

ORIGINAL ARTICLE

A comparison of cold, pinprick and touch for assessing the level of spinal block at caesarean section

I. F. Russell

Department of Anaesthesia, Hull Royal Infirmary, Hull, UK

SUMMARY. The sensory block levels of 102 women undergoing caesarean section under spinal anaesthesia were assessed by four different methods: sharp pinprick (Neurotip pin), cold (ethyl chloride spray), touch (Neurotip tester pin), touch (ethyl chloride spray). While the data indicate a median difference of some 2 segments between the levels of block assessed by sharp pinprick or cold, and touch, there was no constant relationship between these levels of block within the group nor within individual patients: variable and at times very large differences in the levels of block assessed among these modalities existed: up to 10 segments (pinprick – touch); 11 segments (cold – touch). For any one individual, it is not possible to predict the level of block to touch from a known level of block to sharp pinprick or cold. To facilitate comparison of results across future studies it is suggested that block levels to touch sensation should always be reported. The results suggest that, for clinical purposes, there is no difference in outcomes whether Neurotip touch or ethyl chloride spray touch sensations are used. When using diamorphine 100 µg/mL mixed with bupivacaine 0.5% w/v in 8% dextrose, no patient felt any pain or discomfort provided the block to Neurotip or ethyl chloride touch sensations included T6 or above.

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INTRODUCTION

In clinical practice the most common modalities used to assess the spread of spinal anaesthesia are cold, sharp pinprick and touch. For many years it has been recognised that a differential block to these sensations exists at the upper end.^{1–4} Block to cold sensation is usually at a higher level than block to sharp pinprick,^{1–3} but one study found no difference.⁴ In the three studies that tested for it, block to touch was lower than the block to both pinprick and cold.^{2–4} For caesarean section under regional anaesthesia, a block to touch that includes T5 is currently recommended in the newer obstetric anaesthesia text books.^{5–7} Nevertheless, it is not unusual to hear it stated that it does not matter which modality is used to test a block since if one is interested in achieving a particular level of block to touch then one needs only to produce a block to pinprick or cold some two or four segments higher than the desired level of block to

touch,⁸ although such a belief relies on there being a constant fixed relationship between the levels of block assessed by these methods. The data presented in the original studies^{1–4} do not indicate whether the differential block between touch and the other modalities is a constant width in individual patients or not. Greene¹ studied only pin prick and cold sensations while the others presented grouped data.^{2–4} Although not explicitly presented in the data, Rocco and colleagues² clearly indicated that in non pregnant patients there was considerable variability in the width of the differential block among individual patients and stated “knowing the segmental level of loss of pin prick or cold sensation will not permit prediction of the segmental level at which touch is lost.” On the other hand Brull and Greene³ state “the width of the zones of differential blockade to light touch, pinprick and temperature modalities is constant during onset, maintenance, and regression of spinal anaesthesia.” Apart from 4 patients in one study¹ none of the other investigations studied differential block following spinal anaesthesia in pregnant women.^{2–4}

Studies of spinal anaesthesia for caesarean section have noted a segmental difference between the level of blocks assessed by pinprick and touch,^{9–12} with

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Correspondence to: Ian F Russell, Consultant Anaesthetist, Department of Anaesthesia, Hull Royal Infirmary, Hull HU3 2JZ, UK.
Tel.: +44-1482-674542; E-mail: i.f.russell@hull.ac.uk

differences ranging from zero to 10 segments in some women,^{10–12} but the extent and variability among individual women has never been studied in detail.

No previous study has presented a formal comparison of the various clinical methods of testing a spinal anaesthetic during its onset and maintenance and subjected the data to a detailed analysis to show explicitly the extent of variability in differential block within a group of pregnant women. This work provides such a detailed analysis.

