Comparison of lidocaine hydrocarbonate, lidocaine hydrochloride and mepivacaine in the axillary block

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Axillary block was performed on 60 patients undergoing various types of surgical procedures on the upper limb. The patients were divided randomly into three equal groups of 20 and received lidocaine hydrocarbonate 1% or lidocaine hydrochloride 1% or mepivacaine 1%, each solution containing epinephrine 1/400,000. A double-blind design was used. Lidocaine hydrocarbonate and lidocaine hydrochloride were both found to have a shorter latency of analgesia than mepivacaine. Duration of analgesia, quality of the sensory and motor block were not found to be statistically different between the three groups.

Lidocaine hydrocarbonate has been used for many years in Canada, but there is still controversy concerning its alleged superiority over the hydrochloride solutions in epidural anaesthesia.¹⁻⁵ However, its effectiveness in brachial plexus block with the supraclavicular and interscalene approaches has been reported generally to be superior to the lidocaine hydrochloride solutions.⁶⁻⁹

The present study was undertaken to compare the efficacy of lidocaine hydrocarbonate to lidocaine hydrochloride and mepivacaine hydrochloride when used for axillary blocks.

Methods

Sixty patients, 14 of whom had chronic renal failure, were studied in a double-blind manner, after they gave their informed consent. They were randomly divided into three

Key words

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groups of 20 patients each, according to the local anaesthetic solution to be used. Group 1 received lidocaine hydrochloride 1% with epinephrine 1/400,000, Group 2, lidocaine hydrocarbonate 1% with epinephrine 1/400,000 and Group 3, mepivacaine hydrochloride 1% with epinephrine 1/400,000. The three solutions were prepared by diluting 2% solutions, without preservatives, with 0.9 NaCl, and the epinephrine was then added.

The axillary block was performed with a standardized technique using a nerve stimulator¹⁰ by which the median, cubital, radial and musculo-cutaneous nerves were isolated according to the elicited movements. A current of 0.5 ma was used through a 22-gauge insulated pinpoint needle. A total dose of 25 ml·m⁻² of body surface was injected in four fractions, 75 per cent of the total dose being injected in equal parts on the two principal nerve trunks innervating the surgical field and the remaining 25 per cent being injected in equal parts on the two other nerves.

After completion of the infiltration of the first nerve the latency of analgesia was evaluated every minute at the surgical site, using a pin-prick method with a Wartenberg pinwheel. The duration of analgesia was taken to be the difference between the time of complete analgesia at the surgical site and the time of first sensation of pain at that site during or after surgery. The quality of analgesia was defined as complete, partial or inadequate; complete meaning no discomfort at all during surgery, partial meaning some minor discomfort treated with 50 to 100 µg of fentanyl or local infiltration and inadequate meaning a need to repeat the block or administer a general anaesthetic.

Each patient received 2.5–5 mg of diazepam IV before the performance of the block. The motor block was evaluated after establishment of the sensory block at the site of surgery and was arbitrarily defined as being 0, 30, 60 or 100 per cent with 100 per cent indicating complete paralysis of the blocked limbs; 60 per cent loss of extension or flexion of the arm but possible movement of the hands; 30 per cent the ability to perform extension and flexion of the arm against gravity but not against resis-

FIGURE 1 Latency of analgesia in minutes $\pm$ SD to pin-prick for the first nerve injected. Group 1 = lidocaine HCl + E; Group 2 = lidocaine CO₂ + E; Group 3 = mepivacaine + E. * $p < 0.05$; G1 vs G3. ** $p < 0.005$; G2 vs G3.

tance and 0 per cent meaning free movement against gravity and a small resistance.

The results were analysed as follows: for parametric results, an analysis of variance was used, and a *t* test with Bonferoni correction for two by two comparisons. For non-parametric results, Kruskal-Wallis and Mann-Whitney *U* tests were used. The significance level was fixed at $p < 0.05$.

Results

The three patient groups were not different with respect to age, the type of surgery (bone or soft tissues), site of surgery (hand, wrist, forearm or elbow) and use or absence of tourniquet. The mean age was 46 years for all patients. The 14 patients with renal failure were uniformly distributed into the three groups. The total dose of local anaesthetic injected (mean = 42 ml) was not different among the groups.

