INFLUENCE OF THE ADDITION OF POTASSIUM TO 0.5% PRILOCAINE SOLUTION DURING I.V. REGIONAL ANAESTHESIA

D. W. McKEOWN AND D. B. SCOTT

SUMMARY

Six volunteers underwent i.v. regional anaesthesia on two occasions using 0.5% prilocaine 40 ml with potassium 0 or 4 mmol litre⁻¹ added. Addition of potassium produced more rapid sensory blockade to pinprick at five of the six sites tested, although this was statistically significant at only one site (P < 0.05) and more rapid sensory blockade to pinch with Allis forceps at four of the six sites (n.s.). Recovery of sensory blockade was rapid and only one site showed any significant effect, pinprick blockade being prolonged by potassium (P < 0.05), although there was no overall effect. It is suggested that the addition of physiological (extracellular) concentrations of potassium to prilocaine for i.v. regional anaesthesia confers no clinical advantage, but that further study of other agents and sites of blockade is required.

Local anaesthetics act by blocking the conduction of nervous impulses. In addition, conduction may be modified in vitro by the adjustment of certain factors in extracellular fluid such as the potassium concentration (Huxley and Stampfli, 1951), the glucose concentration (Fink and Calkins, 1981) and the osmolarity (Fink, Barsa and Calkins, 1979).

It has also been shown that a physiological concentration of potassium, similar to that in extracellular fluid, when added to isotonic solutions of lignocaine, potentiates its effect in infraorbital nerve blockade in the rat (Kircha, Barsa and Fink, 1983).

In regional anaesthesia, such potentiation of the effect of a drug may lead to a reduction in the dose required, with an associated decrease in the risk of toxicity. This may be of particular value where the i.v. administration of drug is either likely, or mandatory, as in i.v. regional anaesthesia (IVRA).

This study was designed to investigate the effects on IVRA, in volunteers, of 0.5% prilocaine with or without the addition of a physiological concentration of potassium chloride.

SUBJECTS AND METHODS

Six healthy, fasted, male volunteers acted as subjects in the study, which had received approval from the hospital ethics committee. On two occasions separated by at least 4 days, subjects underwent IVRA of the non-dominant limb using a standard technique.

An indwelling needle was inserted to a vein on the ulnar side of the dorsum of the hand, the same vein being used for the subsequent block. A padded pneumatic tourniquet was applied to the upper arm at its thickest point. The arm was elevated and exsanguinated using an Esmarch bandage before inflation of the tourniquet to 300 mm Hg. The Esmarch bandage was removed and 40 ml of local anaesthetic solution injected over 60 s. The solutions used were: 0.5% prilocaine + potassium chloride (final concentration 4 mmol litre⁻¹) or 0.5% prilocaine.

The solutions were administered in a randomized double-blind fashion, and the end of injection was taken as time zero for subsequent testing.

At 1-min intervals from time zero, sensory blockade to pinprick (with a short bevelled needle) and to pinch (Allis forceps) were assessed at six marked sites, chosen for their representation of small peripheral nerve branches (fig. 1) (Urban and McKain, 1982). The time of appearance of blockade was noted. Motor power was tested at 1-min intervals by handgrip of a 500-ml infusion bag connected to a pressure transducer and pen recorder.

Twenty minutes from time zero, the tourniquet was deflated and removed, and testing continued until full recovery of skin sensation had occurred. In addition the subjects were asked to determine at what point they felt their arms had returned to normal.

Following release of the cuff, the subjects were asked to report any systemic side-effects. Results were analysed using Wilcoxon's signed ranks test. P < 0.05 was taken to indicate statistical significance. Where blockade was not evident at a site at 20 min, a score of 21 min was given for the purpose.

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of descriptive statistics (tables I and II), and maximum rank was assigned in the Wilcoxon test.

RESULTS

Onset of pinprick analgesia preceded that of forceps pinching at all sites, and blockade was complete for forceps and pinprick in all subjects with one exception. This individual retained pinprick sensation at one site and forceps sensation at three sites when the plain solution was used.

