

## ZONES OF DIFFERENTIAL SENSORY BLOCK DURING EXTRADURAL ANAESTHESIA

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### SUMMARY

*We have measured spinal segmental levels of anaesthesia to light touch (LT), pinprick (PP) and cold temperature discrimination (TE) during 2% lignocaine extradural anaesthesia in 22 patients, to determine if zones of differential sensory block develop during extradural anaesthesia and, if so, the extent to which TE extends beyond PP or LT levels and how age affects differential block. The median thoracic dermatomal levels were 4.5 for LT, 2.0 for PP and 2.0 for TE. Zones of differential sensory block developed within 5 min of extradural injection of local anaesthetic, and persisted for the next 55 min. In all instances, PP extended more cephalad than LT, and TE extended above PP levels. There were no differences in the extent of zones between the two groups of patients with mean ages of 28 and 48 yr. Thus, during extradural anaesthesia, sympathetic denervation extended one to two spinal segments above the sensory levels of LT and PP anaesthesia, age (28 vs 48 yr) affected neither the cephalad extent nor the width of zones of differential block, and PP levels of anaesthesia were closer to presumed levels of sympathetic block than were LT levels.*

### KEY WORDS

*Anaesthetics, local: lignocaine. Anaesthetic techniques: extradural.*

Extradural anaesthesia results in denervation of somatic motor, sensory and sympathetic fibres. Patient comfort during surgery depends on the extent of sensory denervation, while cardiovascular and especially arterial pressure responses to anaesthesia depend to a major degree on the extent of sympathetic denervation. However, the zone of differential block between the level of sensory anaesthesia and the level of sympathetic block is unclear. The only published prospective

study of the extradural zones of differential block [1] found that the mean levels of sensory anaesthesia were not significantly different from the mean levels at which temperature discrimination was lost. However, it is not clear in this report if "touching the skin with a needle point" measured the level at which light touch was blocked, or if pinprick anaesthesia was measured. More importantly, data on segmental levels of anaesthesia were reported and were analysed statistically as means, not as medians; the latter is preferable, for reasons stated below.

Data on the existence and extent of zones of differential block during spinal anaesthesia are of little value in estimating the extent of these zones during extradural anaesthesia. The width of the zone of differential somatic motor and somatic sensory block averages 2.8 dermatomes [2], significantly less than the average of 4.6 dermatomes which develops during extradural anaesthesia. This provides good evidence that the average dermatomal width of the zone between sensory and sympathetic levels of block during extradural anaesthesia is different from the average of 2 spinal segments [3] present during spinal anaesthesia.

The present study was designed to assess the width of zones of differential block, if any, between light touch, pinprick and temperature (cold) discrimination during extradural anaesthesia under clinical conditions. Further, if zones of differential block were found to exist, the study was designed to determine which level of sensory anaesthesia, light touch or pinprick, might be more indicative of the level of sympathetic denervation. Although it is not a direct function

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of the sympathetic nervous system, temperature discrimination block was used as a clinical correlate of the level of sympathetic denervation [3, 4], as it is the easiest and probably the most reliable method, albeit imperfect, of assessing the extent of sympathetic denervation clinically.

#### PATIENTS AND METHODS

After approval by the institutional Human Investigations Committee, verbal informed consent was obtained from 22 patients (age range 22–76 yr), undergoing extradural anaesthesia for elective surgical procedures. All patients (ASA physical status I, II or III) were devoid of known neuromuscular disease and had no contraindications to extradural anaesthesia. Premedication was not prescribed. During operation, midazolam was given in doses sufficient to relieve anxiety without producing undue sedation (0.01–0.05 mg kg<sup>-1</sup>). The dose of fentanyl, the only intraoperative opioid used, was limited to 2 µg kg<sup>-1</sup> in the first 45 min after extradural injection of local anaesthetic. In all patients, 2% lignocaine with adrenaline (1:200 000) with sodium bicarbonate 0.1 mmol litre<sup>-1</sup> per ml of solution, was injected extradurally.

