ELSEVIER

Ambulatory Surgery 8 (2000) 41–44

Ambulatory Surgery

www.elsevier.com/locate/ambsur

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

Noelle Louise Siew Hua Lim *, Ee Lyn Ong

Department of Anaesthesia and Surgical Intensive Care, Changi General Hospital, 2, Simei Street 3, 529889 Singapore, Singapore

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.

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

* Corresponding author.

0966-6532/00/$ - see front matter
PII: S0966-6532(99)00031-1

Table 1
Distribution of surgical procedures between group one and group two[a]

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

[a] Group one = lignocaine 0.5%. Group two = lignocaine 0.25%+ fentanyl 1 μg kg^{-1} + mivacurium 1 mg.

drainage, compression of the brachial artery ± the use of an Esmarch bandage. Following this, the distal cuff of the tourniquet was inflated to 250 or 100 mmHg above systolic blood pressure, whichever was higher, after which the proximal cuff was inflated to the same pressure. This was carried out to aid exsanguination of the upper limb [8]. After confirming the absence of the radial pulse, the local anaesthetic solution was injected over 90 s by an anaesthetist not involved in the study. The distal cuff of the tourniquet was then deflated. Subsequently loss of pinprick sensation was tested in six areas; namely, the pulps of the index and little fingers, the thenar and hypothenar eminences, the first web space on the dorsum of the hand and the lateral aspect of the forearm, corresponding to the three major nerves supplying the upper limb, i.e. the median, ulnar and radial nerves. Time to loss of sensation of pain to pinprick, i.e. onset of analgesia was recorded from the time of administration of lignocaine. Onset of motor blockade was defined as weakness of finger grip, the control being the patient's unanaesthetised hand.

Intraoperative monitoring by means of electrocardiogram, non-invasive blood pressure and pulse oximetry was performed. Sedation with intravenous midazolam 1–2 mg was given as and when required.

When surgery had been completed, the tourniquet was released cyclically after a minimum of 20-min post-injection of local anaesthetic, i.e. deflated for 5 s, reinflated for 1 min, deflated another 5 s, reinflated another 1 min and subsequently permanently deflated. The patients were then asked to report if they experienced any giddiness, perioral numbness, tinnitus, diplopia, nausea or difficulty breathing.

Postoperatively for 1 h, at 15-min intervals, the patients' pain scores were monitored using a visual analogue scale (from zero to ten).

Analysis of data was performed with the Student's t-test and the Mann–Whitney U-test.

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.

Table 2
Mean (SEM) age, weight, ischaemic time, duration of operation, time to onset of analgesia, lignocaine dose and time to onset of motor block[a]

	Group one ($n = 24$)	Group two ($n = 24$)	P value
Age (years)	32.3 (3.0)	31.0 (3.0)	NS
Weight (kg)	61.9 (2.2)	58.9 (1.5)	NS
Ischaemic time (min)	47.2 (6.0)	40.2 (3.3)	NS
Duration of operation (min)	29.4 (5.2)	22.4 (2.7)	NS
Time to onset of analgesia (min)	5.2 (0.6)	5.1 (0.6)	NS
Lignocaine dose (mg kg^{-1})	2.5 (0.5)	1.7 (0.2)	Not tested
Time to onset of motor block (min)	11.1 (1.3)	3.0 (0.3)	<0.001

[a] Values are mean (SEM) except lignocaine dose: mean (S.D.). Group one = lignocaine 0.5%, group two = lignocaine 0.25%+fentanyl 1 μg kg^{-1} + mivacurium 1 mg. NS: not significant.