Decay of blockade following release of the tourniquet was rapid (fig. 2). Onset of pinprick blockade at the thenar eminence was more rapid in onset and prolonged following tourniquet release. There were no other statistically significant differences, although the onset of the blockade of pinprick was more rapid at five of six sites tested, and forceps blockade at four of six sites when potassium was added (table I). Loss of motor power was complete within 12 min with both solutions. Following the release of the tourniquet, motor power recovered rapidly (fig. 2). There were no differences between the solutions in the onset or recovery of motor blockade.

The times to normal arm sensation were similar in both groups (table II).

Four of the six volunteers noted mild central nervous system side-effects (lightheadedness, hyperacusis) with both solutions. There were no differences in type or severity between solutions.

DISCUSSION

The addition of potassium to lignocaine has been shown to prolong blockade in digital nerve block (Aldrete et al., 1969), and extradural anaesthesia (Bromage and Burfoot, 1966) with the use of high
TABLE I. **Mean times of appearance of blockade following injection, and recovery of blockade following tourniquet release**

<table>
<thead>
<tr>
<th>Site</th>
<th>0.5% Prilocaine + K⁺</th>
<th>0.5% Prilocaine</th>
<th>Onset of blockade to pinch (min ± SD)</th>
<th>Onset of blockade to pinprick (min ± SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4.33 ± 1.97</td>
<td>6.83 ± 4.12 n.s.</td>
<td>5.20 ± 2.17</td>
<td>8.17 ± 6.74 n.s.</td>
</tr>
<tr>
<td>2</td>
<td>7.17 ± 6.15</td>
<td>10.50 ± 6.28 P&lt;0.05</td>
<td>11.50 ± 6.28</td>
<td>14.50 ± 7.32 P&lt;0.05</td>
</tr>
<tr>
<td>3</td>
<td>6.50 ± 5.32</td>
<td>8.67 ± 5.85 n.s.</td>
<td>9.33 ± 6.44</td>
<td>12.83 ± 5.56 n.s.</td>
</tr>
<tr>
<td>4</td>
<td>5.67 ± 4.27</td>
<td>6.50 ± 2.43 n.s.</td>
<td>8.50 ± 4.46</td>
<td>11.00 ± 2.00 n.s.</td>
</tr>
<tr>
<td>5</td>
<td>4.67 ± 2.07</td>
<td>5.50 ± 3.15 n.s.</td>
<td>6.50 ± 2.74</td>
<td>6.67 ± 3.61 n.s.</td>
</tr>
<tr>
<td>6</td>
<td>4.00 ± 2.19</td>
<td>5.00 ± 2.28 n.s.</td>
<td>5.00 ± 2.45</td>
<td>5.50 ± 2.35 n.s.</td>
</tr>
</tbody>
</table>

Recovery of blockade to pinprick (min ± SD) | Recovery of blockade to pinch (min ± SD)

<table>
<thead>
<tr>
<th>Site</th>
<th>0.5% Prilocaine + K⁺</th>
<th>0.5% Prilocaine</th>
<th>Site</th>
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<th>0.5% Prilocaine</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>8.83 ± 5.91</td>
<td>5.00 ± 3.90 n.s.</td>
<td>1</td>
<td>5.00 ± 2.45</td>
<td>4.50 ± 3.21 n.s.</td>
</tr>
<tr>
<td>2</td>
<td>2.67 ± 1.21</td>
<td>1.50 ± 0.55 P&lt;0.05</td>
<td>2</td>
<td>1.83 ± 0.75</td>
<td>1.50 ± 1.22 n.s.</td>
</tr>
<tr>
<td>3</td>
<td>2.17 ± 0.75</td>
<td>2.83 ± 1.60 n.s.</td>
<td>3</td>
<td>1.83 ± 0.41</td>
<td>1.83 ± 1.33 n.s.</td>
</tr>
<tr>
<td>4</td>
<td>2.50 ± 1.22</td>
<td>2.17 ± 1.17 n.s.</td>
<td>4</td>
<td>2.00 ± 0.89</td>
<td>2.17 ± 1.60 n.s.</td>
</tr>
<tr>
<td>5</td>
<td>2.50 ± 1.22</td>
<td>3.17 ± 1.94 n.s.</td>
<td>5</td>
<td>2.67 ± 1.37</td>
<td>2.83 ± 1.47 n.s.</td>
</tr>
<tr>
<td>6</td>
<td>3.50 ± 2.81</td>
<td>5.33 ± 3.39 n.s.</td>
<td>6</td>
<td>4.33 ± 3.33</td>
<td>3.33 ± 1.51 n.s.</td>
</tr>
</tbody>
</table>

