Pantopaque Myelography: Diagnostic Errors and Review of Cases

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Numerous articles dealing with the use of Pantopaque in myelography have appeared in the medical literature in the past three years. While the more typical myelographic pictures due to rupture of the nucleus pulposus are easily recognizable, one occasionally encounters bizarre patterns whose interpretation is difficult. We wish to present some of these unusual patterns, to discuss common sources of error in diagnosis, and to review 215 Pantopaque myelograms. Of the 215 cases examined, 69 came to operation, and the myelographic findings will be compared with the preoperative diagnosis.

TECHNIC

Site of Injection: In myelography for detection of a protruded disk in the lumbar region, the needle should not be introduced at the level of the suspected protrusion, since removal of the oil may be more difficult and defects due to the needle may resemble those due to a protruded disk. If we encounter a defect at the site of introduction of the needle, it is our practice to remove it, continue the fluoroscopic and radiographic examination, and then re-insert the needle for withdrawal of the oil. (See Figs. 9 and 10.)

Fluoroscopic Study: Careful fluoroscopic observation is just as essential in Pantopaque myelography as in examination of the gastro-intestinal tract. Slowing of the oil column, its passage over an apparent partial obstruction or hump, and study of the side on which the narrowed column of oil ascends or descends are all valuable in forming final conclusions (Fig. 3, B). All studies are carried out jointly by members of the neurosurgical and roentgenologic staffs. Spot films are made as indicated; it is our usual practice to make two exposures of each level where the oil is observed, to check the constancy of defects.

Equipment: The ideal table for fluoroscopic use is one which permits at least a 40° tilt in the reverse Trendelenburg position and full upright tilt. A limited range of excursion may be remedied by removing the curved head from the bottom of the table, substituting protective side panels, and installing a shock-proof fluoroscopic tube with cables. This will usually permit from 20 to 30° additional tilt toward the head. The gears on the average table are not constructed to permit this. Additional spacings may be cut in the ones already supplied.

Spot-Film Device: While any spot-film device permitting rapid exposures may be used, we prefer to use one which provides two exposures on one 8 × 10-in. film. Our device embodies a quick change switch from fluoroscopic to radiographic current and was locally constructed. Any such device must be provided with a protective brace which will prevent the screen and spot-film device from falling on the spinal puncture needle. Figure 13 shows such a device with a protective support. This support is readily adjustable for patients of varying thickness.

Amount of Oil Used: The amount of Pantopaque customarily employed is 3 c.c. Recently, we have used 5 and 6 c.c. in several instances. We believe that the additional amount is of advantage (1) for better filling of what is apparently a narrowed canal, (2) for better filling of the caudal sac, and (3) for the simultaneous visualization of several interspaces (Fig. 12).

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Fig. 1. Extra-arachnoid escape of oil.  
A. Oil injected in arachnoid space with beginning escape along nerve roots. 
B. Wide distribution of oil along nerve sheaths, with patient in vertical position. 
C. Film two weeks later, showing oil along course of sacral and sciatic nerves. 
D. Repeat myelogram showing disk defect at L4-5 left. Confirmed.
Fig. 2. Oil injection following easy aspiration of spinal fluid. A. Oil apparently in arachnoid space at L3-4, but extra-arachnoid oil in two parallel columns with escape laterally at D11-12 and D12-L1. B. Lateral view, showing extra-arachnoid distribution of oil. Oil beneath needle point is also extra-arachnoid. C. Film nine days later, showing distribution of oil along nerve roots with some absorption. D. Repeat myelogram, showing defect at L3-S1 left. Interpreted as disk defect, but found to be due to dilated veins.
Fig. 3. A. Oil in arachnoid space and along 4th and 5th lumbar roots, left. B. Film one week later. Oil in arachnoid space has been aspirated but escaped oil remains along nerve roots.

INTERPRETATION

At this hospital myelographic reports are given by the roentgenologic service on the basis of the findings on fluoroscopic and film examination alone. These reports are then correlated with the history and clinical findings, with special reference to neurological manifestations, at a joint conference between members of the roentgenologic and neurosurgical services. Review of the history and physical findings prior to the myelography may bias the opinion of the roentgenologist. In the summary of the cases to be presented later in this article, discrepancies will be noted between the diagnoses of the roentgenologic staff, the clinical opinion of the neurosurgeon, and the operative findings. In many instances the roentgenologic service has made a report in which certain defects in the oil column or filling of the root sleeves were noted. The statement is often made: "These findings are suspicious of ruptured disk, but correlation with the clinical findings will be necessary for a final diagnosis." Such a report is rendered not in a spirit of evasion but with the feeling that only by the correlation of all available evidence can a definite diagnosis be reached in many instances. The roentgenologic reports are made by various members of the staff, with varying experience in Pantopaque myelography. It is therefore felt that the findings described in this report may be somewhat typical of those in the average Army hospital, and may approach results achieved by different examiners in civilian practice.

