

## EFFECT OF SPEED OF INJECTION OF 0.5% PLAIN BUPIVACAINE ON THE SPREAD OF SPINAL ANAESTHESIA

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## SUMMARY

We have studied the influence of two different speeds of injection on the spread of spinal anaesthesia of bupivacaine in 40 orthopaedic patients. In a random order, 0.5% plain bupivacaine 3 ml was administered in 10 or 180 s into the subarachnoid space using a 27-gauge needle with the patients in a lateral horizontal position. The slower speed produced a higher spread of spinal anaesthesia (median difference 2.5 segments,  $P < 0.05$ ).

## KEY WORDS

Anaesthetic techniques: spinal, speed of injection. Anaesthetics local, bupivacaine.

In a spinal canal model an increase in the speed of injection enhances the spread of local anaesthetic solution [1]. However, under clinical conditions this relationship has not been substantiated conclusively [2, 3]. In contrast, Stienstra and van Poorten demonstrated that a slow injection of 0.5% plain bupivacaine at 37 °C with the patient in a sitting position resulted in a significantly higher spread of spinal analgesia than a more rapid injection [4]. This may have been a result of the effect of posture, as a warm hypobaric solution of bupivacaine was used. Plain bupivacaine has a specific gravity of 1.004 at 20 °C and 0.997 at 37 °C (CSF = 1.001 at 37 °C) [5]. In order to eliminate the influence of baricity, a lateral position during the injection of the anaesthetic was used in the present study. Two different speeds of injection were compared using 27-gauge spinal needles.

## PATIENTS AND METHODS

The study was approved by the local Ethics Committee and informed consent was obtained from all patients. We studied 40 patients (ASA I) aged 20–66 yr undergoing orthopaedic surgery of the lower extremity. Patients who were not within 5% of the normal range for body mass index (BMI) for Finnish adults [6] were excluded. All patients were premedicated with diazepam 0.15 mg kg<sup>-1</sup> orally.

The subarachnoid puncture was performed with a 27-gauge spinal needle (Quincke type point, Becton Dickinson, U.S.A.) at the L3–4 interspace in the midline, with the patient in a lateral horizontal position. In a random order, 0.5% plain bupivacaine 3 ml, at room temperature, was injected over 10 s (group A) or 180 s (group B). Spinal fluid (0.2 ml) was aspirated at the beginning of the injection of

bupivacaine. The patients were kept in the lateral horizontal position for 5 min from the beginning of the injection. Thereafter, they were moved to the supine horizontal position.

Segmental spread of analgesia was assessed by an anaesthetist unaware of the speed of injection. Sensory loss was tested bilaterally in the anterior axillary line by pinprick using a short bevel 27-gauge needle. Analgesia was defined as inability to appreciate sharp pinprick. Assessments were made 5, 10, 15, 20, 30, 45 and 60 min after the beginning of the injection and then at 30-min intervals until recovery of normal sensation at the L1 interspace. When the spread of block was not symmetrical, the higher level of the block was taken for comparison of the groups. Motor block was tested simultaneously using the Bromage scale (0–3) [7].

Data were analysed using the Mann–Whitney *U* test for comparison of segmental spread of spinal anaesthesia and Student's *t* test for patient characteristics.  $P < 0.05$  was considered statistically significant.

## RESULTS

There were no differences in patient characteristics between the two groups (table I).

Slow injection (180 s) of 0.5% plain bupivacaine produced a higher spread of spinal analgesia (median T6.5, range L1–T4) than the 10-s injection (median T9, range L1–T2) (fig. 1). The difference was statistically significant 15, 30, 45 and 60 min after

TABLE I. Patient characteristics (mean (SD) [range]) in the rapid (group A) and slow (group B) injection groups

	Group A	Group B
Sex (M/F)	14/6	13/7
Age (yr)	36.9 [20–54]	36.4 [19–66]
Height (cm)	175 (8) [162–190]	173 (9) [153–189]
Weight (kg)	70 (8) [58–87]	71 (11) [50–85]
Body mass index (kg m <sup>-2</sup> )	22.8 (2.0) [19.2–26.3]	23.7 (2.7) [20.4–27.1]

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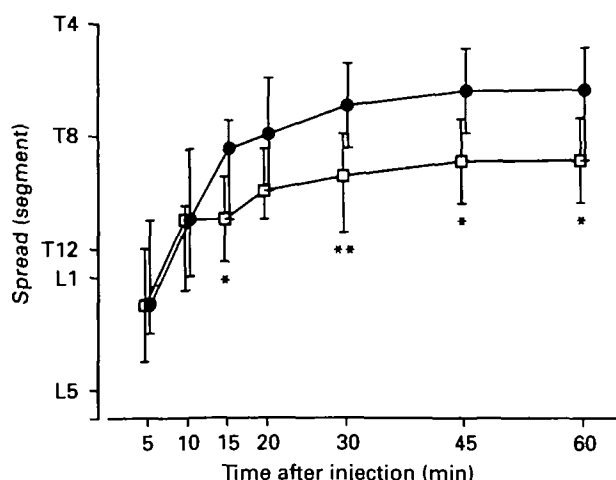


