

## MEASUREMENT OF THE DEPTH TO THE EXTRADURAL SPACE USING ULTRASOUND

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### SUMMARY

Seventy-five patients requesting extradural analgesia for the relief of pain in labour underwent an ultrasound scan to measure the depth to the extradural space. There was a high degree of correlation between these measurements and the subsequent depth of insertion of the Tuohy needle. The advantages of the technique in clinical practice and as an aid to teaching, are discussed.

The technique of extradural analgesia relies on accurate placement of a needle in the extradural space, as recognized by a loss of resistance or change in pressure experienced as the needle is advanced.

If the needle is advanced too far dural puncture may result. Estimates of the frequency of this complication vary (Bromage, 1978; Moir, 1980; Crawford, 1982), but it is certainly more likely to occur while the technique is being learned (Crawford, 1972). Indeed, it seems almost inevitable that dural puncture will occur during the first 25 attempts (Crawford, 1978). Alternatively, the needle may not be advanced enough, and a false "loss of resistance" may be obtained at the level of the interspinous ligament. Placement of the catheter here will result in failure of the block. Obviously, accurate knowledge of the depth of the space before the insertion of the needle would facilitate the performance of extradural blockade, and should lead to a decrease in the complication rate.

Ultrasound scanners are widely used in obstetric practice and the technique is free from adverse effects to mother or fetus. The purpose of this study was to show that ultrasound equipment could be modified to give an accurate measurement of the depth to the extradural space before the performance of the block.

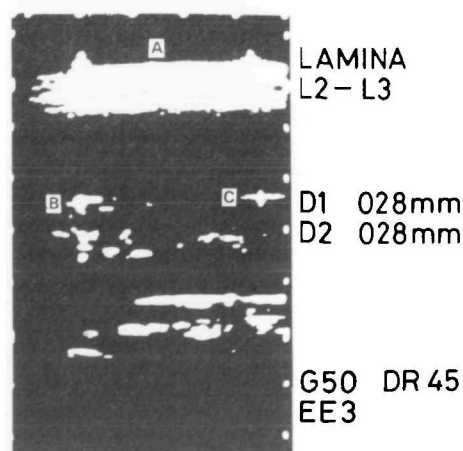
### PATIENTS AND METHODS

Seventy-five patients requesting extradural analgesia for relief of pain in labour participated in this study.

Before the insertion of the extradural needle the

appropriate lumbar segments were scanned, with the patient in a sitting position. The scanner was a Toshiba SAL-20A equipped with a 5-MHz Linear Array Probe. The higher frequency of this probe resulted in better definition of the target area, which was the lamina of the vertebrae.

Further modifications of the scanning technique were used. Thus, scanning was through a saline bag as this resulted in a well-defined echo from the skin surface. Because of the characteristics of this particular probe, this technique also improved the resolution of the target area. The scanner controls were set for maximum gain in the near field and the image was adjusted for maximum contrast instead of the usual "grey scale" display. The effect of these adjustments can be seen in the photograph of a typical scan (fig. 1). Without these modifications it



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FIG. 1. Ultrasound scan of the lamina of L2 and L3 obtained with a Toshiba SAL 30 Scanner. A = Skin surface; B = lamina L2; C = lamina L3. D1 = Depth to space at L2; D2 = depth to space at L3; G = gain; DR = dynamic range; EE = echo enhance.

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was impossible to obtain an image of the lamina.

An image of the laminae of the second and third lumbar vertebrae was obtained. The distance from the skin surface to the ventral aspect of the lamina was then measured in the mid-line using the machine's caliper and image-freeze capability—the caliper being calibrated at  $1600 \text{ m s}^{-1}$ .

The anaesthetist who subsequently performed the block had no knowledge of the ultrasound measurement. A rubber slide was placed over the Tuohy needle so that its depth of insertion could be measured accurately. The two measurements were compared.

## RESULTS

Figure 2 shows the distance that the Tuohy needle was advanced, plotted against the depth to the space as measured by ultrasound. The mean value for the depth to the space measured by ultrasound was 4.13 cm (range 2.9–7.2 cm). The mean value for the measurements with the Tuohy needle was 4.35 cm (range 3.2–7.1 cm). The correlation co-efficient ( $r$ ) was 0.96 ( $P > 0.001$ ).