During operation, patients were monitored according to our departmental standards for patients undergoing extradural anaesthesia. Dose and speed of injection of local anaesthetic were determined by the resident and attending anaesthetist, who were not involved in the study. In all patients, the extradural space was identified by the loss of resistance technique, using an 18-gauge Weiss needle inserted at the 3rd or 4th lumbar interspace with the patients in the flexed lateral decubitus position. After insertion of an extradural catheter 2–3 cm, tests were made for subarachnoid and intravascular insertion and patients were turned immediately to the supine horizontal position. Local anaesthetic was injected extradurally via the indwelling catheter. The volume and frequency of administration of local anaesthetic were at the sole discretion of the primary anaesthetist, and no attempt was made to standardize the anaesthetic care.

All sensory assessments were performed on the same side of the patient by the same observer (S.J.B.), who did not participate in the perioperative administration of i.v. fluids or medications. The dermatomal levels of anaesthesia to light touch, pinprick and temperature

(cold) discrimination were tested and recorded when each modality tested had progressed to at least the T12 dermatome [5]. These levels, and mean arterial pressure and heart rate were measured every 5 min for 30 min, and thereafter every 15 min, until 60 min from the initial injection of local anaesthetic. In addition, total cumulative volumes of i.v. crystalloid solutions administered, doses of vasoactive i.v. agents, if any, and total cumulative dose of local anaesthetic injected extradurally were recorded at the same times. I.v. crystalloid solutions, i.v. vasoactive medications and extradural local anaesthetics were administered according to clinical criteria, and were not influenced by study design.

The most cephalad dermatomal level of loss of each sensory modality was determined by asking the patient to compare differences between sensory stimuli applied to an unanaesthetized area (e.g., the shoulder tip) and to the trunk in the midclavicular line. The level caudal to the lowest level at which light touch was first discerned was considered the most cephalic level of light touch block. The level caudal to the lowest dermatome at which the sensory stimulus felt the same as at the shoulder tip was considered the most cephalic level of block of the sensory modality (pinprick or temperature) being tested. Light touch was measured by applying the dull, hinged end of a sterile safety pin to the skin without indenting it. Pinprick was measured using the sharp tip of a sterile safety pin protruding 3 mm beyond a rubber stopper. Temperature was measured by spraying the skin with a non-toxic, non-flammable, highly volatile mixture of dichlorofluoromethane and trichloromonofluoromethane (FluoriMethane, Gebauer, Cleveland, Ohio) [6]. Arterial pressure was measured using an automated sphygmomanometer, and heart rate was measured from the ECG. The 22 patients were classified into two groups, according to the median age: less than (or equal to) 35 yr, and older than 35 yr.

Although sensory levels of spinal and extradural anaesthesia are almost invariably reported as averages, or means, they represent ordinal, not interval data, as do group Apgar scores and ASA physical status ratings, and are presented, therefore, as medians, with ranges, rather than means and SD or SEM [7, 8]. The widths of zones of differential block, being interval data, are presented in this study as means (SD). Spinal segmental levels of denervation, being ordinal

TABLE I. Details of the 22 patients grouped according to median age. LA = total volume of local anaesthetic (lignocaine) injected extradurally by the indicated observation time

	Median age ≤ 35 yr	Median age > 35 yr
<i>n</i>	12	10
Mean (SD) age (yr)	28 (5)	48 (11)
Weight (kg)	78.8	70.8
Height (cm)	164.9	165.6
LA at 5 min (ml)	7.5 (3.2)	7.5 (3.1)
LA at 15 min (ml)	18.4 (2.7)	19.3 (3.5)
LA at 60 min (ml)	31.3 (3.5)	27.0 (1.4)

TABLE II. Mean, median and 25th–75th percentiles light touch (LT), pinprick (PP) and cold temperature (TE) discrimination. All dermatomes are thoracic except for C7.0, which denotes the 7th cervical dermatome

Dermatomal extent	Sensory modality		
	LT	PP	TE
Mean	4.5 (2.6)	2.6 (2.1)	1.5 (2.5)
Median	4.5	2.0	2.0
25th–75th percentile	2.5–6.5	1.0–4.0	C7.0–4.0

