Iodinated Organic Compounds
as Contrast Media for Radiographic Diagnoses

IV. Pantopaque Myelography

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Since the introduction of Pantopaque in 1941 as a diagnostic aid in contrast myelography (1), 150 Pantopaque myelograms have been made at Strong Memorial and Rochester Municipal Hospitals. The fluidity of the new medium has greatly simplified myelography, and, through this property, the results obtained in the demonstration and study of minimal and maximal defects of the subarachnoid space have been especially satisfactory. Analysis of the results shows that the accuracy of Pantopaque myelography, based on cases that have come to operation, is 95 per cent. Errors both in the use of the medium and in the radiological interpretation appear to be due more to subjective factors than to Pantopaque itself; thus, in the series reported here, most of the errors occurred among the first 50 cases. Since personnel of varied degrees of experience was involved, these errors probably represent the training period required to obtain high accuracy.

**MYELOGRAPHY WITH PANTOPAQUE**

Pantopaque is particularly satisfactory in contrast myelography of the lumbar and cervical regions of the spine. The series reported here, however, includes so few cervical myelograms that the discussion will be limited to the lumbar region.

To reduce the excretory load on the body to a minimum, Pantopaque should always be removed from the spinal canal after the examination has been completed. This goal is easily accomplished by the procedure of Kubik and Hampton (2) provided a satisfactory mid-line puncture is made for the injection of the medium. With a good mid-line puncture the examination, including injection and removal, usually may be completed within fifteen to twenty minutes.

**Position of Patient:** The patient is placed prone on a tilting fluoroscopy table with the head turned to either side. The hands grasp the edge of the table top at the level of the shoulders so that they will be out of the way, and so that the patient can steady himself during the examination. A small pillow is placed under the lower portion of the abdomen in order to straighten the lumbar curve moderately. The feet are placed firmly against the footrest of the tilt table.

**Injection of Pantopaque:** Sterile precautions should be employed as in a routine lumbar puncture. The injection is made in the mid-line, usually between the third and fourth lumbar spinous processes. If a lesion is suspected at that level, however, the interval above or below (preferably below) should be selected. If injection in the lumbar subarachnoid space is not feasible, cisternal injection may be employed. After the skin and the subcutaneous tissues have been anesthetized by infiltration with procaine, an 18- or 20-gauge needle, preferably with a short bevel, is introduced into the subarachnoid space. After the ligamentum flavum has been encountered, the needle is inserted gradually, with great care. When the operator is certain that the needle has entered the subarachnoid space, the stilette is removed, and 3 to 5 c.c. of spinal fluid is aspirated and collected for protein determination. A previously prepared 5-c.c. syringe containing 3 c.c. of Pantopaque is then secured to the adaptor of the needle.
and the contrast medium is slowly injected. This should be accomplished easily; if marked resistance is encountered, the exact position of the needle should be checked. When the Pantopaque has been introduced into the subarachnoid space, the syringe is detached from the needle and the silhouette is replaced. A sterile gauze dressing is then placed over the needle and the patient is ready for the examination.

**Fluoroscopy and Roentgenography:** After the examiners have become dark-adapted, a fluoroscopic examination is made. The Pantopaque should be seen pooled in the middle lumbar region and near the point of the needle. Normal landmarks are then determined so that each interspace may be recognized on examination. A marker is applied to the back of the patient to label and to lateralize the films. Should the amount of injected Pantopaque prove to be too small, because of a large subarachnoid space, an additional 3 c.c. should be injected. The foot of the tilt table is first lowered gradually, and the flow of the column of Pantopaque is studied carefully. When the Pantopaque has collected in the terminal portion of the subarachnoid space, the table is then tilted slowly in the opposite direction, and the flow of the medium is again observed. To prevent the Pantopaque from passing into the cranial ventricles, where it may be immobilized, or from flowing too rapidly over the lumbar curve, which may lead to globulation, the examiners should avoid lowering the head of the patient too rapidly. These maneuvers may be repeated until a satisfactory examination has been completed. Sometimes it may be desirable to roll the patient from side to side in order to study each root adequately.

