RADIOGRAPHIC CONTROL FOR PARAVERTEBRAL INJECTION OF ALCOHOL IN ANGINA PECTORIS*

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(Received for publication November 23, 1943)

Since Mandl (1925) and Swetlow (1926) proposed paravertebral infiltration of the upper thoracic sympathetic ganglia with procaine and alcohol for the relief of intractable angina pectoris, this method has been used with increasing success. With experience it has become apparent that the results are thoroughly satisfactory if the upper three or four thoracic ganglia and their rami are thoroughly impregnated. It must be borne in mind, however, that alcohol, even when injected in 5 cc. amounts, will not diffuse far in the loose areolar tissue between the parietal pleura and the sides of the vertebral bodies. It must therefore be injected within very close proximity to the ganglia in order to be present in sufficient concentration to ensure their destruction.

Three years ago one of us (White, 1940) described an improved technique for placing needles against the sides of the upper four thoracic vertebrae for chemical blocking of the thoracic cardiac nerves,† the sympathetic ganglia, and the white rami communicantes. These structures carry afferent impulses from the heart to the corresponding spinal nerves and from there they run over posterior roots into the spinal cord. This technique has been used in the last 20 patients out of a total series of 76. The results have been satisfactory in 85 per cent of these patients, followed from one to twenty-seven months; 14 of them have had complete relief from their distressing attacks, and 3 have had their former intractable pain so reduced that it could be satisfactorily handled with routine medical methods. There were 2 failures, and 1 patient died of a painless coronary occlusion shortly after the injection. The two failures were due to inaccurate anatomical placement of the needles, especially the upper ones inserted under the first and second ribs. The exact situation of the sclerosing solution was brought out by injecting ½ cc. of lipiodol before removing the needles and checking its position by subsequent x-ray. The radio-opaque oil showed that the injection must have missed the first thoracic ganglion, because the tip of the needle was inserted too far caudally or to an insufficient depth. From a physiological viewpoint,

* This article has been released for publication by the Division of Publications of the Bureau of Medicine and Surgery of the U.S. Navy. The opinions and views set forth are those of the writers and are not to be construed as reflecting the policies of the Navy Department.

† The cervical ganglia do not require blocking, because there are no direct connections between them and the spinal cord. All painful impulses which reach these upper ganglia over the cervical cardiac nerves must descend in the sympathetic chain at least as far as the first thoracic ganglion before they can enter the spinal nerves over the white communicating rami.
failure to destroy the first and second thoracic ganglia was evident, because the patient did not develop vasomotor and sudomotor paralysis of the side of the head and arm and a Horner’s sign. While the latter is not an absolute essential, it has been our experience that satisfactory relief of cardiac pain cannot be counted on unless the hand becomes warm and dry from blocking the vasoconstrictor and sudomotor fibres which also run through these upper thoracic ganglia. The problem of effective cardiac deafferentation by chemical block therefore resolves itself into one of more accurate insertion of the needles, especially the upper two, which are the most difficult to place. While the injection of lipiodol helped us to determine the cause of our failures, it was of no assistance in preventing them.

We have recently discovered that this difficulty can be overcome if a portable x-ray is taken after the needles have been inserted according to the usual technique based on the bony anatomical landmarks (White, 1940). The position of the patient for injection under radiographic control is shown diagrammatically and photographically in Fig. 1, a and b. The film taken in the oblique position shows the relation of the needles to the bodies of the vertebrae. For one who is not thoroughly accustomed to paravertebral injection, the procedure may be carried out in the x-ray department on the fluoroscopic table, so that more frequent visualization of the needles may be obtained in the course of their insertion. In general, however, we prefer to carry out these injections with the patient in his bed and to take the films with a portable apparatus. This obviates the necessity of transferring the patient from the x-ray table back to his bed, a manoeuvre which may shift the position of the alcohol and cause severe pleural pain. One or, at most, two lateral oblique films should be all that are necessary to ascertain that the tips of the needles have been placed in contact with the sides of the appropriate vertebrae and inserted to the depth of the sympathetic chain, a posi-

Fig. 1a. Diagrammatic view of patient in bed with needles inserted against the sides of the upper four thoracic vertebrae, to show position of x-ray tube and cassette. These injections are done on the side to which the pain is referred. In angina pectoris a left-sided injection is done for pain referred to the left arm and precordium. However, the injection must often be made bilaterally in two separate stages, and occasionally a right-sided injection is required for pure right-sided pain.
tion which ensures a chemical barrage between the ganglionated sympathetic chain and the heart anteriorly, as well as the spinal nerves posteriorly. No film from another angle is necessary, because the needle tips are always kept in contact with bone.