## DISCUSSION

Seventy-one of the 75 ultrasound measurements were less than those measured using the Tuohy

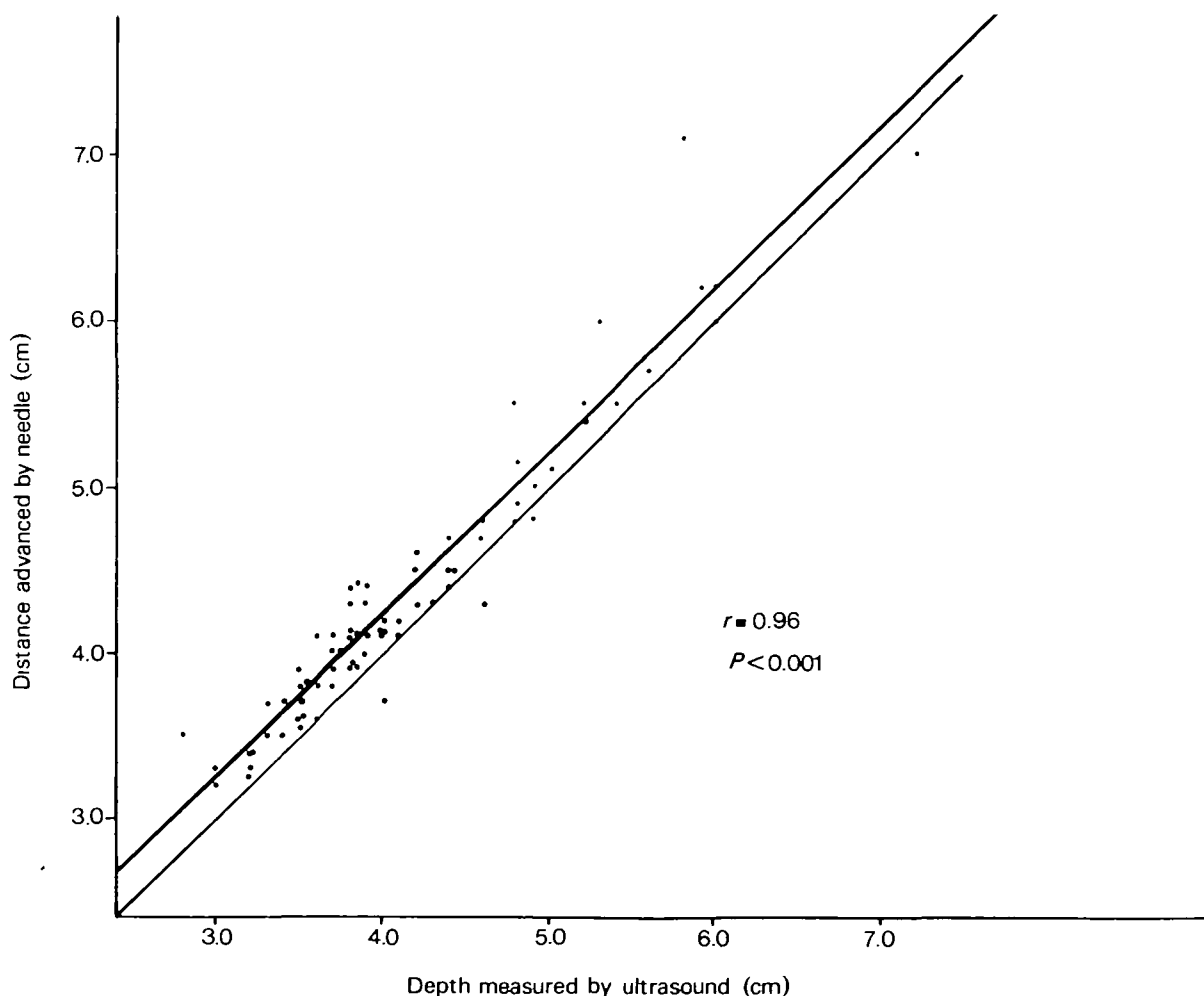


FIG. 2. Correlation between the ultrasound and Tuohy measurements (upper line) in relation to the line of 100% correlation (lower line).

needle, and the mean of the ultrasound measurements was 0.2 cm less than the mean of the Tuohy needle measurements. However, the ultrasound measurement would be expected to be less than that of the Tuohy needle as the depth was measured to the anterior or surface of the lamina. The Tuohy needle must be inserted slightly beyond this to allow passage of the catheter.