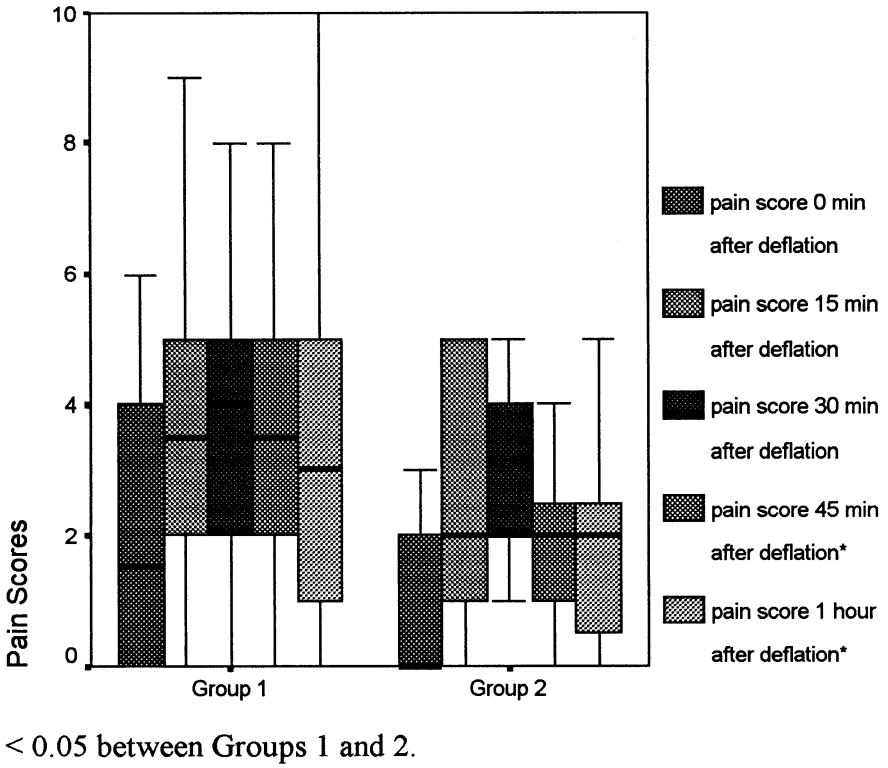

Fig. 1. Comparison of postoperative pain scores between group one (0.5% lignocaine) and group two (0.25% lignocaine + fentanyl 1 μg kg^{-1} + mivacurium 1 mg). [median ± interquartile range] * $P < 0.05$ between groups one and two.

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.

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 $\mu g\,kg^{-1}$ 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

[1] Sztark F, Thicopé M, Favarel-Garrigues JF, Lassié P, Petitjean ME, Dabadie P. The use of 0.25% lidocaine with fentanyl and pancuronium for intravenous regional anesthesia. Anesth Analg 1997;84:777–9.

[2] Elhakim M, Sadek RA. Addition of atracurium to lidocaine for intravenous regional anaesthesia. Acta Anaesthesiol Scand 1994;38:542–4.

[3] Armstrong P, Power I, Wildsmith JAW. Addition of fentanyl to prilocaine for intravenous regional anaesthesia. Anaesthesia 1991;46:278–80.

[4] Pitkänen MT, Rosenberg PH, Pere PJ, Tuominen MK, Seppälä. Fentanyl-prilocaine mixture for intravenous regional anaesthesia in patients undergoing surgery, Anaesthesia 1992;47:395–8.

[5] Acalovschi I, Cristea T. Intravenous regional anesthesia with meperidine. Anesth Analg 1995;81:539–43.

[6] Reuben SS, Steinberg RB, Kreitzer JM, Duprat KM. Intravenous regional anesthesia using lidocaine and ketorolac. Anesth Analg 1995;81:110–3.

[7] Armstrong P, Brockway M, Wildsmith JAW. Alkalinisation of prilocaine for intravenous regional anaesthesia. Anaesthesia 1990;45:11–3.

[8] Henderson CL, Warriner CB, McEwen JA, Merrick PM. A North American Survey of intravenous regional anesthesia. Anesth Analg 1997;85:858–63.

[9] Brown EM, McGriff JT, Malinowski RW. Intravenous regional anaesthesia (Bier block): review of 20 years' experience. Can J Anaesth 1989;36:307–10.

[10] McGlone R, Heyes F, Harris P. The use of a muscle relaxant to supplement local anaesthetics for Bier's blocks. Arch Emerg Med 1988;5:79–85.

[11] Nagasaka H, Awad H, Yaksh TL. Peripheral and spinal actions of opioids in the blockade of the autonomic response evoked by the compression of the inflamed knee joint. Anesthesiology 1996;85:808–16.

[12] Gissen AJ, Gugino LD, Datta S, Miller J, Covino BG. Effects of fentanyl and sufentanil on peripheral mammalian nerves. Anesth Analg 1987;66:1272–6.

[13] Torrance JM, Lewer BMF, Galletly DC. Low-dose mivacurium supplementation of prilocaine i.v. regional anaesthesia. Br J Anaesthesia 1997;78:222–3.