PROLONGED ANALGESIA AFTER CUFF RELEASE FOLLOWING I.V. REGIONAL ANALGESIA WITH PRILOCAINE

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SUMMARY

In a prospective randomized study, 60 outpatients received 0.8%, 1.5% or 2% prilocaine (4 mg/kg body weight) as i.v. regional anaesthesia for operations in the carpal region. The latent period, quality and duration of analgesia after release of the tourniquet were analysed. The latent period was shortest with 2% prilocaine. The duration of analgesia after tourniquet release increased from 5.7 min with 0.8% to 15.6 min with 2% prilocaine. The plasma concentrations after 1.5% prilocaine were significantly less than with 0.8% prilocaine.

Intravenous regional anaesthesia (IVRA) is a technically simple method with which to produce surgical analgesia. Rapid onset of action, a low failure rate and rapid recovery with the possibility of going home quickly and safely make it particularly suitable for outpatient surgery. The principal disadvantage, apart from a limit to the operating time of 90 min, is that the surgeons complain of difficulty with haemostasis, because analgesia becomes inadequate, on average, 3–5 min after releasing the tourniquet. However, the use of 0.2% or 0.25% bupivacaine 1.5 mg kg\(^{-1}\) (Rousso et al., 1979; Ware, 1979; Enright, Smith and Wyant, 1980) provided analgesia for 8–14 min after the release of the tourniquet and so permitted the use of IVRA for hand surgery.

Recently, there have been a number of reports detailing serious, or even fatal, complications with the use of bupivacaine in IVRA (Burlingham, 1980; Magora et al., 1980; Davis, Gill and Weber, 1981; Henderson, 1980). In a comparative study with equipotent dosages of 0.2% bupivacaine and 0.8% prilocaine, we demonstrated that the toxicity of bupivacaine was significantly greater \((P<0.01)\), with maximum values reaching 85% of the toxicity limit (Tryba et al., 1982). Thus at a dose of 1.5 mg kg\(^{-1}\) one can expect toxic symptoms in individual patients. For this reason we felt obliged to develop a modification of IVRA which offered a similarly long period of analgesia after release of the tourniquet, but which did not cause an increase in toxicity.

PATIENTS AND METHODS

In a prospective study, 60 outpatients were randomly allocated to three equal groups to receive, without prior medication, prilocaine 4 mg kg\(^{-1}\) in the concentrations 0.8%, 1.5% or 2% for operations in the carpal region (ganglia, synovectomy, denervation).

After positioning an indwelling cannula in the contralateral arm, a 20-gauge Teflon cannula was inserted to a vein on the back of the hand. A rubber bandage was wrapped round the arm requiring operation, reaching up to the double tourniquet on the upper arm, and the proximal cuff was pumped up to 300 mm Hg. To concentrate the local anaesthetic in the operation area, a third tourniquet was positioned proximal, but very close to, the operation site. The local anaesthetic was injected over a period of 1 min and, after a further 1 min, the third tourniquet was removed (fig. 1). Immediately afterwards the Teflon cannula was removed and the point of injection was compressed for 1 min. The onset of analgesia was tested using pinprick and immediately afterwards, sterile cleansing of the arm was commenced. When the operation started, the pressure in the cuff was allowed to decrease to 70 mm Hg greater than systolic arterial pressure. For haemostasis, intermittent release of the tourniquet took place—at the earliest, 20 min after the injection of the local anaesthetic. This lasted for 3 min, with release of the tourniquet for 20 s and closure for 40 s on each occasion. Analgesia was assessed by questioning the patient during closure of the wound and again later by pinprick.

In a separate investigation, 10 patients in each
group received either 0.8% or 1.5% prilocaine 4 mg kg\(^{-1}\). The plasma concentrations were determined by gas chromatography 1, 5 and 10 min after the sudden release of the tourniquet. The samples were taken from the contralateral arm.

The statistical analysis of the results was carried out with the Wilcoxon test.

**RESULTS**

The patient groups did not differ in respect of age, weight or sex. In no patient were subjective or objective signs of toxicity observed.