FIGURE 2 Quality of analgesia. Group 1 = lidocaine HCl + E; Group 2 = lidocaine CO₂ + E; Group 3 = mepivacaine + E.

FIGURE 3 Quality of motor block. Group 1 = lidocaine HCl + E; Group 2 = lidocaine CO₂ + E; Group 3 = mepivacaine + E.

Latency for pin-prick analgesia was shortest with lidocaine hydrocarbonate and lidocaine hydrochloride (Figure 1), and this difference was statistically significant when compared to the latency with mepivacaine.

The quality of analgesia (Figure 2) and quality of motor block (Figure 3) and the duration of analgesia (Figure 4) were not significantly different among the three groups.

Discussion

This study of lidocaine hydrocarbonate in axillary block did not find that this solution was statistically different from lidocaine hydrochloride in terms of rapidity of onset and motor block. With a technique of axillary block which selectively localizes the nerves, as performed here, the quality of sensory block was not found superior. However, diffusion of the local anaesthetic likely plays a larger part in plexus blocks where only one injection is performed and some diffusion is needed to anaesthetize the

FIGURE 4 Duration of analgesia in minutes $\pm$ SD. Group 1 = lidocaine HCl + E 1/400,000; Group 2 = lidocaine CO₂ + E 1/400,000; Group 3 = mepivacaine + E 1/400,000.

whole plexus. This diffusion effect is evident in the interscalene approach use by Sukhani *et al.*⁹ where lidocaine hydrochloride was found to anaesthetize the entire hand in 53 per cent of patients and lidocaine hydrocarbonate in 87 per cent of patients. The effect of improved diffusion is less apparent with our technique where we measure the latency for one specific nerve. The rate of diffusion and the time it takes for a solution injected on a nerve to produce anaesthesia in the area innervated by that nerve, are two different concepts. A part of the controversy about carbonated lidocaine in epidural anaesthesia concerns that problem.¹¹ In fact, the studies that looked at the time for analgesia to develop in different dermatomes (latency profile) showed a marked advantage of the carbonated solutions over the hydrochloride solutions in epidural and in plexus block anaesthesia.^{5,8} However, the studies that determine the time to reach the highest dermatome level with epidural anaesthesia¹⁻⁴ or the time to achieve complete analgesia when injections are made at a specific nerve, as in the present study, show a less marked advantage for carbonated lidocaine.

In the present study the 1% solutions were prepared from 2% solutions by dilution with 0.9 NaCl and the epinephrine was then added, just before the injection. This may be detrimental to the hydrocarbonated solutions because of dilution of the pCO₂.¹² The pCO₂ of the solution was 88.9 kPa (669 mmHg) before dilution and 40.9 kPa (308 mmHg) after dilution.

Considering that 1% or 1% equivalent solutions are suggested for plexus anaesthesia,¹³ the 1% equivalent of lidocaine hydrocarbonated preparations could be more convenient than 2% solutions in plexus or peripheral nerve blocks.

We conclude that in the context of this study carbonated lidocaine, although faster in onset than mepivacaine, was not significantly different from lidocaine hydrochloride in onset time. Carbonated lidocaine, lidocaine hydrochloride and mepivacaine hydrochloride were not different with respect to quality of analgesia, quality of motor block and duration of analgesia.

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Résumé

Soixante patients soumis à différentes chirurgies du membre supérieur sous bloc axillaire ont été étudiés. Ils ont été divisés au hasard en trois troupes de 20 patients selon qu'ils reçurent comme anesthésique local de la lidocaïne hydrochlorée, de la lidocaïne hydrochlorée, de la lidocaïne carbonatée ou de la mépivacaïne, chaque solution contenant 1% du produit actif avec épinéphrine 1/400,000. L'étude était à double insu. La latence d'analgésie a été plus courte pour la lidocaïne carbonatée et la lidocaïne hydrochlorée que pour la mépivacaïne. La durée d'analgésie, la qualité des blocs sensitif et moteur n'ont cependant pas été trouvés significativement différents dans les trois groupes.