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Effect of glucose concentration on the subarachnoid spread of tetracaine in the parturient

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Abstract: We have studied the effect of glucose concentration on the spread of tetracaine spinal anesthesia in 40 parturient patients. Forty women undergoing cesarean section received a subarachnoid injection of tetracaine 8 mg dissolved in either 5% or 10% glucose solution. The maximum cephalad spread of analgesia [median (range)] was higher with 10% glucose [T3 (T4-C8)] than with 5% glucose [T4 (T5.5-T2)]. The time from the spinal injection to the maximum spread of analgesia (mean ± SD) was significantly shorter with 10% glucose (15 ± min) than with 5% glucose (28 ± 16 min). The cumulative dose of ephedrine was higher with 10% glucose (19 ± 10 mg) than with the 5% glucose (13 ± 8 mg). In tetracaine spinal anesthesia, the rate of onset of analgesia was faster and the maximum level of analgesia was higher in the 10% glucose solution than in the 5% glucose solution.

Key words: Spinal anesthesia, Hyperbaric tetracaine, Obstetric

Introduction

One of the most important factors influencing the subarachnoid spread of local anesthetics is the baricity of the solution injected [1], but the influence of the glucose concentration has received attention little [2–4]. Particularly in the parturient, no data are available for the effect of alteration in glucose concentration on the subarachnoid spread of local anesthetics. The present study was undertaken since no direct comparison between 5% and 10% glucose solutions has been performed in the parturient.

Patients and methods

Forty parturient patients (ASA I, age 22–39 years) undergoing cesarean section gave informed consent to participate in the study, and the study protocol was approved by the Hospital Ethics Committee.

None of the patients had any contraindications to spinal anesthesia. None of the patients was premedicated. Patients were placed in the right lateral position on a horizontal operating table. Under aseptic conditions, lumbar puncture was performed at the L3-4 interspace with a 25-gauge Quincke needle by the median approach. The needle was inserted with its bevel oriented parallel to the dural fibers and then rotated 90° to direct the bevel cephalad. The correct position of the needle was confirmed by aspiration and reinjection of 0.1 ml of cerebrospinal fluid before and after the administration of the drug. The patients (20 in each group) were allocated randomly to receive tetracaine 8 mg dissolved in 2 ml of 5% glocose (specific gravity: 1.0198 at 20°C) or 10% glucose (1.0385 at 20°C) solution, which was prepared in a syringe immediately before injection by dissolving a crystalline preparation. The syringe preparation was performed by a doctor who did not participate in the anesthetic management. The test solution was injected over 40 s and patients were turned to the supine horizontal position. Left uterine displacement was applied to the patients until the beginning of the operation. No attempt was made to influence the spread of analgesia by manipulating the operating table.

An observer who was unaware of the glucose concentration injected assessed bilaterally the spread of analgesia according to a dermatomal chart [5] using the pinprick method at 5, 10, 15, 20, 30, and 60 min after the spinal injection. If the analgesic levels of both sides obtained were different, the average value was used for analysis. The motor blockade was assessed by a modified Bromage's score (0 = ability to raise extended leg; 1 = inability to raise extended leg; 2 = inability to flex the knee; 3 = inability to flex the ankle) at the time intervals mentioned above.

Arterial pressure and heart rate were measured by automatic sphygmomanometry every minute until delivery and every 5 min thereafter. Lactated Ringers' solution, 500 ml, was infused before induction of spinal anesthesia. Prophylactic ephedrine (10 mg) was given

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intravenously immediately after the spinal injection. When systolic arterial pressure decreased to 100 mmHg, additional ephedrine (5 mg) was given intravenously repeatedly.

Results are expressed as mean ± SD or median (range). Comparisons between groups were made by Student's unpaired *t*-test for parametric data; Mann-Whitney *U*-test for non-parametric data. $P < 0.05$ was considered to be significant.

Results

The two groups of patients were comparable in age (30.4 ± 4.3 and 31.0 ± 4.4 years for 5% and 10% glocose group, respectively), height (1.56 ± 0.05 m *vs* 1.55 ± 0.04 m), weight (61.9 ± 7.0 kg *vs* 61.7 ± 9.5 kg), body mass index (25.2 ± 2.3 $kg \cdot m^{-2}$ *vs* 25.8 ± 2.3 $kg \cdot m^{-2}$), and gestation (38.0 ± 2.2 weeks *vs* 37.6 ± 2.0 weeks).

All cases had adequate blockade for surgery. The time from spinal injection to delivery was not different between groups (26 ± 4.7 min and 26 ± 5.0 min for 5% and 10% gloucose group, respectively). The cephalad spread reached significantly higher levels with the 10% glucose than with the 5% glucose 5 min after the spinal injection (Fig. 1).