During fluoroscopy the movement of the image of the column of Pantopaque is observed closely for deviations in flow. If the image is indented, or if the flow of the column is partially or completely arrested, the behavior of the Pantopaque in the region of the vertebral column in which the defect occurs is carefully studied. Postero-anterior roentgenograms are taken routinely to demonstrate the third, fourth, and fifth lumbar intervertebral disk spaces. To demonstrate medially located lesions, the postero-anterior views may be supplemented with lateral and lateral-posterior roentgenograms. Defects demonstrated must be constant, and there must be agreement among the observers as to their presence before concluding the examination. Average technical factors that may be employed for the spot films are as follows: distance, 25 inches; kv. p., 85; ma., 100; time, 1/10 to 3/10 second, depending on the thickness of the patient. The area under investigation is diaphragmed as closely as possible to provide the maximum contrast possible. For the lateral and lateral-posterior views a Potter-Bucky diaphragm should be employed. It is essential that the fluoroscopic table be equipped with an efficient apparatus that permits rapid switching from fluoroscopy to roentgenography.

**Removal of Pantopaque:** At the completion of the examination, the Pantopaque is collected around the tip of the needle under fluoroscopic visualization and aspirated by means of an empty sterile syringe attached to the lumbar puncture needle. It is usually possible to remove 80 or 90 per cent of the injected Pantopaque without difficulty, but success in removing all the medium is determined usually by the accuracy with which the mid-line puncture was made. The amount removed can be identified in the barrel of the syringe, where it forms a layer under the spinal fluid simultaneously aspirated. Sometimes it is necessary during aspiration to turn the needle gently when its bevel becomes blocked by a nerve root or a meningeal margin. Occasionally the medium must be maneuvered under the tip of the needle two or three times under fluoroscopic visualization before all of it can be removed. In rare instances all these procedures are unsatisfactory, in which case the simplest practice is usually to make another lumbar puncture at a lower level, for example between L5 and SI. At all events, before removing the needle a roentgenogram should be taken.
after aspiration to check conclusively how much Pantopaque has been removed. After processing this final film, the needle is withdrawn and a sterile dressing is applied. A normal Pantopaque myelogram with complete removal of the medium is reproduced in Figure 1.

After-Care of the Patient: The patient may be permitted to move himself from the fluoroscopic table to his bed, but the same precautions are taken as after a routine lumbar puncture. The patient is kept flat on his back for six to twenty-four hours. If the examination has been carefully done, there should be little discomfort. When the contrast medium is not removed, an occasional patient may experience transient symptomatic abnormalities consisting of some muscular aching, headache, slight paresthesia in the lower extremities, and infrequently slight temperature elevation. Such symptoms may last twenty-four to thirty-six hours. No sequelae have been observed.

**Contraindications:** Pantopaque should not be injected where a lumbar puncture is contraindicated, nor within ten days of a previous lumbar puncture. The latter precaution is necessary to avoid subdural and extra-arachnoid extravasations.

**Analysis of Results**

Of this series of 150 cases examined by Pantopaque myelography, 97 were surgically explored. In 5 cases the operative findings were at variance with the radiological interpretations, giving a diagnostic accuracy of 95 per cent in this group. Four of the errors occurred among the first 50 cases. In 2 of the cases erroneously diagnosed defects were found radiologically at L4, but in neither was a lesion discovered at operation. In both instances it is possible that the exploration may have been incomplete, since the defects were prominent on the myelograms. The other 3 cases were interpreted as normal on the basis of the radiological findings. Two of these patients proved to have herniated disks at L5, and the third to have syringomyelia.

Review of the roentgenograms of the cases with disks at L5 showed that the interpretations were too cautious. The error in the third case may be attributed to faulty technic, since the fluoroscopic notes contained a reference to a delay of the movement of the Pantopaque column at C6.

