INTERCOSTAL NERVE BLOCK: SPREAD OF INDIA INK INJECTED TO THE RIB'S COSTAL GROOVE

D. C. MOORE

SUMMARY

Three and five millilitres of India ink were injected bilaterally into the costal groove of the 9th or 10th ribs of 14 cadavers. The spread was observed and the costal groove of the rib injected was dissected, with the one above and one below. Nunn and Slavin's study (1980) of similar injections in two cadavers indicated that an injection of one costal groove blocked not only the intercostal nerve of that groove, but at least the one above and below it. The present study verified the author's previous report that only the intercostal nerve in the costal groove of the rib injected is anaesthetized.

Two recent anatomical studies of block of the intercostal nerves have been published (Moore, Bush and Scurlock, 1980; Nunn and Slavin, 1980). Both studies used the same technique of injection and marker solution was injected into the costal grooves of the ribs of two cadavers. Nunn and Slavin (1980) removed the bony rib cages after postmortem, injected 3 ml of India ink at the 6—7 or the 8—9 intercostal space, visualized the spread, fixed the thoracic cages in formalin, decalcified them with formic acid, sectioned them, stained them with haematoxylin and eosin or Masson's stain, mounted them on 5 cm x 5 cm slides, and examined the slides. On the other hand, to simulate as closely as possible the technique of performing an intercostal nerve block under clinical conditions, Moore, Bush and Scurlock (1980) injected 5 ml of blue liquid latex into the costal groove of the 9th or 10th ribs with the cadaver in the prone position. After the viscera had been removed, the spread of the latex was visualized and the tissue dissected away from the intercostal nerves so that the spread of latex could be determined.

Nunn and Slavin observed the India ink to spread to the paravertebral space and "...to pass between ribs and pleura to reach the adjacent intercostal spaces, again passing through the fibers of the intercostalis intimus to reach the triangular compartments (costal grooves in the ribs) and the included nerves within these spaces." They "presumed" that the intercostal nerves of the ribs above and below the one injected had at least a "high probability" of being blocked. Moore, Bush and Scurlock (1980) concluded that only the intercostal nerve of the rib injected was blocked.

Solutions of India ink and blue liquid latex have markedly different consistencies. This may have been the basis for the differences in results reported by Nunn and Slavin (1980) and by Moore, Bush and Scurlock (1980). The present study was undertaken to determine whether this was so.

METHODS

The grooves in the 9th or 10th ribs of 14 cadavers were injected bilaterally with India ink 7.5 cm lateral to the spinous process of the vertebra. The injection was made through a short-bevelled (2 mm) 22-gauge, 3.8-cm needle. The technique of injection was identical to that used in our previous study, except for the following.

In six of the corpses, the method simulated the injection of Nunn and Slavin: that is, the needle, after being advanced 3—4 mm past the caudad edge of the rib and into the costal groove, was fixed in position and the India ink was injected. In the other six, the needle, after being placed in the costal groove, was jiggled 2 mm as the India ink was injected. The latter type of injection was the same as that which has been used by us for bilateral anaesthesia of the lower seven intercostal nerves in more than 12 000 surgical patients for upper intra-abdominal surgery (Moore, 1965).

In 12 cases the injection was performed with the cadaver in the prone position before autopsy. In four of those injected in the prone position, 3 ml of India ink was injected; in another six, 5 ml was injected; in two, 3 ml was injected on one side and
Fig. 1. Injection before postmortem of 3 ml of India ink as the needles were moved forward and backward in the grooves in the 10th ribs. (A) Right side of cadaver after removal of viscera. INK and arrows = spread of ink. P and open arrows = approximate point of injection. (B) Left side of cadaver after removal of viscera shows ink in blood vessels anterior to surface of rib. (C) Dissection of right side of corpse shows no spread of India ink to intercostal grooves of the ribs above or below the one injected. E = cut pleura, subserous fascia, endothoracic fascia, and internal intercostal muscle covering groove of 9th rib reflected cephalad. Note, no ink in these tissues. N-9 = nerve of costal groove of 9th rib. N-11 = nerve of costal groove of 11th rib. a = artery. v = vein (both contain some blood).
Fig. 2. Injection before postmortem of 5 ml of India ink with the needles fixed in the grooves of the 10th rib. (A) Thorax of cadaver after removal of viscera. Endothoracic fascia cut at vertebra and removed from it. S and arrow = spread of ink behind this fascia. P and open arrows = approximate point of injection of India ink. INK and arrows = spread of India ink. F = fat. (a) Dissection of nerves in costal grooves above and below ones in which 5 ml of India ink was injected. N-9 = 9th intercostal nerves (vein above one on left contains small amount of blood). N-11 = 11th intercostal nerves. E = cut pleura, subserous and endothoracic fascia, and internal intercostal muscle below 9th rib which has been reflected caudad from it to expose contents of its groove. The same technique was used to expose contents of the groove of the 11th rib. Note, no ink in muscles. (c) Dissection of the costal groves of the 10th ribs into which India ink was injected. N-10 and arrows = 10th intercostal nerves with forceps under them. Note the extent of the spread of the India ink following dissection of 10th intercostal on left side of cadaver—compare C with B.
5 ml on the other side. Two cadavers were injected
after postmortem (removal of the heart, lungs, great
great vessels, abdominal viscera). These cadavers
were turned first on one side and 3 ml of India ink
injected. They were then turned on the other side
and 5 ml was injected.

In the first 12 cadavers, approximately 90 min
elapsed from the time of injection until the areas of
injection were examined. In the two cadavers with
autopsy before injection, it was possible to visualize
the spread of the India ink in the ribs
injected within 30 s. In all 14 cadavers, the spread
of the India ink was photographed before dissection.