METHOD

The data presented are from patients undergoing caesarean section with spinal anaesthesia. The spinal anaesthetics were performed either by the author in person or by a trainee closely supervised by the author. All the blocks were assessed by the author to ensure consistency of technique. For personal audit purposes, a detailed contemporaneous record of the levels of block to sharp pinprick sensation and loss of touch sensation to a blunt pin has been kept for all caesarean section patients. More recently the levels of loss of touch and cold sensations from ethyl chloride spray have also been recorded routinely. Approval was obtained from the Local Research Ethics Committee to analyse this latter routinely collected dataset and submit it for publication.

Loss of sharp pinprick and touch sensations were both assessed by using the blunt rounded pin end of a Neurotip tester¹³ (Owen Mumford, Brook Hill, Woodstock, Oxford, OX20 1TU). Loss of cold sensation and touch sensations were also assessed using an ethyl chloride spray (Roche Consumer Health Care, Welywn Garden City, Hertfordshire, England AL7 3AY). The levels of block were assessed 2, 5, 10, 15, 20, and 30 min after the spinal injection and again at the end of surgery. Before the block was assessed at each time interval with each modality, a control stimulus was applied to the skin just below the clavicle in the line of the nipple (if this area was blocked an area of normal sensation was found at a higher neurological level on the upper arm). First the blocks to touch and sharp pinprick were assessed with the Neurotip, moving in a cranial direction from just above the left groin, in the nipple line; the level at which Neurotip touch was first felt and then the level at which sharp pinprick sensation was felt (the patient was asked to report when the stimulus felt the same as the control) were recorded. The Neurotip was touched momentarily against the skin and stepped up the abdomen in approximately 2–3 cm steps towards the head. When the levels of appreciation of Neurotip touch and sharp pinprick had been detected on the left, they were assessed on the right side. Assessing the right and left sides took around 15–20 s. Next the levels of

appreciation of touch and cold sensation from the ethyl chloride spray were determined on the left and right sides. When assessing these levels the ethyl chloride was directed at the skin from a distance of about 5 cm and a continuous jet was sprayed onto the skin as the container was moved in a cranial direction.

The levels of block presented below refer to the highest *blocked* dermatome, in other words one lower than the level at which the sensation was present. Because of the rapid spread of spinal anaesthesia in the first few minutes, the 2-min assessments have not been used in the comparative statistical analysis.

Surgery was allowed to start when T6 was either blocked to touch, or expected to be blocked to touch before surgery had reached the peritoneal cavity.

For statistical analysis the spinal segments were numbered from S5 to C2 as 1 to 29 and these were treated as ordinal data. A modification of the Bland Altman plot was used to illustrate the range of differences in block levels between pairs of assessment methods.^{14,15} For calculation of the proportion of women who had more than 3 dermatomes difference between the level of block assessed by loss of sharp pinprick (or cold) sensation and that assessed by loss of Neurotip touch sensation, the data were log-transformed. The Friedman test for multiple related samples and the Wilcoxon signed ranks test for pairs of related samples were also used where appropriate. There were six pairs of assessments to compare at six time intervals: pinprick versus cold; pinprick versus Neurotip touch; pinprick versus spray touch; cold versus Neurotip touch; cold versus spray touch; Neurotip touch versus spray touch. $P < 0.05$ was taken as indicating significance after using a Bonferroni correction factor of 36. Statistical analysis was performed using SPSS version 11.5.

RESULTS

Data on the levels of block were collected from 102 women having spinal anaesthesia for caesarean section (99 single shot spinals, 2 combined spinal epidurals, and 1 spinal catheter). The spinal anaesthetic consisted of 0.5% bupivacaine (8.75–15 mg) in 8% dextrose, containing diamorphine (100 µg/mL). The spinal anaesthetic was usually induced in the right lateral position but 11 spinals were induced in the sitting position and 2 in the left lateral position. Some whole group data are shown in Table 1.