**Quality of analgesia**

In all patients, the analgesia for surgery was good and on no occasion was systemic supplementation required. With 1.5% and 2% prilocaine, analgesia was complete until the final wound closure in all patients. In the group receiving 0.8% prilocaine, six patients reported feeling the needle prick during wound closure, in two patients local supplementation was provided.

**Latent period**

Whereas complete analgesia with 0.8% and 1.5% prilocaine took place after 7 min on average, the time to achieve complete analgesia with 2% prilocaine was on average only 4.7 min, and was thus significantly ($P<0.05$) shorter compared with the less concentrated solutions (table I).

**Duration of analgesia after release of the tourniquet**

The period of analgesia after the release of the tourniquet increased with increasing prilocaine con-

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**Table I. Onset of total analgesia and persistence of analgesia in relation to different concentrations of prilocaine**

<table>
<thead>
<tr>
<th>Prilocaine</th>
<th>n</th>
<th>Weight (kg)</th>
<th>Time of onset total analgesia (min) (mean(range))</th>
<th>Persistence of analgesia after cuff release (min) (mean(range))</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.8%</td>
<td>20</td>
<td>66.1 ± 13.6</td>
<td>7.2 (4–9)</td>
<td>5.7 (4–8)</td>
</tr>
<tr>
<td>0.5 ml kg(^{-1})</td>
<td>20</td>
<td>69.6 ± 11.9</td>
<td>6.8 (5–9)</td>
<td>10.8 (8–18)</td>
</tr>
<tr>
<td>1.5%</td>
<td>20</td>
<td>74.6 ± 10.7</td>
<td>4.7 (4–6)</td>
<td>15.6 (12–22)</td>
</tr>
<tr>
<td>2%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.2 ml kg(^{-1})</td>
<td>20</td>
<td></td>
<td></td>
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</table>
PRilocaine in IVRA

centrations from, on average, 5.7 min with 0.8% to 15.6 min with 2% prilocaine (P<0.01). Prilocaine 1.5% also proved to have a significantly (P<0.01) longer effect (10.8 min) than 0.8% prilocaine. Similarly, the difference between 2% and 1.5% prilocaine was statistically significant (P<0.05).

Plasma concentrations

One minute after releasing the tourniquet, the plasma concentrations of 0.8% and 1.5% prilocaine 4mgkg⁻¹ (fig. 2) were not substantially different. After 5 min the plasma concentration with the 1.5% solution was on average only one-third of that with 0.8% prilocaine (P<0.05). After 10 min the difference was even more significant (P<0.01).

DISCUSSION

A drug with the lowest possible toxicity is required for IVRA. Prilocaine fulfils this requirement (Eriksson, 1966; Goffin, 1967). As with all local anaesthetics with a short duration of action, the use of the usual concentrations (0.5–1%) means that pain returns after release of the tourniquet in a matter of a few minutes. For this reason, the use of bupivacaine in IVRA has increased, because it provides longer analgesia suitable for operations requiring haemostasis (Ware and Caldwell, 1976; Enright, Smith and Wyant, 1980). However, bupivacaine can cause serious, sometimes fatal complications in individual patients (Burlingham, 1980; Henderson, 1980; Magora et al., 1980; Davies, Gill and Weber, 1981). In one study the toxic concentration of 2000 ngmg⁻¹ in plasma (Meyer and Naschef, 1977) was exceeded when using bupivacaine in a dose of 1–1.5 mg kg⁻¹.

Serious complications have not been described with prilocaine (Wildsmith, 1982). Even after inadvertent injection of double the quantity of prilocaine (8 mg kg⁻¹) and sudden release of the tourniquet the patient complained only of a brief feeling of nausea, and a decrease in arterial pressure of 15 mg Hg was observed (personal communication).

The use of 1.5% and 2% prilocaine allows a period of analgesia after the release of the tourniquet which is longer than that with 0.2% bupivacaine (Ware and Caldwell, 1976) or 0.25% bupivacaine (Rousso et al., 1979; Enright, Smith and Wyant, 1980). By extending the intermittent release of the tourniquet, the necessary period of analgesia for haemostasis and wound closure can be achieved. In addition, toxicity is diminished (Thorn-Alquist, 1966). In patients in whom brachial plexus block is contraindicated, we have achieved periods of anaesthesia of up to 30 min for synovectomy and surgery of Dupuytren’s contracture.