This study showed significantly more rapid onset of blockade to pinprick at only one site during IVRA with added potassium. The effects on onset times of pinprick and forceps blockade seemed similar at other sites, but were not statistically significant (table I). There was no apparent overall effect on the recovery of sensation.

In conclusion, there seems to be little clinical advantage to the addition of physiological concentrations of potassium to prilocaine solutions for IVRA. However, further study of other drugs and sites of administration is necessary to elucidate the relevance of previous in vitro and in vivo studies, and it may be that nerve trunk anaesthesia is a more appropriate model for study.

**REFERENCES**


**EINFLUẞ DER GABE VON KALIUM ZU EINER 0,5% IGEN PRILOCAINLÖSUNG FÜR I.V.-REGIONALANÄSTHESIE**

Sechs freiwillige Probanden erhielten bei zwei Sitzungen i.v.-Regionalanästhesien mit 40 ml 0,5%igem Prilocain mit oder ohne 4 mmol Liter⁻¹ Kalium. Bei fünf der sechs Probanden führte die Kaliumgabe zu einer schnelleren sensorischen Blockade auf Nadelstiche, obwohl dies nur in einem Fall statistisch signifikant war (*P* < 0,05), und bei vier der sechs Probanden zu einer schnelleren sensorischen Blockade auf Zwicken mit der Alliszange (nicht signifikant). Die Erholung der sensorischen Blockade erfolgte schnell, und nur in einem Fall war die Blockade auf Nadelstiche durch Kalium signifikant verlängert (*P* < 0,05).

Die Gabe physiologischer (extrazellulärer) Kaliumkonzentration zu Prilocain für i.v.-Regionalanästhesie bringt keinen klinischen Vorteil. Weitere Untersuchung anderer Agentien und Blockadegebiete sind jedoch notwendig.

**SUMMARY**

Six volunteers were given two sessions of i.v.-Regional anaesthesia with 40 ml of 0.5% prilocaine with or without 4 mmol litre⁻¹ potassium. Five of the six volunteers showed an earlier sensory blockade when potassium was added, although this was significant only in one case (*P* < 0.05). Four of the six volunteers showed an earlier sensory blockade when pinching with the Allis forceps. The recovery of the sensory blockade was rapid and potassium only significantly prolonged the blockade of the needle prick in one case (*P* < 0.05). The use of potassium to add a sensory advantage was not significant overall. We suggest that the addition of physiological concentrations (extracellular) of potassium to prilocaine does not provide an advantage clinically but further investigations are needed of other agents and blockade areas.

**RESUMEN**

Seis voluntarios fueron sometidos a una anestesia regional i.v. en dos oportunidades al usar 40 ml de prilocaina al 0,5% con adición de 0 6 4 mmol litro⁻¹ de potasio. La adición de potasio produjo un bloqueo sensorial más rápido al incidir con alfiler en cinco de los seis lugares ensayados, aunque dicha observación era significante desde el punto de vista estadístico solo en un lugar (*P* < 0.05) así como un bloqueo sensorial más rápido al pellizco con fórceps Allis en cuatro de los seis sitios (n.s.). La recuperación del bloqueo sensorial fue rápido y sólo un lugar demostró un efecto significativo, el bloqueo al alfilerazo prolongándose por causa del potasio (*P* < 0.05) aunque no se registró ningún efecto global. Se sugiere que la adición de concentraciones fisiológicas (extracelulares) de potasio a la prilocaina con miras a administrar una anestesia regional i.v. no brinda ninguna ventaja clínica, pero que se necesitan estudios ulteriores de otros agentes y lugares de bloqueo.