The costal grooves of the ribs injected, and the
ribs above and below them, were dissected and
photographed. In the first cadaver, an attempt to
dissect the grooves of the ribs injected met with
disaster. Not only did the manipulation (lifting of
pleura, the subserous fascia and the endothoracic
fascia with forceps) spread the India ink, but when
these tissues which confined it were opened, the
India ink rapidly diffused over the pleura, staining
the adjacent tissues. Therefore, in the remaining
13 cadavers the costal grooves of the ribs injected
were dissected last.

RESULTS

In all but one side of the 14 cadavers, the spread of
India ink was similar. Spread was the same
whether the needle was fixed in place or moved
forward and backward as the injection was made.
Spread observed 90 min after injection was no
greater than that observed after 30 s.

The India ink had distributed itself as follows.
From the point of injection, it spread in the costal
groove of the rib injected 7.5 cm towards the mid-
line to lie alongside the homologous vertebra, and
it spread 7–8 cm peripherally (fig. 1A, fig. 2A). As
reported by Nunn and Slavin (1980), the ink
entered the internal intercostal muscles below that
rib, remaining under the pleura, the subserous
fascia, and the endothoracic fascia covering that
muscle (fig. 1A, fig. 2A). Contrary to the observa-
tion of Nunn and Slavin (1980), it did not pass over
the rib below the groove injected (fig. 1C, fig. 2B) and it
did not spread into the internal intercostal muscle
above the rib injected (fig. 2B). When dissected,
the intercostal nerves above and below the one
injected showed no evidence of being bathed by
the India ink (fig. 1C, fig. 2B). Exposure of the
nerves in the costal grooves injected showed them
to be completely blackened by India ink (fig. 2C).

Finally, cutting of the endothermal fascia at the
point of adherence to the periosteal covering of the
thoracic vertebrae, as was done when the anterior
portion of the vertebrae were cut off at post-
mortem, confirmed our previous observation that
this fascia confined a solution injected to the costal
grooves (fig. 2A) (Moore, Bush and Scurlock,
1980). Therefore, when a solution reaches the
vertebrae, it spreads only cephalad and caudad
along the posterior half of the sides of the verte-
brae, but not further anteriorly into the preverte-
bral space (fig. 2A).

In one cadaver, and only on one side, some of the
India ink must have entered a vessel in the costal
groove as it was jiggled because the fine network of
vessels under the pleura became visible (fig. 1B).
The vessels of the rib injected appear to communi-
cate with those at least one rib above and below the
one injected.

DISCUSSION

It is difficult to explain why Nunn and Slavin
(1980) observed a different spread of dye from that
found in these 14 cadavers studied here. They used
essentially the same technique of injecting the
groove in the rib as was done in six of the present
specimens in which the needle was fixed in
position as the India ink was injected. They did not
state the length of bevel of the needle. A disposable
needle with a long (4 mm) bevel could account for
distribution of the India ink into more fascial
planes. On the other hand, moving a short-bevel
needle to and fro as the ink was injected should
give the same result as a long-bevel needle fixed in
place. Perhaps in both of the cadavers studied by
Nunn and Slavin, the needles entered blood
vessels, and spreads similar to that observed on
one side of one cadaver in our study resulted (fig.
1B). From our study the chance of this occurring is
one in 28, but it is unlikely that it could escape
from the vessels to bathe the nerves.

India ink can be spread easily and rapidly by
manipulation of, pressure on, lifting of, or cutting
of tissue; this was learned during the dissection of
the 14 cadavers (fig. 2C and B, compare left sides).
Therefore, the removal of the thoracic cage before
injection by Nunn and Slavin (I could not do this
because the bodies were to be embalmed for
burial), its preparation for sectioning, or section-
ing itself, might explain the differences in observa-
tion.
This study confirmed that the optimal site to block the intercostal nerves is at the angle of the rib, not only because the groove in the rib is broadest and deepest at this point, but because the fat which accumulates in the thoracic cage of a well-nourished patient lies over the ribs and anterior to its groove in this area. Therefore, it provides additional protection against pleural puncture (fig. 2A).

ACKNOWLEDGEMENTS

The author acknowledges with appreciation the assistance and co-operation of D. Bauermeister, S. P. Hammar, R. F. Wheelis, S. Patterson and D. Dai, staff physicians of the Department of Pathology of The Mason Clinic and the Virginia Mason Hospital, their two dieners, Harry M. Anderson and James W. Gordon, as well as R. Sundberg, T. Ubben and R. Schlag of the Department of Medical Photography.

REFERENCES


INTERCOSTAL NERVE BLOCK

INTERCOSTAL-NERVENBLOCKIERUNG:
AUSBREITUNG VON TUSCHE, DIE DIE IN DIE
RIPPENRILLEN INJEZIERT WURDE

ZUSAMMENFASSUNG


BLOQUEO DEL NERVO INTERCOSTAL:
DISPERSIÓN DE LA TINTA CHINA INYECTADA A
LA FISURA COSTAL DE LA COSTILLA

SUMARIO

Se inyectaron bilateralmente tres y cinco mililitros de tinta china en la fisura costal de la novena y décima costillas de 14 cadáveres. Se observó la dispersión y se seccionó la fisura costal de la costilla inyectada, junto con la inmediata inferior y la inmediata superior. El estudio de Nunn y de Slavin en 1980 sobre inyecciones similares en dos cadáveres indicó que una inyección en una fisura costal bloqueó no sólo el nervio intercostal de esa fisura, sino también por lo menos el de la inmediata superior y el de la inmediata inferior. El presente estudio verificó el informe previo del autor en el que se declara que sólo se anestesia el nervio intercostal de la fisura costal perteneciente a la costilla inyectada.