

## CONTINUOUS INTERCOSTAL NERVE BLOCKADE *An Anatomical Study To Elucidate Its Mode Of Action*

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### SUMMARY

India ink was injected through extradural catheters placed in the posterior intercostal space in 12 cadavers undergoing autopsy and the subsequent spread of the India ink was assessed under direct vision. The ink spread subpleurally to reach a number of intercostal spaces and medially to reach the paravertebral space. It is concluded that analgesia extending over a number of dermatomes is achieved by subpleural tracking of local anaesthetic to reach intercostal nerves above and below the one injected.

In a recent clinical study (Murphy, 1983) continuous intercostal nerve blockade was used successfully to provide relief of pain after cholecystectomy performed through a Kocher's incision. Blockade was achieved by the placement of an extradural catheter into a single intercostal space and by "topping up" with bupivacaine as required. The exact nature and extent of blockade were unclear but, since the surgical incision extended over a number of dermatomes, a number of intercostal nerves must have been blocked to achieve the complete analgesia recorded. This is in keeping with the anatomical findings of Nunn and Slavin (1980) on whose work the clinical study was based. Since large volumes of local anaesthetic (20 ml) were used, it was considered prudent to examine the exact nature of the nerve blockade, and this formed the basis of the present study.

In cadavers about to undergo postmortem examination, dye (to simulate the local anaesthetic) was injected to the posterior intercostal space and the extent of its spread determined under direct vision. Although only unilateral blockade was required in the clinical study, to facilitate collection of numbers, catheters were inserted bilaterally in the cadavers.

### MATERIALS AND METHODS

The extradural catheter was inserted to the intercostal space in a manner similar to that described in the clinical study (Murphy, 1983).

The cadaver was turned onto one side and the intercostal space between the 7th and 8th or 8th and

9th ribs located at 7 cm from the midline posteriorly. Following skin puncture at this point, a disposable Tuohy needle (Portex Ltd) was inserted and advanced until contact was made with the uppermost rib. The needle was then "walked down" the rib until it just slipped under the lower border. The needle was advanced 3 mm and, with the bevel of the needle pointing medially, an extradural catheter was advanced 3–4 cm through the needle, which was then withdrawn. This process was repeated on the other side and both catheters secured in position.

Following removal of the viscera for postmortem examination, 20 ml of dye (India ink) was injected through each extradural catheter in turn and its spread studied.