FIG. 1. Spread of analgesia after injection of 0.5% plain bupivacaine 3 ml into the subarachnoid space over 10 (□) and 180 (●) s (median (quartile range)). \*  $P < 0.05$ ; \*\*  $P < 0.01$  between groups.

injection of bupivacaine. At 60 min one patient in each group had an unequal block of more than two segments. In both groups two patients had incomplete (Bromage scale 2) motor block in one or both legs.

Sufficient anaesthesia for surgery of the lower extremities was achieved in all patients in the study. There were no complications.

#### DISCUSSION

The final spread of spinal anaesthesia was higher when 0.5% plain bupivacaine 3 ml was administered in 180 s compared with 10 s in patients in a lateral horizontal position. This result is in agreement with the earlier clinical findings of Stienstra and van Poorten [4]. They demonstrated a significantly higher spread of analgesia after a slow (60-s) injection of 0.5% plain bupivacaine 3 ml, warmed to 37 °C, compared with a fast (mean 5.6-s) injection with the patient in a sitting position. The difference was rather modest (on average, 1.5 segments). They concluded that the spread of the block may have been influenced by the longer sitting period during the slow injection of warmed bupivacaine, which is hypobaric at body temperature [5]. In the present study, we injected plain bupivacaine at room temperature with the patient in the lateral horizontal position in order to minimize the influence of baricity. Slow injection in our study was 180 s compared with 60 s in the study of Stienstra and van Poorten [4]. These factors may contribute to the median difference of 2.5 segments. In both groups of patients in this study, the interindividual variation in the cephalad spread of the blocks was as large as in

earlier studies [8]. Therefore, speed of injection probably has only a minor influence on prediction of the spread of spinal anaesthesia with plain bupivacaine.

Increased speed of injection was found to enhance the spread of a local anaesthetic solution in the spinal model used by Lanz and colleagues [1]. It is likely that this model simulates the rather complicated structure of the subarachnoid space inaccurately. In addition to the variable configuration of the spinal canal, and variations in the lumbar lordotic curve, the subarachnoid space contains CSF, spinal cord, cauda equina, blood vessels, nerve roots and septae. Therefore, the turbulence in the subarachnoid space during fast injections through thin needles may be too small to facilitate enhanced spread of a local anaesthetic solution.

It may be that a fast injection of a local anaesthetic solution may produce a bulk displacement of CSF, and the solution may remain stationary near the injection site. Injection at a slower speed may not be associated with bulk displacement or pressure changes in the CSF, resulting in a greater spread of local anaesthetic in the limited space between the arachnoid and the spinal cord.

We conclude that a slow injection of 0.5% plain bupivacaine via 27-gauge needles is preferable to rapid injection when a large spread of analgesia is desired.

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#### REFERENCES

1. Lanz E, Theiss D, Erdmann K, Becker J. Modelluntersuchungen zur Ausbreitung der "isobaren" Spinalanaesthesia. *Regional Anaesthesia* 1980; 3: 4-9.
2. Neigh JL, Kane PB, Smith TC. Effects of speed and direction of injection on the level and duration of spinal anaesthesia. *Anesthesia and Analgesia* 1970; 49: 912-916.
3. McClure JH, Brown DT, Wildsmith JAW. Effect of injected volume and speed of injection on the spread of spinal anaesthesia with isobaric amethocaine. *British Journal of Anaesthesia* 1982; 54: 917-920.
4. Stienstra R, van Poorten F. Speed of injection does not affect subarachnoid distribution of plain bupivacaine 0.5%. *Regional Anaesthesia* 1990; 15: 208-210.
5. Chambers WA, Edström HH, Scott DB. Effect of baricity on spinal anaesthesia with bupivacaine. *British Journal of Anaesthesia* 1981; 53: 279-282.
6. Heliövaara M, Aromaa A. *Height, Weight and Obesity of Finnish Adults*. Helsinki: Publications of the Social Insurance Institution, Finland. ML: 19, 1980; 91-92.
7. Bromage PR. A comparison of the hydrochloride and carbon dioxide salts of lidocaine and prilocaine in epidural analgesia. *Acta Anaesthesiologica Scandinavica* 1965; 9 (Suppl. XVI): 55-69.
8. Tuominen M. Bupivacaine spinal anaesthesia. *Acta Anaesthesiologica Scandinavica* 1991; 35: 1-10.