocaine combined with fentanyl and mivacurium for intravenous regional anaesthesia (IVRA) of the upper limb

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Received 27 June 1999; accepted 30 June 1999

Abstract

In this study, two groups of patients undergoing intravenous regional anaesthesia (IVRA) for surgery on the forearm or hand have been compared. The first group received 0.5% lignocaine while the second received 0.25% lignocaine + fentanyl 1 μg kg⁻¹ and mivacurium 1 mg. A prior study comparing 0.5% lignocaine to pancuronium 0.5 mg with 0.25% lignocaine and fentanyl 1 μg kg⁻¹ showed a faster onset of motor block in the 0.5% lignocaine group [1]. This study demonstrates a significantly faster onset of motor block in the mivacurium-administered group. The potential advantage of mivacurium is its non-organ dependent metabolism by plasma cholinesterase. There was no difference in the onset of the sensory block. It is well known that there is little postoperative analgesia associated with conventional Bier's block. The study found lower pain scores in the second group 45 min and 1 h post-operatively. Anaesthesia was successful in all cases and none of the patients experienced muscle weakness after tourniquet release. © 1999 Elsevier Science B.V. All rights reserved.

Keywords: Analgesia; Fentanyl; IVRA; Lignocaine 0.25%; Mivacurium; Muscle relaxation; Toxicity

1. Introduction

Intravenous regional anaesthesia (IVRA) needs no introduction. First described by August Bier in 1908, it soon lost popularity with the advent of specific brachial plexus blocks. In 1963, Holmes repopularised the technique and to date, many modifications have been described [1–7]. Today, IVRA has remained popular owing to the fact that it may be safely administered by people with basic skill levels as well as the low incidence of side effects associated with the technique [8,9]. IVRA is often used in the ambulatory surgery setting.

In conventional Bier’s block, 0.5% lignocaine is administered in a volume of 30–40 ml, equivalent to a dose of 2.5–3 mg kg⁻¹ for an average-sized patient in our Asian population. The present study looks at the use of 0.25% lignocaine with fentanyl 1 μg kg⁻¹ and mivacurium 1 mg in a volume of 40 ml, corresponding to 1.5–2 mg kg⁻¹. This combination confers several potential advantages namely allowing earlier tourniquet release, a lower risk of systemic toxicity should tourniquet failure occur, postoperative analgesia and profound muscle relaxation of rapid onset.

2. Methods

The Hospital Ethics Committee approved this double-blind study. Informed consent was obtained from the patients. Forty-eight unpremedicated patients, ASA physical status I or II, presenting for elective or emergency surgery of the forearm or hand, were randomly allocated to two groups. In group one, the patients were administered 30 ml of 0.5% lignocaine while the patients in group two were given 40 ml of lignocaine 0.25% combined with 1 μg kg⁻¹ of fentanyl and 1 mg of mivacurium.

Following the insertion of a 22-gauge intravenous cannula in the non-operative limb, a 22-gauge intravenous cannula was placed as distally as possible on the dorsum of the hand of the operative limb. Exsanguination of the limb was then achieved with anti-gravity...
Table 1
Distribution of surgical procedures between group one and group two

<table>
<thead>
<tr>
<th>Cases</th>
<th>Number of cases in group one</th>
<th>Number of cases in group two</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wound debridement, toilet and suture of hand</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>Removal of implants from forearm or hand</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Carpal tunnel release</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Excision of ganglion</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Open reduction, internal fixation of finger</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Release of trigger thumb/trigger finger/tenosynovitis</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Manipulation and reduction of Colles' fracture</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Removal of foreign body of hand</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Excision biopsy of palm cyst/finger nodule</td>
<td>0</td>
<td>2</td>
</tr>
</tbody>
</table>

* Group one = lignocaine 0.5%. Group two = lignocaine 0.25%+fentanyl 1 μg kg⁻¹+mivacurium 1 mg.

3. Results

The two groups were comparable in patient demographics, distribution of surgical procedures [Table 1], mean ischaemic time, duration of operation and time to onset of analgesia.