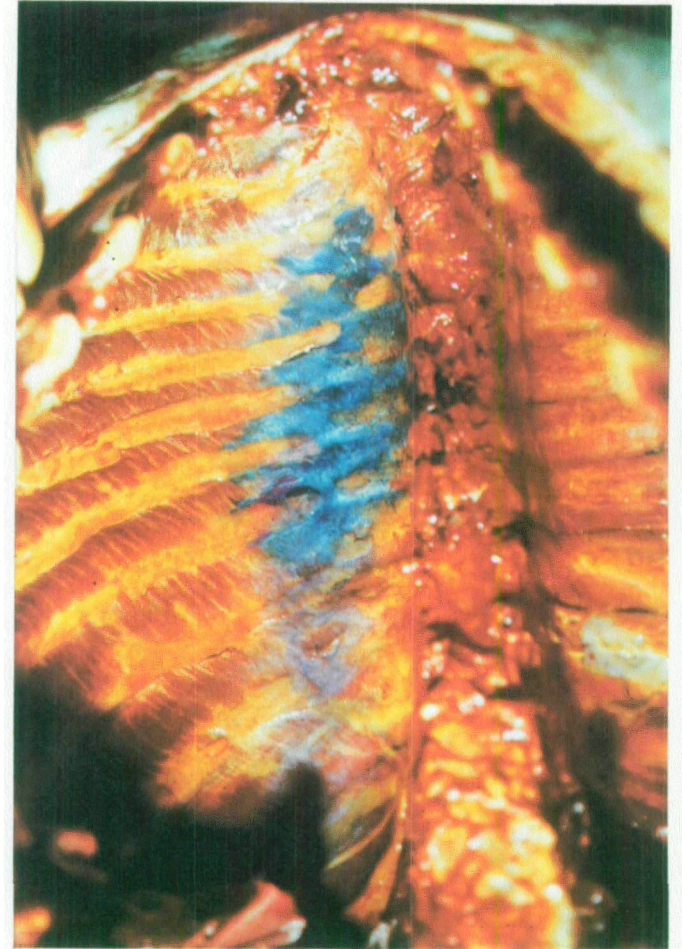
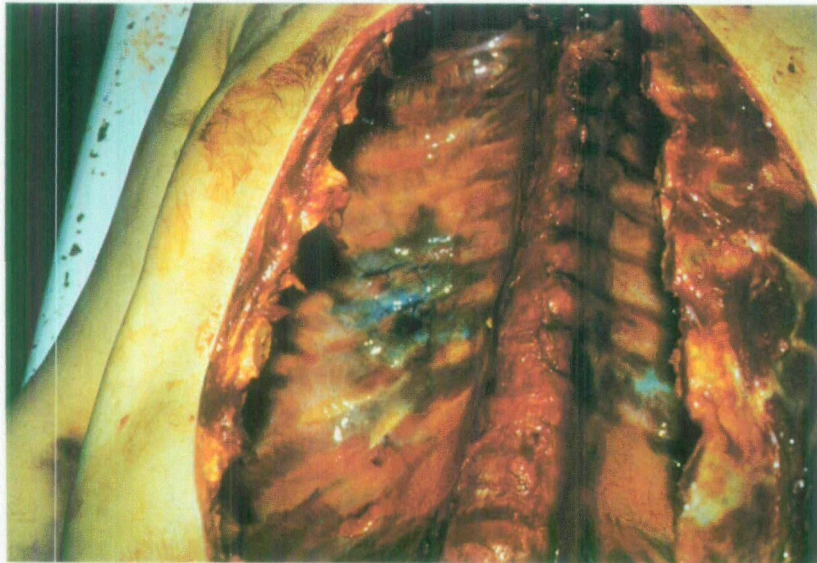
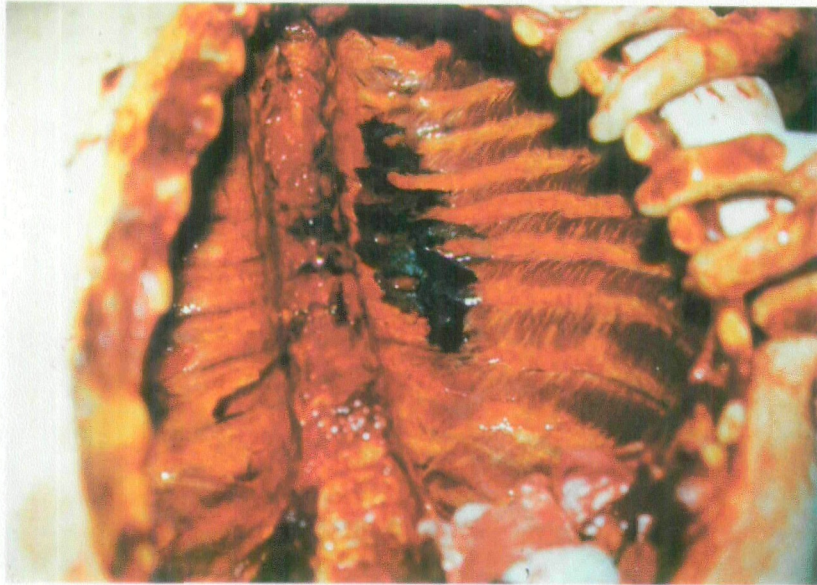
### RESULTS

In all, 24 posterior intercostal spaces were cannulated, in 12 cadavers. In five, the integrity of the parietal pleura was found to be broken following the division of pleural adhesions and removal of the thoracic viscera, with resultant spillage of the dye into the thoracic cavity. In one further case, the catheter was incorrectly placed superficial to the posterior intercostal membrane and the dye could be seen in the muscle and extending medially and laterally in one intercostal plane only.

Figures 1–3 show the typical extent of spread in the remaining cadavers. Dye appeared initially approximately 4 cm from the lateral border of the vertebrae. Thereafter, it spread medially and laterally, cephalad and caudad, and also caused the parietal pleura, under which it appeared, to be lifted anteriorly.

The dye spread at least 2 cm medially in all cases. In half of the cases it reached the paravertebral space.

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**FIG. 1.** (top left) **Case I.** India ink is seen to spread in the subpleural space over six intercostal spaces. It can also be seen leaking over the vertebrae anteriorly, having spread into the paravertebral space from the initial site of injection.

**FIG. 2.** (bottom left) **Case II.** Ink spreading over an indefinite number of intercostal spaces as a result of increased thickening of the parietal pleura.

**FIG. 3.** (above) **Case III.** India ink seen clearly in six interspaces, and some evidence of spread to a further three spaces.

Laterally, the dye spread at least 2 cm and at most 4 cm from its point of initial appearance.

By pushing the parietal pleura forward, the dye was spread easily subpleurally to reach intercostal spaces above and below the one cannulated. In one case, only two intercostal spaces were bathed in dye. In all the other cadavers the intercostal spaces immediately above and below the one cannulated were reached. In four cases the dye extended to include a total of more than five spaces.

