COMPARISON OF BUPIVACAINE AND LIDOCAINE FOR INTRAVENOUS REGIONAL ANALGESIA

A.C. ENRIGHT, G.G. SMITH AND G.M. WYANT

ABSTRACT

In a double blind study, seven volunteers were given lidocaine 0.75 per cent and bupivacaine 0.25 per cent in two trials to compare the agents for use in intravenous regional analgesia. There was no significant difference between the two agents in the duration of analgesia after removal of the tourniquet. Bupivacaine produced fewer side effects. It also consistently produced persistent analgesia on the posterolateral aspect of the forearm.

ALTHOUGH INTRAVENOUS REGIONAL ANALGESIA was first introduced by Bier in 1908,[1] it was not until 1963, when Holmes introduced the use of lidocaine,[2] that it began to gain widespread popularity. Since then it has been found to be effective in producing anaesthesia for minor operations on the limbs.[2-7]

One of the disadvantages of the technique has been that when the tourniquet is removed too early the circulation is flooded with local anaesthetic, which then is likely to cause a systemic reaction. Removal of the tourniquet at any time will cause the analgesia to disappear in a matter of seconds. Thus the tourniquet cannot be removed until wound closure is complete and, consequently, haemostatis cannot be guaranteed.

It was reasonable to expect that the situation might change with the introduction of bupivacaine. It was postulated that analgesia might persist for several minutes after circulation has been re-established in the limb, due to the greater protein binding of bupivacaine as compared to lidocaine.[8-10] When making a direct comparison between lidocaine and bupivacaine for intravenous regional analgesia, Ware[11] found bupivacaine to be superior because of its more profound analgesia and muscle relaxation, without causing adverse effects. However, he also found that "recovery times were similar for the two drugs". It was therefore proposed to induce intravenous regional analgesia in volunteers and compare the differences between the two agents in a blind study using each individual as his own control.

A.C. Enright, M.B., F.R.C.P.(C), Assistant Professor; G.G. Smith, Medical Student; G.M. Wyant, M.D., F.R.C.P.(C), F.F.A.R.C.S., Professor, Department of Anaesthesia, University Hospital, University of Saskatchewan, Saskatoon, Saskatchewan S7N 0W8.

METHOD

The two drugs were administered to seven volunteers in random sequence, with a two-week interval between tests. This study was approved by the President's Advisory Committee on Human Experimentation. All volunteers were fasting before being given 40 ml of a solution of 0.25 per cent bupivacaine or 0.75 per cent lidocaine, these being the concentrations commonly used in our institution. Volunteers were screened for absence of systemic disease and sensitivity to local anaesthetics. On both occasions the injection site used was the dorsum of the hand of the non-predominant side. A 21-gauge butterfly needle was inserted. Observations were blinded in that neither the observer nor the subjects were aware which agent was being used. No premedication was given. The arm was elevated and exsanguinated with an Esmarch bandage. The tourniquet was inflated to 300 mm Hg, the bandage was then removed and the arm lowered. The local analgesia solution was then injected slowly. The tourniquet remained inflated for 30 minutes, during which time observations relative to the onset of analgesia were made. After 30 minutes the tourniquet was deflated intermittenly, for 10 seconds every 30 seconds, to avoid a systemic reaction.[12] Observations were then made concerning the disappearance of analgesia.

The criterion used to determine onset and duration of analgesia was sensation to pin-prick in the nail bed area of the fingers. Observations were also made of the detection of stimuli from a nerve stimulator applied to the dorsum of the hand, and of progression and regression of motor weakness or loss.

RESULTS

There was no difference between the two agents in the average onset time of analgesia. In

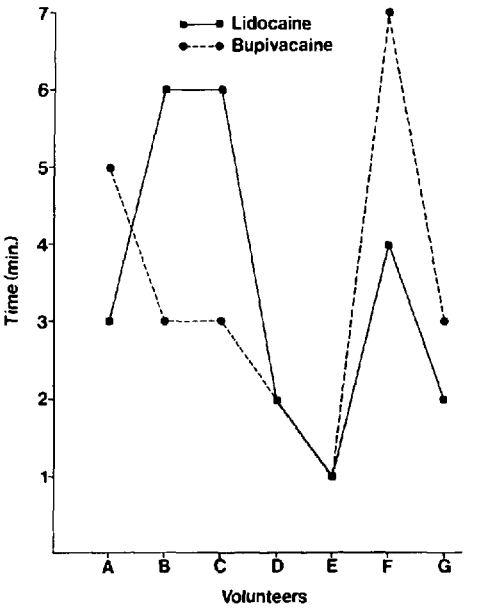

FIGURE 1 Duration of Analgesia after removal of tourniquet as determined by sensation to pin prick.