When the differences between the median levels assessed by each modality at each time interval were analysed there were no statistically or clinically significant differences between the left and right sides for any of the sensory testing modalities used, so only data for the left side are presented. The onsets and spreads of the

Table 1. Patient data: mean (standard deviation) or median [lower, upper quartile]*

Age (years)	30.5 (5.87)
Weight at booking (kg)	70.6 (16.2)
Weight at caesarean section (kg)	83.8 (16.2)
Height (cm)	164.1 (7.0)
BMI at booking (kg/m ²)	26.4 (6.05)
BMI at caesarean section (kg/m ²)	31.2 (5.71)
Gestation (weeks)*	38 [38, 39]
Time from end of spinal injection to skin incision (s)	607 (198)
Time from skin incision to delivery (s)	395 (166)
Time from spinal to end of surgery (s)	2659 (667)
Elective (n)/emergency (n)	86/16

block as assessed by the various modalities are shown in Fig. 1. With the exception of the differences between the block levels assessed by cold and sharp pinprick and between Neurotip touch and ethyl chloride touch at the end of surgery, there were statistically significant differences between the paired levels of block assessed by all the different methods at all time intervals (significance ranged from $P < 0.03$ to $P < 0.0000001$ after Bonferroni correction).

The range of differences (amalgamated for all time periods) between the various methods of block testing is shown in Figs. 2–5. Since the data distribution is skewed the median differences and the 5 and 95% centiles for the differences are shown.¹⁵ One way analysis of variance tests indicated that the ratios of the within-patient variance to the within-group variance were 4.46, 5.24, 1.75 and 3.53 for the pinprick versus Neurotip touch, cold versus Neurotip touch, ethyl chloride touch versus

Neurotip touch and cold versus pinprick groups respectively. In the vast majority of cases block to pinprick was lower than block to cold but on 29 occasions (spread among 20 women), block to cold was lower than block to pinprick.

When the individual differences between levels of block assessed by sharp pinprick and Neurotip touch were analysed, the data indicated that for 24% of the paired assessments the difference was greater than 3 dermatomes and in 9% of assessments this difference was greater than 4 dermatomes. Within the actual data in Fig. 2, 18 women had a difference in the levels of block of 5 or more segments during the period from 10 to 30 min. In five of these women this large segmental difference was associated with a sharp pinprick block that included the T4 dermatome or above while the level of Neurotip touch block was below T5: T6 (2 cases), T7 (1 case), and T8 (1 case), T11 (1 case).

When the individual differences between levels of block assessed by cold and Neurotip touch were analysed, it was found that in 34% of the paired assessments the difference was greater than 3 dermatomes and in 17% of assessments it was greater than 4 dermatomes. Within the actual data in Fig. 3, 18 women had a difference in the levels of block of five or more segments during the period from 10 to 30 min. In six of these women this large segmental difference was associated with a block to cold of T4 or above while the level of Neurotip touch was below T5: T7, (2 cases), T8 (2 cases), T10 (1 case), T11 (1 case).