It was not possible to assess accurately the extent of spread of the dye in the paravertebral space since, on reaching this space, the dye mixed with blood from the vessels in the paravertebral space and, thereafter, some leaked anteriorly to escape into the thoracic cavity from the point where the visceral pleura had been stripped away.

In time, the dye tended to seep through the pleura without disruption of its architecture.

#### DISCUSSION

Although the anatomy of the chest wall has been well defined, a number of studies on the injection of dye into the intercostal space have been reported recently, with confusing results.

The external intercostal muscle originates from the lower border of the ribs and is inserted to the upper border of the ribs immediately below. The fibres are directed downwards and laterally, originating from the tubercles of the ribs posteriorly to near the costal cartilages anteriorly where they are replaced by an aponeurotic layer: the anterior intercostal membrane. The internal intercostal muscle originates from the floor of the costal groove anteriorly and extends inferiorly and posteriorly as far as the angles of the ribs where it is replaced by the posterior intercostal membrane, an aponeurotic layer which is inserted to the upper border of the ribs immediately below and continues medially as far as the costotransverse ligament.

The innermost muscle layer, the transversus thoracis group, is a thin and incomplete plane of muscle and tendinous fibres and comprises subcostales, intercostales intimi and sternocostalis muscles. The fibres extend in the same direction as the internal intercostal muscle, but may be inserted to the second or third ribs below the one of origin.

Moore, Bush and Scurlock (1980) reported that an injection of blue liquid latex to the intercostal space remained bound to the space injected. Nunn and Slavin (1980), on the other hand, found that India ink could spread from its site of injection to

“pass over the internal aspect of the ribs above and below the space, with a high probability of block of the nerves in these segments”. A further study (Moore, 1981) refuted this statement. A possible explanation for the discrepancy may be that, in Moore's studies, injections of dye may not have pierced the posterior intercostal membrane and were bound by this sturdy structure. This occurred once in the present study and gave rise to tracking of the dye in one intercostal plane only.

The evidence from the present study supports the findings of Nunn and Slavin (1980) and serves to explain the extent of blockade achieved in the earlier clinical study. It is clear that subpleural tracking of local anaesthetic is the main component of this technique. It is not clear to what extent paravertebral spread contributes to the blockade.

The consistency of spread of solution injected to the intercostal space using this technique was borne out by the study.

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#### BLOC CONTINU DU NERF INTERCOSTAL

*Etude anatomique pour élucider son mode d'action*

#### RESUME

De l'encre de Chine a été injectée par des cathéters de péridurale mis en place dans l'espace intercostal postérieur de 12 cadavres secondairement autopsiés et la diffusion de l'encre de Chine qui s'en est suivie a été étudiée à ciel ouvert. L'encre avait diffusé sous la plèvre pour atteindre un certain nombre d'espaces intercostaux et en dedans jusqu'à l'espace paravertébral. Nous en concluons que l'analgesie étendue sur un certain nombre de dermatomes est obtenue par une diffusion sous-pleurale de l'anesthésique local qui atteint des nerfs intercostaux au-dessus et en-dessous de celui initialement visé.

KONTINUIERLICHE  
INTERCOSTALNERVEN-BLOCKADE

*Eine anatomische Studie zur Erhellung  
ihrer Wirkungsweise*

ZUSAMMENFASSUNG

An 12 Leichen wurde während der Autopsie indische Tinte durch Extraduralkatheter injiziert, die in den hinteren Intercostalraum eingeführt worden waren, um die Ausbreitung in diesem Gebiet unter direkter Sicht einzuschätzen. Die Tinte breitete sich subpleural über eine Anzahl von Intercostalräumen und medial bis in den Paravertebralraum hin aus. Durch subpleurale Injektion von Lokalanästhetika kann also über Blockade höher und tiefer als die Injektionsstelle gelegener Intercostalnerven eine Analgesie erzielt werden, die eine Anzahl von Dermatomen umfaßt.

BLOQUEO CONTINUO DEL NERVIO  
INTERCOSTAL

*Un estudio anatómico para elucidar su modo de acción*

SUMARIO

Se inyectó tinta china a través de sondas extradurales colocadas en el espacio intercostal posterior en 12 cadáveres bajo autopsia y se evaluó la diseminación subsecuente de la tinta china por vista directa. La tinta se diseminó subpleuralmente para alcanzar un número de espacios intercostales y medialmente para alcanzar el espacio paravertebral. Se concluye que la analgesia que se extiende sobre un número de dermatomas se hace por vía subpleural que permite al agente anestésico local alcanzar los nervios intercostales encima y debajo del en que se inyectó el agente.