In the remaining four patients, each occurring early in the series, the ultrasound depths were greater than those measured by the Tuohy needle. This was thought to be a result of misinterpretation of the echoes, and measurement to the posterior surface of the body of the vertebra instead of the lamina. In three of these four patients, subsequent re-scanning confirmed this error, which could then be avoided later in the series.

In the other patient it was not possible to obtain a convincing echo from the lamina even after re-scanning. Thus, in only one out of the 75 patients was it not possible to identify the lamina with this equipment.

For the best correlation the Tuohy needle would need to be inserted perpendicularly to the skin, and the anaesthetists performing the block were asked to do this whenever possible. In 43 of the 75 measurements the ultrasound reading was within 2 mm of the measurement using the Tuohy. In the remaining 28 the discrepancy can almost certainly be explained by insertion of the needle at an angle less than 90° to the skin.

Hitherto there has been no useful clinical method for measuring the depth to the extradural space before performance of extradural blockade. A measurement can be obtained from a lateral radiograph of the lumbar spine, but x-rays are best avoided in pregnancy and this technique has little practical application. Moreover, the x-ray image is magnified and any measurements must be adjusted mathematically.

Measurements of the spinal canal have been obtained previously, the back being scanned in the 15° oblique plane (Porter, Hibbert and Wellman, 1980). However, for this study it was necessary to scan in the mid-line corresponding to the position of insertion of the Tuohy needle. Scanning the lumbar spine in the mid-line was found to be technically difficult. Until the described method was used it was impossible to obtain a useful image of the target area. A major part of the work of this study was the development of these modifications to the scanning technique.

Ultrasound scanning of the lumbar spine can give an accurate reading for the depth to the extradural space. Prior knowledge of the depth to the space should facilitate the performance of the extradural block and may decrease the complication rate. It should prove a valuable aid in teaching the technique.

#### ACKNOWLEDGEMENT

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#### ESTIMATION DE LA PROFONDEUR DE L'ESPACE PERIDURAL PAR LES ULTRASONS

##### RESUME

Soixante quinze patientes qui requerraient une analgésie péridurale au cours du travail ont subi une échographie pour mesurer la profondeur de l'espace péridural. Il y avait une très forte corrélation entre ces mesures et la profondeur à laquelle se trouvait ensuite placée l'extrémité de l'aiguille de Tuohy. Les avantages de cette technique en pratique clinique et comme aide à l'enseignement, sont discutés.

#### MESSUNG DER TIEFE DES EXTRADURALRAUMS MITTELS ULTRASCHALL

##### ZUSAMMENFASSUNG

Fünf und siebenzig Patientinnen, die zur Linderung von Wehenschmerzen Extraduralanästhesie bekamen, wurden mit Ultraschall untersucht, um die Tiefe des Extraduralraums zu messen. Es zeigte sich eine hochgradige Korrelation zwischen diesen Messungen und der nachfolgende Insertionstiefe mit der Tuohy-Nadel. Die Vorteile dieser Technik in der klinischen Praxis und als Lernhilfe werden diskutiert.

#### MEDICION DE LA PROFUNDIDAD HASTA EL ESPACIO EXTRADURAL MEDIANTE ULTRASONIDOS

##### SUMARIO

Con el objeto de medir la profundidad hasta el espacio extradural, se sometió a setenta y cinco pacientes que necesitaban una analgesia para aliviar los dolores del parto a un examen radioscópico por ultrasonidos. Hubo una fuerte correlación entre dichas mediciones y la profundidad consecuente a la que se insertó la aguja de Tuohy. Se discute de las ventajas de esa técnica en actividades clínicas y como una ayuda a la enseñanza.