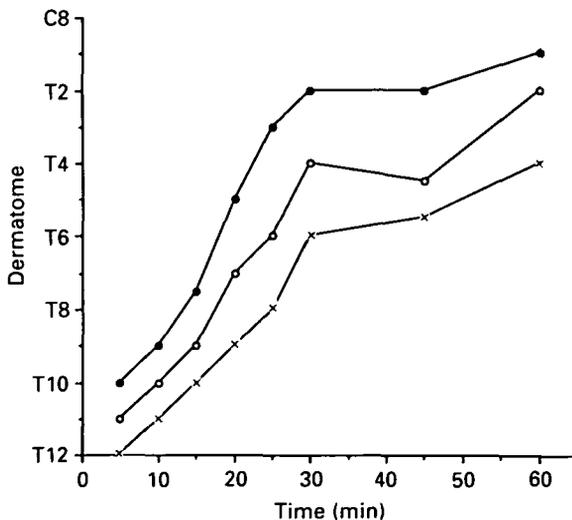


FIG. 1. Thoracic (T) or cervical (C) dermatomal levels of light touch (x), pinprick (O) and cold temperature (●) denervation as a function of time during extradural anaesthesia.

data, are presented as median (and 25th–75th percentiles). However, because most readers are accustomed to mean (SD) data for group levels of

TABLE III. Mean (SD) width (dermatomes) of light touch to pinprick (LT–PP) and pinprick to temperature (PP–TE) zones of differential anaesthesia as a function of time. *n* = Number of observations at each time interval

Time	LT–PP		PP–TE	
	<i>n</i>	Width	<i>n</i>	Width
5 min	8	1.0 (0.5)	12	1.3 (0.6)
10 min	13	1.8 (2.0)	22	1.1 (0.9)
15 min	18	1.5 (0.7)	22	1.1 (1.2)
20 min	20	1.8 (0.9)	22	1.4 (0.8)
25 min	19	2.3 (1.3)	21	1.6 (1.4)
30 min	21	2.3 (1.6)	21	1.6 (1.3)
45 min	10	2.6 (1.6)	10	1.3 (1.0)
60 min	5	2.8 (3.1)	5	1.2 (1.6)

extradural anaesthesia, these are included also. Ordinal (non-parametric) data were analysed using Wilcoxon rank sum test or, where appropriate, by Wilcoxon signed rank test for paired data. Interval (parametric) data were analysed by *t* test for independent samples or, where appropriate, paired *t* test. Statistical significance was defined as  $P < 0.05$  for all analyses.

## RESULTS

The four males and 18 females in the study had a mean age of 38.6 yr (range 22–76 yr), mean weight 75.2 (15) kg, and mean height 165.3 (9) cm. Five of the patients were ASA physical status I, 14 were ASA II, and three were ASA III. Details of the 22 patients grouped according to their median age of 35 yr are represented in table I.

The highest, most cephalic dermatomal level for light touch was T4.5 (SD 2.6), for pinprick T2.6 (2.1) and for temperature T1.5 (2.5) ( $P < 0.05$  for the differences between each of the three sensory modalities). The most cephalic median dermatomal levels (with 25th–75th percentiles) for light touch, pinprick and temperature are shown in table II. Changes in the dermatomal extent for each of the three sensory modalities are shown in figure 1. Analysis of the denervation level of three sensory modalities revealed no significant differences in the most cephalic extent in the group of patients younger than 35 yr compared with the older group.

The difference between the levels of light touch (LT) and pinprick (PP) (i.e., the zone of differential block between light touch and pinprick sensory modalities), and the zone of differential block between pinprick and tempera-