The maximum cephalad spread of analgesia was significantly higher in the 10% glucose group [T3 (T4-C8)] than in the 5% glucose group [T4 (T5.5-T2)] ($P < 0.01$). The time from the spinal injection to the maximum cephalad spread of analgesia was significantly shorter in the 10% glucose group (15 ± 6 min) than in the 5% glucose group (28 ± 16 min) ($P < 0.01$), but no significant difference between groups was found in the time to onset of total motor block in the legs (7.8 ± 3.4 min and 7.5 ± 3.0 min for 5% and 10% glucose, respectively).

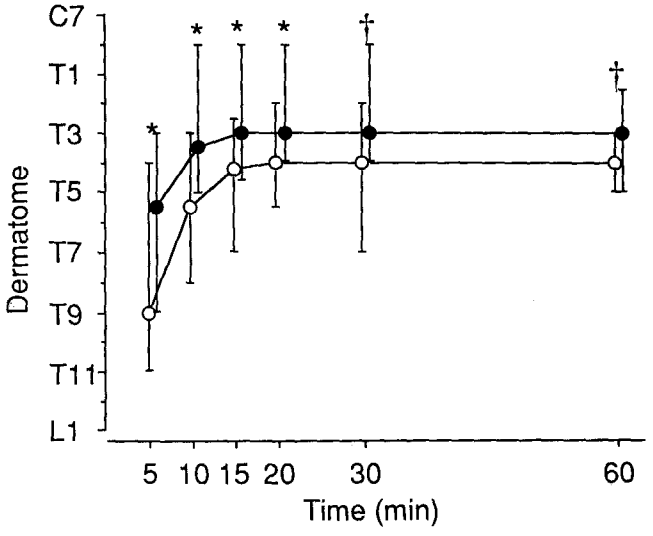

Fig. 1. Cephalad spread of analgesia after subarachnoid injection of tetracaine (8 mg) in 5% (open circles) and 10% (closed circles). glucose solutions. Median (range). *$P < 0.001$, †$P < 0.01$:5% *vs* 10%

There was no significant difference between groups in the maximum decrease in mean arterial pressure after spinal injection (26 ± 11 mmHg and 32 ± 15 mmHg for 5% and 10% glucose, respectively). The cumulative dose of ephedrine (the prophylactic dose and the dose in addition to it), which was given during the period from spinal injection until delivery, was higher with 10% glucose (19 ± 10 mg) than with 5% glucose (13 ± 8 mg) ($P < 0.05$).

Discussion

This study shows that changing the glucose concentration (5% and 10%) influences the spread of tetracaine spinal anesthesia. The rate of onset of analgesia is faster and the maximum level of analgesia was higher in the 10% than in the 5% glucose solution.

In the supine horizontal position, hyperbaric local anesthetics injected at the apex of the lumbar curvature spreads down to the lowest region of the thoracic hollow under the influence of gravity. The development of blockade is closely related to the movement of local anesthetics in a cephalad direction. This cephalad movement may be faster with the 10% than with the 5% glucose solution because of the difference in baricity between the two solutions.

Chambers et al. studied 0.5% bupivacaine solutions containing 0%, 5%, and 8% glucose [2]. The two hyperbaric solutions spread further than the glucose-free solution, while the mean values for analgesia are similar for the two hyperbaric solutions. In the present study, the 10% glucose solution always produced significantly higher levels of analgesia compared with the 5% glucose solution. The reasons for the difference between Chambers' study and ours are not clear, but may be related to the fact that we compared 10% glucose with 5% glucose, while they used 8% and 5% glucose. Furthermore, we examined term parturient patients. The cephalad movement of local anesthetics may be faster in the 10% glucose solution than in the 5% glucose solution because of exaggerated lumbar lordosis at term pregnancy [6].

With respect to lower glucose concentrations, Lee et al. compared the subarachnoid spread of 0.5% tetracaine containing 0%, 1.25%, 2.5%, and 5% glucose [3]. All the solutions containing glucose behave similarly, though the initial rate of spread of the 1.25% glucose solution is slightly slower. Moreover, Bannister et al. examined the spread of 0.5% bupivacaine containing 0.33%, 0.83%, and 8% glucose in nonpregnant patients [4]. The maximum spread of sensory block is

significantly higher with 8% glucose than with 0.83% glucose or 0.33% glucose. The rate of onset of sensory block is slower with solutions containing 0.33% and 0.83% glucose than with 8% glucose, while 0.33% glucose is insufficient to overcome the poor predictability experienced with glucose-free solution.

Spinal anesthesia with hyperbaric tetracaine causes a greater change in cardiovascular indices. In the present study, there were no differences in the changes in mean arterial pressure between 5% and 10%. However, the cumulative dose of vasopressor was slightly higher in the 10% glucose group than in the 5% glucose group. The higher the dose of vasopressor to compensate for maternal hypotension, the greater the potential effects on uterine blood flow. Therefore, with respect to the uasge of vasopressor, the 5% glucose solution may be more appropriate for cesarean section than the 10% glucose solution.

In summary, in tetracaine spinal anesthesia, the rate of onset of analgesia was faster and the maximum level of analgesia was higher with the 10% glucose solution than with the 5% glucose solution.

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