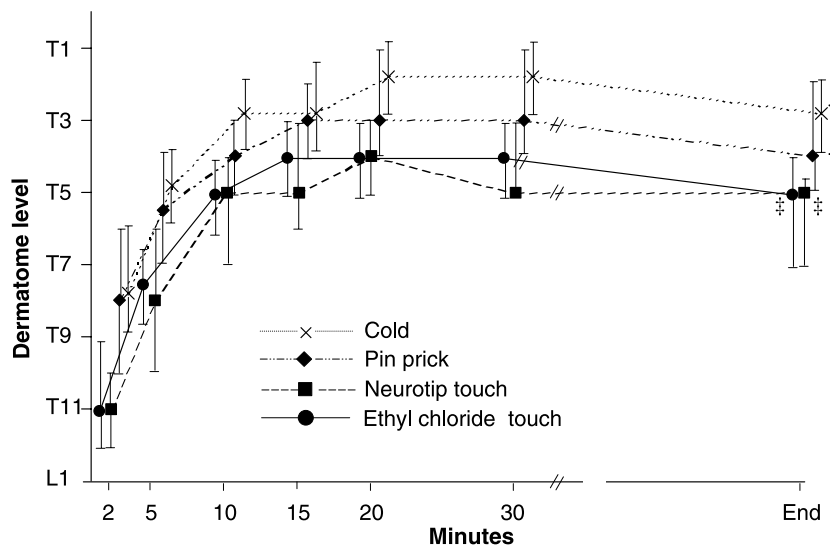


Fig. 1 Median levels of block assessed by each modality at each time interval. The bars represent upper and lower quartiles. Cold = ethyl chloride cold sensation; pinprick = Neurotip sharp pinprick sensation; Neurotip touch = Neurotip touch sensation; ethyl chloride touch = touch sensation from ethyl chloride spray. ‡: no significant difference between the levels assessed by cold and pinprick at the end of surgery. †: no significant difference between the levels assessed by Neurotip touch and ethyl chloride touch at the end of surgery.

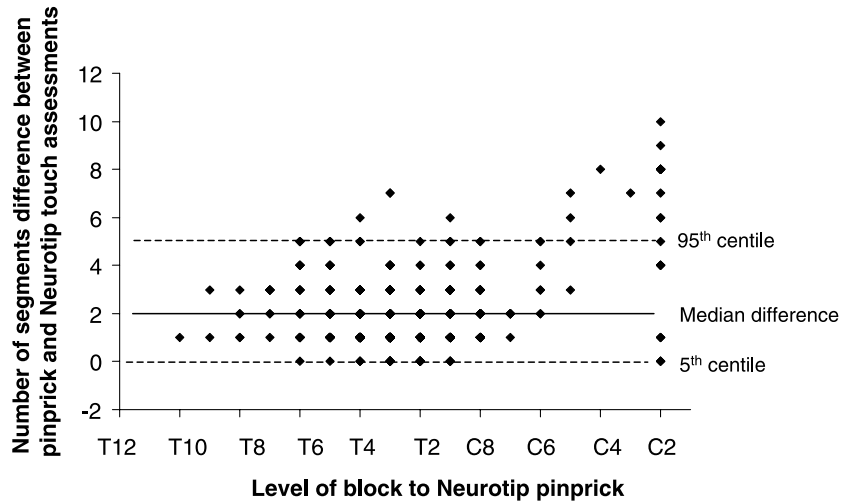


Fig. 2 The number of dermatomes difference between the levels of block assessed by sharp pinprick and Neurotip touch against the corresponding level of block to sharp pinprick (all patients at all time intervals). Because of superimposition of data points not all the individual plotted points are visible. The interquartile range was pinprick varying from 1 to 3 segments above Neurotip touch. A positive difference indicates that the level of block to pinprick was above the level of block to touch.

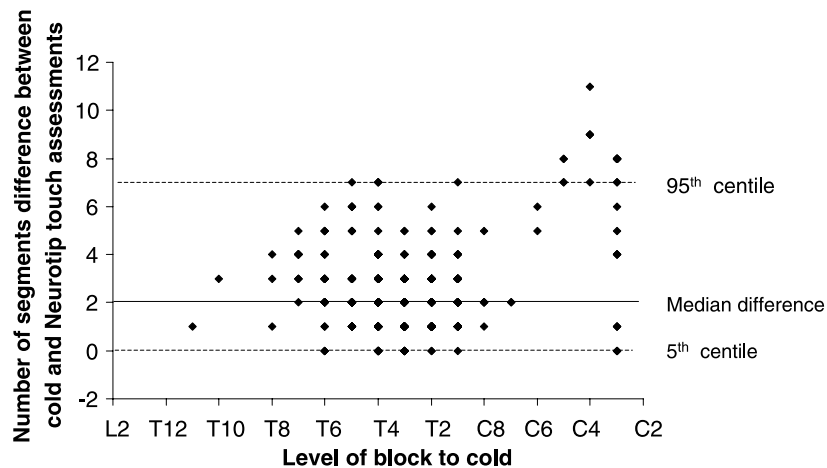


Fig. 3 The number of dermatomes difference between the levels of block assessed by cold and Neurotip touch against the corresponding level of block to cold (all patients at all time intervals). Because of superimposition of data points not all the individual plotted points are visible. The interquartile range was cold varying from 1 to 3 segments above Neurotip touch. A positive difference indicates that the level of block to cold was above the level of block to touch.