The onset of motor blockade was significantly faster in group two (P < 0.005) [Table 2]. In addition, pain scores 45 min and 1 h postoperatively were significantly lower in group two. (P < 0.05). [Fig. 1]

Anaesthesia was successful in all cases. Five patients in group one reported slight giddiness after the tourniquet was deflated, one of whom also had tinnitus. In group two, 11 patients experienced slight giddiness. None of the patients in group two experienced diplopia, skeletal muscle weakness or nausea after release of the tourniquet.
4. Discussion

Our study demonstrates that 0.25% lignocaine combined with fentanyl 1 μg kg⁻¹ and mivacurium 1 mg is a suitable alternative to 0.5% lignocaine for intravenous regional anaesthesia of the upper limb. Mivacurium, being metabolised by plasma cholinesterase, has a short duration of action. Moreover, the average dose of lignocaine in group two was 1.7 mg kg⁻¹ which represents a significant reduction in the administered dose of lignocaine, thus allowing for an increased margin of safety should inadvertent systemic administration of drug occur.

Sztark et al. [1] reported a delayed onset of motor blockade with the use of pancuronium 0.5 mg added to lignocaine 0.25% combined with fentanyl 1 μg kg⁻¹. Elhakim et al. [2] found that adding 2 mg of atracurium to 0.5% lignocaine resulted in a significantly greater degree of muscle relaxation as opposed to 0.5% lignocaine alone, although there was no significant difference in the time taken to achieve motor block. Our study shows a significantly faster onset of motor blockade when 1 mg of mivacurium was added to 0.25% lignocaine with fentanyl 1 μg kg⁻¹ with no effect on the onset of analgesia. A possible explanation is that vasodilatation as a result of histamine release from mivacurium enhances delivery of the drugs to their site of action. Indeed, the majority of patients in group two developed transient extreme erythema of the operative limb upon administration of the drug combination. Muscle relaxants in IVRA have been postulated to interfere with muscle spindle activity resulting in loss of muscle tone and reduction of central input because they are the sensory end organ of skeletal muscle. This may then facilitate the manipulation and reduction of bone fractures or dislocations, potentially useful in the emergency room. McGlone et al. [10] found that closed reduction of wrist fractures was facilitated and quality of analgesia improved with the addition of 2 mg of atracurium to the Bier’s block. It is important to be aware of the risk of anaphylaxis or anaphylactoid reactions when administering mivacurium.

Evidence for the existence of peripheral opioid receptors is not lacking [11]. Gissen et al. [12] postulated that high concentrations of fentanyl may exert a weak local-anaesthetic type action on peripheral nerves. It is unlikely that fentanyl exerts a significant peripheral analgesic or local anaesthetic action when administered in this concentration to the tourniquet-isolated limb because there was no difference in the onset of analgesia between the two groups.

In contrast to Sztark’s [1] finding of a lack of improvement in postoperative analgesia in the group of patients given fentanyl 1 μg kg⁻¹ with 0.25% lignocaine and pancuronium 0.5 mg, we have found significantly lower pain scores at 45 min and 1 h postoperatively.

Fig. 1. Comparison of postoperative pain scores between group one (0.5% lignocaine) and group two (0.25% lignocaine + fentanyl 1 μg kg⁻¹ + mivacurium 1 mg). [median ± interquartile range] * P < 0.05 between groups one and two.
This may be attributable to the central analgesic effects of fentanyl upon tourniquet release.

As was in common with the findings of several authors, [4,13] 11 patients in group two, as opposed to five patients in group one, experienced slight giddiness after tourniquet release which subsided within 10 min. None of the patients developed any other symptoms of local anaesthetic toxicity except for a single patient in group one who also had tinnitus. No one experienced any nausea or vomiting. Plasma concentrations of local anaesthetic have been found to be higher in patients given a fentanyl/prilocaine combination versus prilocaine alone [4]. This was attributed to the vasodilator effect of fentanyl resulting in a more rapid washout of local anaesthetic from the limb following cuff deflation. In any case, the total dose of lignocaine used in group two was similar to that used to treat cardiac arrhythmias.

To summarise, we feel that the combination of 0.25% lignocaine with fentanyl 1 \( \text{µg} \cdot \text{kg}^{-1} \) and mivacurium 1 mg for IVRA may be a useful substitute for 0.5% lignocaine for minor surgery of the forearm or hand as well as to facilitate the manipulation and reduction of fractures in the emergency room setting. However, we reiterate that the presence of personnel trained in airway management and resuscitation is necessary when employing this technique because of the inherent risks of administration of a muscle relaxant, however small the dose.

Acknowledgements

The authors would like to thank Drs Chan Soo Toon, Fong Chung Ming, staff of the Department of Anaesthesia, Changi General Hospital for their invaluable help and Glaxo Wellcome for generously donating the mivacurium.

References