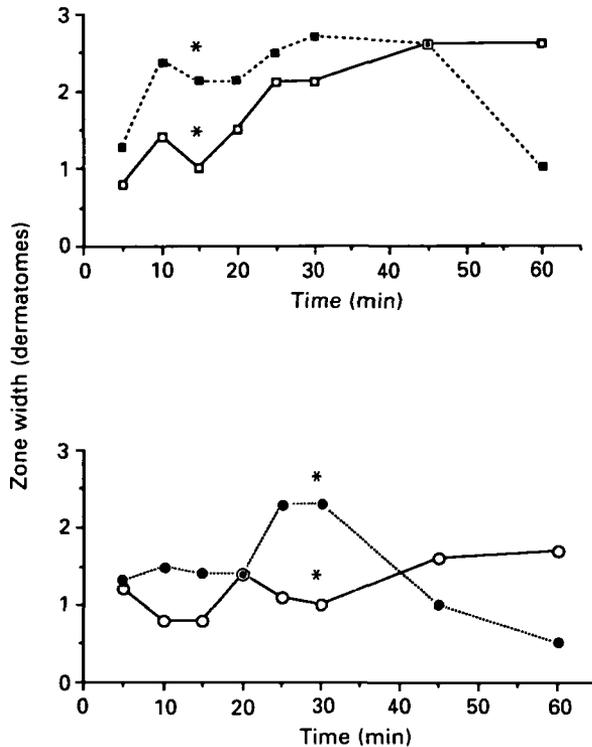


FIG. 2. Width (number of dermatomes) of zones of differential block as a function of age. □ = LT-PP, age ≤ 35 yr; ■ = LT-PP, age > 35 yr; ○ = PP-TE, age ≤ 35 yr. ● = PP-TE, age > 35 yr. \*  $P < 0.05$ .

ture (TE), was statistically significant at 5 min (i.e., the LT-PP and PP-TE zones of differential block were both statistically different from zero at the 5-min observation time). These zones of differential anaesthesia remained constant and statistically different from zero over the entire study ( $P < 0.05$ ) (table III). The width of the LT-PP zone (mean 1.0 (0)) in patients younger than 35 yr was statistically less than in the older group (mean 2.1 (0.6)) at the 15-min interval. Similarly, the width of the PP-TE zone (1.0 (0.7)) in the patients younger than 35 yr was statistically less than that in the older group (mean 2.3 (1.5)) at 30 min (fig. 2).

The mean width of the LT-PP zone was 1.0 (0.5) dermatomes. The tendency of this zone to increase its width over time did not reach statistical significance. Similarly, the width of the PP-TE zone of differential sensory block remained statistically unchanged during the study (table III), even as the levels of sensory denervation continued to increase (fig. 1).

The mean total volume of local anaesthetic administered over the 60-min observation period was 29.6 ml, 7.5 ml of which was administered in the first 5 min, inclusive of 5.0 ml used for test doses for subarachnoid (2 ml) and intravascular (3 ml) injection (table I). There were no significant differences in the group of patients older than 35 yr compared with the younger group with respect to total dose of local anaesthetic, dose of local anaesthetic at each measurement time, dose of i.v. fentanyl or vasoactive substances, total amount of i.v. fluids, or haemodynamic state as reflected by changes in mean arterial pressure or heart rate.

#### DISCUSSION

This study has shown that extradural anaesthesia, in common with spinal anaesthesia, is associated with zones of differential sensory block, and contradicts the results of a previous study [1].

The time at which these zones of differential anaesthesia reached statistical significance was 5 min or less. When these zones had appeared, they remained unchanged over the entire study. Although there was a tendency for the LT-PP zone width to increase with time, this did not reach statistical significance during the 60 min of observation. The width of the PP-TE zone also remained constant over time. Although the total dose of extradural local anaesthetic required to achieve a given anaesthetic level is greater than the dose required to achieve the same level of sensory denervation with spinal anaesthesia, it appears that both regional techniques are associated with development and maintenance of zones of differential sensory block [6].

The mechanisms of these zones of differential block are unknown during both extradural and spinal anaesthesia. However, the existence of these zones is important, as it demonstrates that for any given pinprick sensory level, the extent of sympathetic denervation (assessed by level of temperature anaesthesia) is always more extensive than either pinprick or light touch sensory levels. Although the widths of LT-PP at 15 min and PP-TE at 30 min were both less in the group of patients younger than 35 yr, this difference was not apparent at any other time. Therefore, in the relatively narrow age range studied in the present report, age did not appear to influence either cephalic extent or the width of zones of differential block. These findings are consistent

with other reports which have shown that the relationship between age and extradural dose requirements is linear in patients aged 20–40 yr; however, this relationship is not maintained in patients older than 50 yr [9]. It is possible that the width of the zones of differential block might also be different in patients older than 50 yr.

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