Four women experienced intra-operative pain. Three had a sharp pinprick or cold block that included the T4 dermatome or above: the fourth had sharp pinprick block to T5. All these women had a Neurotip block below T6 at the time of their pain. For two of these women increments of intravenous fentanyl (up to 200 μg in total) after delivery were sufficient to complete surgery. The third woman had the epidural component of her combined spinal epidural topped up before delivery of the infant. The fourth woman (sharp pinprick blocked to T5, Neurotip touch blocked to T7) had her surgery

interrupted (at the time of opening the rectus sheath), the wound edges approximated with two stitches and covered with a wound dressing, before she was turned into the right lateral position for a repeat spinal.

The differences in block levels assessed by sharp pinprick or cold and Neurotip touch at the start of surgery are shown in Fig. 6. The differences in block levels assessed by sharp pinprick and Neurotip touch are shown for the individual time intervals in Fig. 7. No patient with a block to Neurotip touch which included T6 experienced pain.

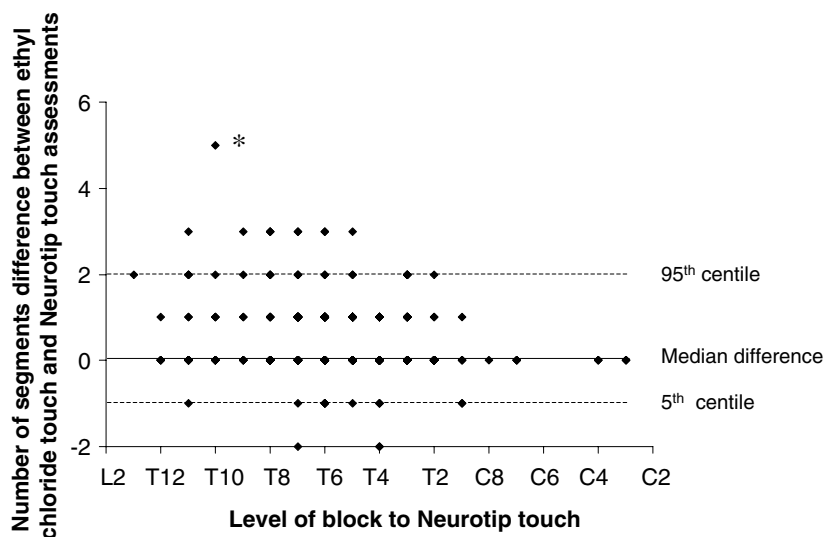


Fig. 4 The number of dermatomes difference between the levels of block assessed by ethyl chloride spray touch and Neurotip touch against the corresponding level of block to Neurotip touch (all patients at all time intervals). Because of superimposition of data points not all the individual plotted points are visible. The interquartile range was ethyl chloride touch ranging from 0 to 1 segment above Neurotip touch. A positive difference indicates that the level of block to ethyl chloride spray touch was above the level of block to Neurotip touch.*This point appears to have been incorrectly recorded in the original data (see text).