SOURCES OF ERROR

Extra-Arachnoid Injection of Oil: Injection of oil outside the arachnoid space has occurred in the hands of members of the neurosurgical staff with varying amounts of experience. When one considers the small distance between the subarachnoid space and the subdural space, it is not surprising that extra-arachnoid injection of oil may very easily occur. In many
instances the oil has been seen to escape into the subdural and extradural spaces even though spinal fluid was withdrawn without difficulty and no bleeding was encountered. The pattern produced by injection of oil outside the arachnoid space varies widely. In some instances it is represented by two parallel columns of oil with an unfilled center, somewhat similar to the pattern found in intramedullary tumors (Fig. 2). In other instances the oil has been seen to escape through the foraminae and apparently along the course of the lumbar and sacral nerves immediately after injection (Fig. 3). This rapid escape of oil along the nerve roots seems to indicate passage through pre-existing channels rather than slow migration by way of the lymphatics.

One must recognize the patterns produced by subdural and epidural injection of oil in order that a false diagnosis of tumor, arachnoiditis, etc., will not be made. Oil injected in the 4th lumbar interspace often rapidly reaches the lower thoracic region, as illustrated in Figure 1, A.

It would appear that the extent of the arachnoid spaces and the dural sheaths outside the spinal canal is quite variable, if one is to judge by the manner in which oil is occasionally found distributed. Further study is indicated to determine the extent of the arachnoid and dura outside the vertebral canal. We have attempted to study this space by injection of oil in the subdural space at autopsy, but the findings to date are somewhat inconclusive, and it is planned to conduct further investigation along this line.

*Centrally Protruded Disk:* Central pro-
Fig. 5. A. Apparent complete division of oil column. Clinical symptoms of paraplegia suggesting cauda equina tumor. Large ruptured disk found at operation. B. Same case showing oil trickling through on right and joining two oil masses.
C. Block at L3-4 with feathered lower border of oil column. Long history suggesting cauda equina tumor.
D. Oblique view of same case. Operation disclosed large ruptured disk and localized arachnoiditis.
Fig. 6. A. Narrow canal with lateral defects at L3-4 and L4-5, with obliteration of root sleeves. B. Oblique view, showing defects at L3-4 and L4-5. Operation revealed protruded disks at both interspaces, with root compression.

...trusion of the disk may fail to produce any lateral deformities of the oil column, but the column may appear to be thinned overlying the disk. This fact has been ably discussed by Copleman (3) and more recently by Soule, Gross, and Irving (8). Our experience is in accord with theirs.

Arachnoid Block: French and Payne (6) reported eight cases with cauda equina injury and complete blockage in association with ruptured intervertebral disks. We have observed two such cases in our series. Distinction from tumor may not be easy. In one case, in addition to a protruded disk there was a localized arachnoiditis (Fig. 5, C and D).

Varices: The myelographic pattern of varices of the cord has been described by several writers. We have observed two cases of very definite lateral defects of the central oil column produced by varices. Further study of the films has shown linear extensions of the deformity into the central oil column, which are not usually noted in the presence of a protruded disk. Whenever this pattern is encountered, one should be suspicious of the presence of varices, although the coexistence of a ruptured disk or tumor cannot be ruled out (Fig. 4).

Adhesions: We have had occasion to do myelography on patients from whom a ruptured disk had previously been removed, who had symptoms suggestive of recurrence. The myelograms showed irregular deformity of the oil column. At operation, extensive scar tissue was found, producing pressure on the nerve roots, but no recurrent disk rupture. These cases present one of the most difficult diagnostic problems.

Epidural Abscess: Figure 11 shows a rather unusual myelographic pattern obtained in a patient who had previously had a disk removed elsewhere. It was felt that a portion of the oil might lie epidurally, or that there might be extensive arachnoiditis or scarring following surgery. Operation disclosed an epidural abscess.

Narrow Oil Column: As has been men-
tioned by Camp (2), Soule et al. (8), Arbuckle, Shelden, and Pudenz (1), if the oil column is less than 16 mm. in width, the protruded disk may not produce any defect demonstrable in the myelogram. We again wish to call attention to the advisability of using a large amount of oil to fill out what is apparently a narrow arachnoid space where this condition is encountered.

**Non-Filling or Incomplete Filling of the Root Sleeves:** The filling of root sleeves by Pantopaque is so variable that we do not feel that a definite diagnosis can be based upon non-filling alone. However, good filling on one side, associated with poor filling on the other, or absence of filling, constitutes evidence suspicious of a ruptured disk. In cases where one root sleeve at a certain level filled well and the opposite one did not fill well, we have found that, if the patient was placed in a lateral position with the unfilled side down, it could often be satisfactorily filled. Fail-

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*Fig. 7.* Narrow canal with shallow lateral defect at L5-S1 right. Large ruptured disk found at operation.