In the 53 cases which were not explored, clinical and radiological evidence disagreed in only 2 instances. In each of these cases the clinical findings pointed to a herniated intervertebral disk, but in neither did the myelograms confirm this impression. Although herniated intervertebral disks were diagnosed both clinically and radiologically in about half of the remaining cases, operation was performed in none. Subsequent follow-up of this group, and of the group with negative diagnoses, should be valuable both clinically and diagnostically.

**Minimal and Maximal Defects**

The reproductions in Figures 2 and 3 of two myelograms from the series of 150 serve to illustrate the value of the fluidity...
of Pantopaque in contrast myelography. In the first case (Fig. 2) there is a minimal defect with an absent root. Defects of this type are easily shown with Pantopaque, although such a lesion is seen more clearly on the roentgenogram than during fluoroscopy. For this reason it is desirable to

process the films during the course of the examination, so that it will not be necessary to repeat the injection and removal of the medium should the results be equivocal. In the second case (Fig. 3) a rather unusual multiple defect is shown in the myelogram. Here, too, the fluidity of Pantopaque is responsible for the result. These illustrations serve to emphasize that the extremes are usually the most difficult defects to demonstrate accurately. Defects intermediate in size are readily recognized both during fluoroscopy and roentgenographically. Complete obstructions, particularly those at L5, are frequently difficult to differentiate from congenital variations of the sac in this area. In this connection, the studies of Horwitz (3) on the anatomical variations of the lower lumbar and sacral regions show that the termination of the caudal canal varies greatly from individual to individual. In those cases where a high termination of the lumbar sac is seen during fluoroscopy, a roentgenogram should be taken with the patient in a nearly erect position. The differentiation between a high termination and a block can be determined usually from the film. A high termination will show a tapering of the lumbar sac with the sacral root sleeves clearly evident, whereas a block will present an abrupt transverse cut-off of the Pantopaque column.

Fig. 2. Minimal defect with absent root at L4.

Fig. 3. Multiple defects at L3 and L4.
DISCUSSION

When Pantopaque was developed (1), an absorbable medium was the goal. Subsequent experience has shown that the fluid character of the new medium is an equally valuable property. Because of the fluidity of Pantopaque, myelography may be carried out rapidly and with great accuracy, as is shown in this series. Similar conclusions have been reached by Spurling and Thompson (4) and by Bradford (5). Detailed discussion of the types of defects seen on the myelograms is unnecessary, since they are essentially the same as those obtained by the more viscous iodized oils. These defects have been well described by Hampton and Robinson (6), Camp (7), Robinson (8), and Hyndman, Steindler, and Wolkin (9), and have been summarized by Bradford and Spurling (10).

Although the fluidity of Pantopaque is regarded usually as an asset, it has been cited by Pugh (11) as a disadvantage, in that the medium flows too easily and may globulate as it passes over the lumbar curve. In the series discussed in this paper, globulation has been uncommon and, where it has occurred, the globules could be reunited easily. The same experience has been reported by Hyndman, Steindler and Wolkin (9).

In spite of an extended experience with Pantopaque over a period of three years, the rate of absorption of the medium in man cannot be given with any exactness. If the conditions within the spinal canal are such that a marked degree of globulation of the residual Pantopaque occurs, or if the medium is spread over a large surface, the rate of absorption in man appears to approach the rate of 3 c.c. per year that was noted in dogs (1). On the other hand, when the medium is contained in the caudaequina region, the rate of absorption is so slow that it may be of the order of 0.5 to 1.0 c.c. per year. Provisionally, the rate of absorption may be set at 1 c.c. per year. Observations by several groups, particularly by Wyatt and Spurling (12), confirm this value.

SUMMARY

The results in 150 cases of Pantopaque myelography show that use of the new medium simplifies the procedure and leads to high accuracy. The technic of lumbar myelography is described in detail.

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REFERENCES