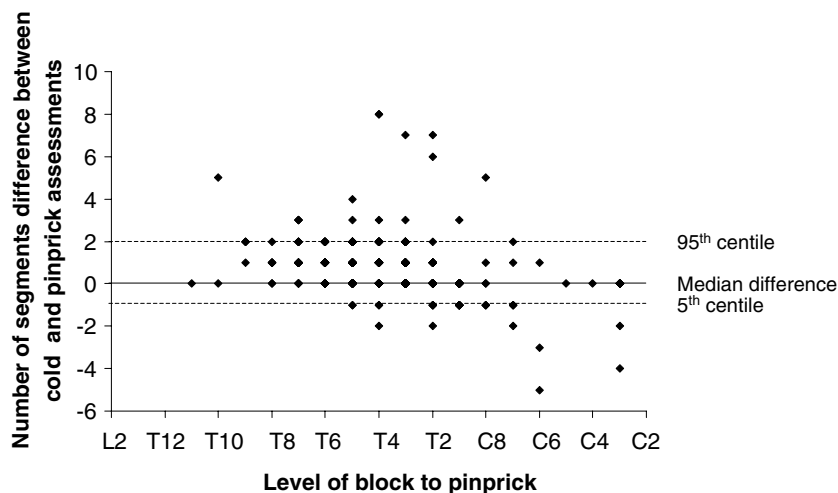


Fig. 5 The number of dermatomes difference between the levels assessed by cold and sharp pinprick against the corresponding level of block to sharp pinprick (all patients at all time intervals). Because of superimposition of data points not all the individual plotted points are visible. The interquartile range was cold varying from 0 to 1 segment above sharp pinprick. A positive difference indicates that the level of block to cold was above the level of block to pinprick.

DISCUSSION

Several investigations have concluded that during spinal anaesthesia there is about a two-segment difference between the levels of block assessed by sharp pinprick and touch sensations,^{2,4} but three studies of spinal anaesthesia for caesarean section have mentioned wide variations between pinprick and touch levels in individual patients.¹⁰⁻¹² The data in the present study clarify this apparent contradiction. When all the data were

grouped there was a median difference of two segments between the levels of block to touch and that to sharp pinprick or cold (Figs. 1-3, 6 and 7) but when the data are examined in more detail it is clear that for any one individual there is no constant relationship between the levels of block to touch and that to pinprick or cold (Figs. 2-5). The range of differences in block levels to these modalities was from 0 to 10 segments between sharp pinprick and Neurotip touch and from 0 to 11 segments between cold and Neurotip touch. While much

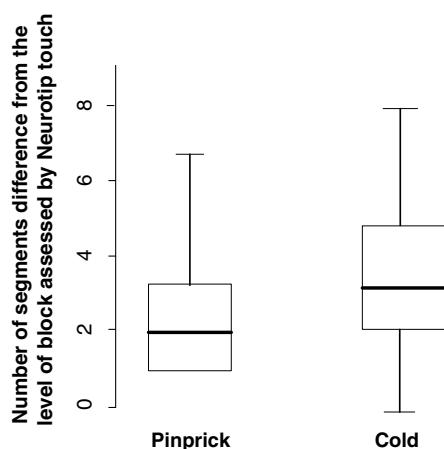


Fig. 6 Box plots showing the number of dermatomes difference between block levels assessed by sharp pinprick and Neurotip touch, and between those assessed by cold and Neurotip touch at skin incision. Median = thick line within the box; upper and lower quartiles (upper and lower edges of the box). Whiskers are defined within SPSS as the most distant point which does not meet the definition of an outlying point: since there are no outliers or extreme values the whiskers represent the range. Box length is the interquartile range. A positive difference indicates that the levels of block to pinprick or cold were above the levels of block to touch.

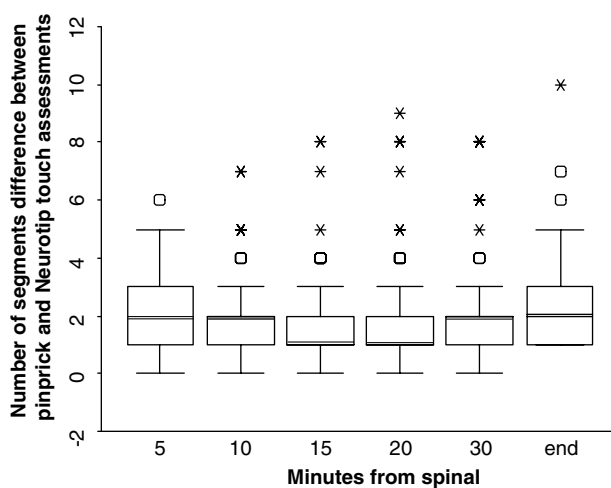


Fig. 7 Box plots showing the number of dermatomes difference between block levels assessed by sharp pinprick and Neurotip touch at each of the assessment times. Median = thick line within the box; upper and lower quartiles (upper and lower edges of the box); whiskers are defined within SPSS as the most distant point which does not meet the definition of an outlying point; □ represents outlying points, defined as those with values between 1.5 and 3 box lengths from the upper or lower edge of the box. * represents extreme points, with values more than 3 box lengths from the upper or lower edge of the box. Box length is the interquartile range. A positive difference indicates that the level of block to pinprick was above the level of block to touch.

of the unpredictability was due to between-patient variability, the analysis of variance tests indicated that within-patient variability could not be ignored.