*Fig. 8.* A. Notching of oil column on right at L3-4. Obvious needle defect. B. Same case, with deflection of oil column to left by ruptured disk at L5-S1 right. Confirmed at operation.
ure to use this maneuver may result in false impressions. Epstein (5) called attention to the use of the Valsalva maneuver in the attempt to force oil into the root sleeves. We have not found this uniformly successful. While it was used routinely in several cases, it has now been abandoned. As mentioned by Scott and Furlow (7), however, the Valsalva maneuver (expiration with glottis closed) does provide a usually painless method of expelling the oil through the lumbar puncture needle after the examination is completed. This method is somewhat slower, as a rule, than aspiration, but it is more comfortable for the patient and is often just as effective. We usually attempt aspiration and, if that is not successful, resort to the Valsalva maneuver or have the patient cough several times.

In reference to technic and interpretation, we wish to emphasize that films of good diagnostic quality are just as important in myelography as in any other roentgenologic study. Only by having films of good detail and sufficient contrast to show various oil densities can one obtain the maximum amount of information from the radiographs. A procedure such as myelography, which involves preoperative preparation, spinal puncture, probable headache after spinal puncture, and effort and time on the part of the neurosurgeon and radiologist, should not be jeopardized by technically poor films.

REVIEW OF CASES

There were 215 instances in which the history, signs, and symptoms of a ruptured nucleus pulposus were such that the neurosurgical staff felt that myelography was indicated. In 107 patients the x-ray findings confirmed the clinical impression and showed changes compatible with a rup-
tured intervertebral disk. There were also 8 instances in which an abnormal myelogram could not be considered characteristic of a ruptured disk. This group will be discussed later.

Of the 107 patients with positive myelograms, 57 (53 per cent) were operated upon. Of these 57 patients, 51 (89.4 per cent) showed a disk lesion at operation. Six patients (10.6 per cent) had negative explorations. Nine patients with negative x-ray findings were operated upon, because of what seemed to be classical clinical findings of a ruptured disk. In 5 (56 per cent) of these 9 patients, the findings on exploration were negative, while 4 (44 per cent) were found to have a definite rupture of the nucleus pulposus.

It may be considered somewhat unusual that such a small proportion of this group were subjected to surgery. This fact may be explained by the conservative point of view taken both by the Army Medical Department and this Neurosurgical Center as to the indications for surgical therapy of this condition in military personnel. Many patients in spite of positive findings, both clinical and roentgenologic, showed minimal disability and could be returned either to limited duty in the Army or to their civilian occupations without operative treatment.

The 8 abnormal myelograms mentioned above, which could not be considered characteristic of a ruptured disk, may be considered briefly. These were divided in respect to the x-ray diagnosis as follows:

- Myelograms suspicious of ruptured disk but needing clinical confirmation: 3
- Arachnoiditis: 1
Postoperative scar tissue ........................ 1
Unsatisfactory, because of extra-
arachnoid oil ..................................... 1
Multiple filling defects, cause un-
known .............................................. 1
Block ........................................... 1

Of the 8 patients, 3 came to operation. In the case labeled “postoperative scar
tissue” a recurrent disk was found. The one diagnosed simply as “block” showed a
small epidural abscess, and the one con-
sidered as “roentgenologically suspicious
of a disk but needing clinical confirma-
tion” showed a ruptured disk.

SUMMARY AND CONCLUSIONS
1. A study has been made of 215 con-
secutive lumbar myelograms in order to
determine the sources of diagnostic error.
Some of the errors are described and illus-
trated.
2. The technic of myelography is briefly
reviewed, with suggestions as to appara-
tus to be employed.
3. The diagnostic and operative statis-

ducted at L3-S1 with 3 c.c. of oil. B. Same case with 6 c.c. of oil, showing
left root sleeve filled, but shorter than the right. Normal myelogram. No operation.
Fig. 13. A. Spot film device used in myelography and gastro-intestinal examinations, showing one half of 8 X 10-inch cassette ready for exposure. 1. Bar with ring used to return cassette to fluoroscopic position and close fluoroscopic switch setting. 2. Trip lever used to throw half of cassette in radiographic position and close radiographic switch. 3. Lever to throw second half of cassette in radiographic position.

B. Adjustable bracket to support fluoroscopic arm. Threaded bolt permits varying height of spot-film device for patients of different thicknesses.

tics in this group have been briefly summarized.

4. The roentgenologic interpretations were made by several observers and are believed to represent a fair cross section of such interpretations in Army hospitals.

5. We wish to emphasize the necessity of close correlation of the clinical and roentgenologic findings.

BIBLIOGRAPHY