Fig. 2. Oblique x-ray to show position of ganglionated sympathetic chain in upper thorax in a cadaver. The position of the inferior cervical ganglion is marked by the loop in the wire and the upper two metal clips. That of the succeeding five thoracic ganglia is shown by the lower clips. Note that the first thoracic ganglion lies nearly at the anterior edge of the corresponding vertebra.
FIG. 3. Oblique x-ray to show position of needles taken during an actual paravertebral injection. This patient developed a striking Horner's sign and a hot, dry hand, as proof of the effective impregnation of the upper ganglia. The tips of the two upper needles would have been in even closer contact with the ganglia if they had been inserted a centimeter deeper.

The position of the ganglionated sympathetic chain is shown in Fig. 2. This x-ray was made from a cadaver in which the position of the sympathetic trunk was marked by a metal wire and the ganglia by dural clips. By comparing this view with Fig. 3, made in the course of an actual paravertebral injection, a good idea is given of the depth to which the needles must be in-

FIG. 4. Oblique x-ray taken after preliminary insertion of needles. This illustrates a common cause of failure to impregnate the first thoracic ganglion. The uppermost needle has been inserted pointing too far caudalwards, so that its tip, instead of being in contact with the side of the first thoracic vertebra, is touching the lower edge of the second.
serted to ensure the maximum concentration of procaine and alcohol around the upper four thoracic ganglia and their cardiac rami. The first and second thoracic ganglia lie nearly at the anterior edge of the corresponding vertebral bodies. Fig. 4 illustrates a frequent cause of failure to block the important first thoracic ganglion. Due to the moderate kyphosis of the upper thoracic spine, the operator tends to insert the upper two needles in an increasingly caudal direction and, because 7 to 8 cm. of the 10 cm. needle lies hidden beneath the skin, it is hard to realize that the tip of the first may actually be placed caudal to the second. In this case no alcohol will reach the first thoracic ganglion, and the relief of angina pectoris will often be incomplete. We believe that this accounts for the frequent failure to obtain a definite Horner’s sign, and that it is of great importance to make sure that the shafts of all four needles lie parallel to one another. Such a mistake will be brought out clearly and the error prevented if the position of the needles is checked radiographically prior to injection.

In the patient in whom the position of the needles was first checked in this way, difficulty had been encountered in producing the characteristic signs of a successful blocking of the upper two thoracic ganglia with the small quantity (2 cc.) of procaine that we regularly inject as a clinical test of the accurate placement of the needles. The x-ray shows that the uppermost needle had been inserted too far caudalwards, and that its tip had completely missed the first and was touching the lower edge of the second thoracic vertebra (as shown in Fig. 4). After removal and reinsertion of this needle in a more cephalad position, it came to lie in the proper position against the body of the first thoracic vertebra (Fig. 3). This film also shows that the tips of the needles had been pushed well forward on the bodies of the vertebrae, although an additional 5 to 10 mm. would have been even more effective in laying down a chemical barrage between the ganglionated sympathetic chain and the heart. The patient developed a striking Horner’s sign and remained free of precordial and arm pain. He died painlessly of coronary infarction three months later.

We believe that this simple method of checking the position of the needles by x-ray will be a distinct aid in the accuracy of paravertebral injection for the chemical destruction of the cardiac sensory axons.

We wish to express our indebtedness and sincere thanks to Dr. G. W. Holmes, Acting Chief of the X-ray Department, and to Mr. O. E. Merrill, who has taken these portable films.

REFERENCES