The use of a third tourniquet is absolutely essential during the injection to ensure that no proximal flow of anaesthetic occurs, because only a very small volume (0.2–0.25 ml kg⁻¹) of local anaesthetic is injected. In operations in the palmar area or distal from the Teflon needle, we inject the anaesthetic with the patient seated and the arm hanging and leave the patient in this position for 2 min with the third tourniquet in place. If the size of the lower arm and hand are large in relation to the body weight, or if the patient’s weight is less than 60 kg, an increase in the prilocaine dose to 5 mg kg⁻¹ is recommended, or restriction of the concentration to 1–1.25%.

One important effect of more concentrated prilocaine is the reduced plasma concentration observed 5 min after the cuff release. It is likely that more local anaesthetic diffuses into the surrounding tissue because of the greater concentration gradient. Since the local anaesthetic is eliminated from the tissues more slowly, this explains the lower plasma concentrations.

The methaemoglobin formation observed with prilocaine is of no importance at the dose used for IVRA and attains clinical significance only with a prilocaine dose greater than 600 mg (Harris and Cole, 1968; Hjelm and Holmdahl, 1965; Tryba et al., 1982).

CONCLUSIONS

We consider that: it is no longer necessary to use bupivacaine in i.v. regional anaesthesia; prilocaine is a drug of choice for IVRA because of the lower
toxicity; effective analgesia of the upper extremities can be achieved with 4 mg/kg body weight; analgesia after release of the tourniquet can be extended to more than 15 min by using 1.5–2% prilocaine without exceeding the dose of 4–5 mg kg\(^{-1}\); the use of highly concentrated prilocaine for the same total quantity lowers the toxicity.

REFERENCES


PROSPEKTIVE STUDIE ZUR VERLÄNGERUNG DER ANALGESIE NACH ÖFFNEN DER BLUTSPERRE BEI I.V. REGIONALANÄSTHESIE MIT PRILOCAIN

ZUSAMMENFASSUNG

In einer prospektiven randomisierten Studie erhielten jeweils 20 ambulante Patienten mit Operationen im Handgelenkbereich 0,8%, 1,5% oder 2% Prilocain (jeweils 4 mg/kg KG) zur intravenösen Regionalanästhesie. Latenzzeit, Analgesiqualität und Schmerzrückkehr nach Öffnen der Blutsperrre wurden untersucht. Die Analgesiezeit nach Öffnen der Blutsperrre stieg mit zunehmender Prilocainkonzentration von 5,7 Minuten durchschnittlich bis 2% bis auf 15,6 Minuten im Mittel bei 2%. Die Latenzzeit bis zum Einsetzen der vollständigen Analgesie war mit 2% Prilocain am kürzesten. Die Plasmaspiegel des hoch konzentrierten Prilocain waren signifikant niedriger als Prilocain 0,8%.

ANALGESIA PROLONGADA DESPUÉS DE LIBERAR EL TORNIQUETE A RAÍZ DE ANALGESIA INTRAVENOSA REGIONAL CON PRILOCAINA

RESUMEN

En el transcurso de un estudio prospectivo de carácter aleatorio se administró a 60 pacientes 0,8%, 1,5% ó 2% de prilocaina (4 mg/kg de peso del cuerpo), como anestesia intravenosa regional para fines de intervenciones quirúrgicas en la región carpiana. Se analizaron el periodo de latencia, la cantidad y la duración de la analgesia después de soltar el tourniquete. El periodo de latencia fue más corto cuando la prilocaina administrada fue del 2%. La duración de la analgesia después de soltar el tourniquete aumentó desde 5,7 minutos, para el 0,8%, hasta 15,6 minutos, para el 2%. La concentración para el 2% de prilocaina fue significativamente inferior que con 0,8% de prilocaina.