Many published studies have used a level of block to pinprick to T4 to indicate adequate anaesthesia for

caesarean section.^{16–22} However, the results of these investigations indicate that pinprick to T4 is very unreliable in predicting the adequacy of spinal anaesthesia for caesarean section: the need for intraoperative supplements ranged from 0 to 95%.^{16–22} Several of these authors noted that increasing the dose of local anaesthetic reduced the incidence of intraoperative pain,^{17,18,20} despite there being no significant change in the levels of block to pinprick. Although these authors recommended the use of the larger dose of spinal local anaesthetic for the “improved quality of block,” none of them commented on the obvious implication of their results: assessing the block by pinprick was not capable of detecting the improved quality of block provided by the higher doses. Analysing the data in these studies shows that in the absence of spinal opioids, pinprick testing was scarcely better than chance at predicting the adequacy of the spinal: 45% of all the patients experienced moderate to severe pain.^{16–22}

If, as suggested,^{6–8,23} a block of T5 to touch is the required level before surgery to predict a pain-free caesarean section, then the data in Fig. 6 illustrate the problem of trying to predict the level of touch from pinprick or cold assessments. Three of the four women who did experience intra-operative pain were classified as outliers in Fig. 7 (the repeat spinal was on the 75th centile). In three of the four cases pinprick and cold were blocked to at least T4 but the Neurotip touch block was only to T7 or T8 in all four cases.

It has been suggested that a block to pinprick to T4 with complete paralysis of the legs is sufficient to ensure adequate spinal anaesthesia for caesarean section.²⁴ However, since all four women with intra-operative pain in the current series had complete paralysis of the legs with a block to pinprick and cold which included T4 or T5, it seems unlikely that predicting the adequacy of a block for caesarean section on such a combination has much to recommend it. Neurologically, paralysis of the legs merely indicates that there is sufficient local anaesthetic within the lumbar spinal canal to block the motor nerves to the legs, but gives no indication of how dense the block might be at higher thoracic levels.

Levels of block to touch are rarely presented in studies of caesarean section performed with regional anaesthesia, but it would help our understanding of block assessment if touch levels were to be presented as a routine in future studies. In a very short time the evidence should accrue to ascertain if touch does indeed detect an improved quality of block not detectable by cold or sharp pinprick testing.

Except in one patient (Fig. 4), there was a close association between the levels of block to touch assessed by the ethyl chloride spray and the Neurotip tester. On examination of the original paper record for this one patient there appears to be a transcription error - all other

assessments were identical. Although the level of block to ethyl chloride touch was not always identical to level of block to Neurotip touch, the outcome data suggest that in normal clinical practice ethyl chloride spray touch sensation can be considered equivalent to Neurotip touch in predicting the likely adequacy of spinal anaesthesia. This finding is supported by a recent study where loss of sensation to ethyl chloride touch was used as indicative of adequate anaesthesia: the only patients who required intraoperative supplements were those in whom surgery was prolonged and the block regressed below T5.²⁵

In conclusion, the data in this study of spinal anaesthesia for caesarean section indicate a median group difference of some two segments between the level of block to touch and that to sharp pinprick or cold, but there is no constant relationship between these levels within individual patients. For any one individual, it is not possible to predict the level of block to touch from the level of block to sharp pinprick or cold. Finally, when using diamorphine with 0.5% hyperbaric bupivacaine, it would appear that a block to Neurotip touch that includes T6 at skin incision is likely to provide a pain-free caesarean section.

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