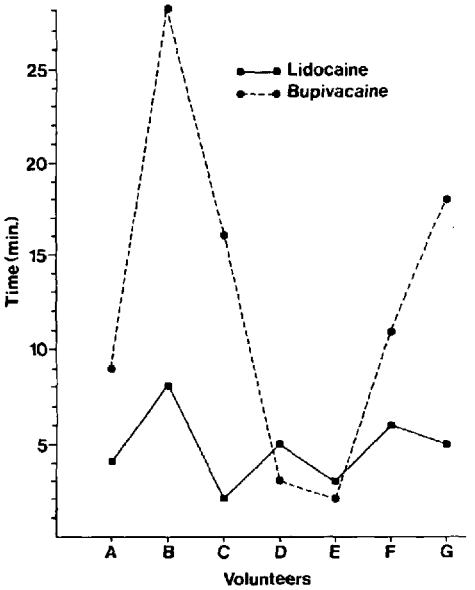

FIGURE 2 Duration of Analgesia after removal of tourniquet as determined by sensation to nerve stimulator.

TABLE I

SIDE EFFECTS

Description of side effects	Number of volunteers experiencing effect	
	Lidocaine	Bupivacaine
Dizziness or lightheadedness	4	2
Tinnitus	3	3
Visual disturbances	2	0
Numbness of tongue	2	0
Constricted throat	1	0
Euphoria	1	0
Burning on injection	1	0

all cases, there was almost complete loss of motor power. Paired t-test showed that there was no difference between the two agents with regard to the average time at which a sharp stimulus was first detected following deflation of the tourniquet. There was, however, considerable individual variation. (Figure 1). On testing the duration of analgesia, as determined by sensation to nerve stimulation, there was a mean difference of 7.71 minutes in favour of bupivacaine, with a standard deviation of difference of 8.2 minutes, giving a T_6 (paired t) value of 2.49. ($p < 0.05$) (Figure 2). The only side effects noted with bupivacaine on release of the tourniquet were dizziness and tinnitus. The same effects, but of greater intensity, were noted with lidocaine. Lidocaine also produced several other side effects (Table I). Only one volunteer had no side effects after lidocaine. With bupivacaine, analgesia persisted on the posterolateral aspect of the forearm for 200 to 360 minutes in all subjects and motor weakness of wrist extensors for 100 to 310 minutes. No such residual effects were noted with lidocaine.

DISCUSSION

The results of this study made it difficult to draw a definite conclusion as to whether there would be longer duration of analgesia after operation with one agent as opposed to the other when used in intravenous regional analgesia. There was considerable individual variation in response to the agents, with volunteers "D" and "E" showing almost no differences between the two agents to both types of stimuli. The other volunteers showed such differences, but volunteers "B" and "C" favoured one agent for one stimulus and the other agent when given the other

stimulus. As the responses differed depending on which stimulus was applied, it may be postulated that response to surgical stimuli might be different again.

Another finding of interest was that bupivacaine had far fewer and less severe post-analgesic side effects than lidocaine. On this basis, bupivacaine appears to be the better agent. Ware[6] came to a similar conclusion.

One result which showed a very obvious difference between agents was the persistent analgesia and motor weakness on the posterolateral aspect of the forearm. Raj and Lowor-bers[14] concluded that the site of action in intravenous regional analgesia is at the main nerve trunks. They found that the analgesic travels in the vascular channels near the main nerve trunks at the elbow. The vascular channels take the analgesic to the core of the trunks, from where it diffuses out to the periphery. They conclude that "since ulnar and median nerves are surrounded by large venous channels, we have an explanation for the development of analgesia and paralysis in the anteromedial forearm earlier than posterolaterally". By the same token the extended period of analgesia and motor weakness noted in this study may be due to the lack of vascularity around the radial nerve, which allows the more protein-bound bupivacaine to remain in the nerve and not to be removed by the blood as quickly as the less protein-bound lidocaine. As this persistent analgesia was noted exclusively and consistently with bupivacaine, it is unlikely that it results from nerve compression by the tourniquet or similar mechanical reasons. If this persistent analgesia proves to be a constant finding in clinical cases, it may be useful in specific procedures on the forearm.

From this study we can conclude that due to its fewer side effects and excellent anaesthetic properties, bupivacaine 0.25 per cent should be recommended over lidocaine 0.75 per cent as the agent of choice for intravenous regional analgesia.

We are unable to conclude, however, that one agent would give longer lasting analgesia than the other after the tourniquet has been removed.

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RÉSUMÉ

Lors d'une étude à double insu, on a administré de la lidocaïne 0.75 pour cent et de la bupivacaïne 0.25 pour cent à sept volontaires en deux séances dans le but de comparer ces deux agents couramment utilisés pour l'anesthésie régionale intraveineuse. Une fois le garrot enlevé, on n'a pas trouvé de différence significative entre les deux médicaments pour la durée de l'analgésie. La bupivacaïne a produit moins d'effets secondaires et a produit une analgésie persistante de la face postérolatérale de l'avant-bras.