Upright Large Volume Dynamic Myelography

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The usual Pantopaque myelographic study, employing 6 or 9 c.c. of contrast material with the patient prone, in oblique and lateral projection, has long been recognized as inadequate in certain types of cases. Patients with undeniable neurologic changes in the lower extremities have too frequently been declared free from evidence of pathology because the opaque myelographic study failed to reveal the defect.

The neural canal is a three-dimensional structure and therefore possesses a posterior surface as well as anterior and lateral margins. Pantopaque, being heavier than the spinal fluid, settles to the most dependent areas, which, when the patient is in prone position, are along the anterior surface. In some instances, a lateral radiograph taken across the table will show some of the posterior surface outlines, but this is not so in every case.

The spine is a dynamic structure and the configuration of the spinal canal changes with bending. It is to be expected that, when the spine is carrying weight, certain pressures may develop that may disappear when the weight is removed.

Patients with increased lumbar lordosis frequently suffer low-back pain and pain in the legs upon becoming fatigued. Many observers beside ourselves have long suspected that these symptoms arise from actual pathological changes that we have failed to demonstrate because we did not visualize the neural canal in all of its three dimensions. Grayson and Black (4), as well as many others (1, 2, 6), recognized these deficiencies and made considerable progress towards eliminating them by increasing the amount of contrast substance in order to fill the subarachnoid space more completely. The effect of motion upon the contours of the canal was considered by Bell et al. (1) and Briere and Colcough (2), who instituted large-volume studies with weight-bearing. Attempts were made to visualize disk lesions after bending movements, but it is our understanding that the bending was done prior to radiography and was not maintained during film exposure.

Having encountered numerous baffling failures in demonstrating lesions that we knew must be present, we have attempted to combine various factors needed to visualize all the surfaces of the canal with the patient in prone, oblique, and upright weight-bearing positions, together with upright lateral projections taken with the spine in flexion and in extension. It is our practice to employ this technic with patients who display definite cauda equina type symptoms that can be supported by the history and physical findings. Included in this group are those who have obtained a solid surgical fusion of L-4, L-5 and the sacrum without relief of symptoms and at times with an increase in neurological deficit. Also included are those in whom fusion is not solid and symptoms persist. Neurologic examination of this group demonstrates evidence suggestive of some mechanical impingement upon the cauda equina, either constant or intermittent. We have found that it is worthwhile also to check those patients with persisting symptoms in whom adequate evidence was not obtained by the use of routine prone Pantopaque studies.

It is our practice to give the patient a mild sedative prior to bringing him to the x-ray department. We have found that 1 grain of codeine plus 1 grain of Luminal Sodium, hypodermically, produces satisfactory relaxation. The lower extremities are wrapped with elastic tensor bandages to minimize the danger of vascular hypo-
tension when a change is made from prone to upright position.

The patient is placed prone upon the radiographic table with the footboard securely in place. With the usual surgical precautions as to skin sterilization, draping, etc., the spinal puncture is made. For this we prefer an 18-gauge needle. In order to avoid needle artefact in the region under investigation, the puncture is made at a level above that of the suspected lesion, if possible. In no instance, however, should it be high enough to contact the conus medullaris. Following puncture, the usual tests of spinal fluid dynamics are carried out.

We prefer to observe the entrance of the first few drops of Pantopaque under the fluoroscope to make sure that the needle is adequately placed in the subarachnoid space. Satisfactory protection of the operator from radiation is provided by a small-lumen rubber or polyethylene tube approximately 16 inches in length, which transmits the Pantopaque from the syringe to the needle. With the patient’s head somewhat elevated, the first few drops of contrast substance are observed to enter the subarachnoid space. If all is satisfactory, the x-ray is turned off and the rest of the medium is instilled under usual light. After replacing the stylet in the needle, prone, oblique, and lateral studies are carried out.

If a large-volume dynamic study is indicated, a 12-c.c. ampule is opened and the Pantopaque is slowly added through the needle. The contrast level is checked from time to time by slowly raising the table until the patient is in a near-standing position. When the injection is adequate, the stylet is replaced in the needle, which remains in situ, and the patient is redraped, care being taken that the drapes are secure enough to remain in place in the upright position. If additional postero-anterior or oblique film studies seem desirable, they can be made at this time.

The table, equipped with Bucky diaphragm, is slowly elevated to vertical

A. Upright dynamic myelogram (15 c.c.), May 1, 1958, with spine flexed.

B. Upright dynamic myelogram (15 c.c.), May 1, 1958, with spine hyperextended.


position, which brings the patient to a standing position on the footboard. A tall stool is placed behind him and, properly assisted, he seats himself upon it. The footboard is then removed from the table and the stool is rotated to bring him into a true lateral position. An 11 X 14-inch cassette is placed in the Bucky tray and the x-ray tube is positioned at 40-inch tube-film distance. The patient now bends forward as far as possible in order to flex the spine, care being taken to prevent rotation of the pelvis anteriorly during the maneuver. He is then centered to the Bucky and the central beam from the tube is directed at the level of the
Fig. 4. Case II. Solid fusion of L4-5, S1. Posterior defect at L3-4. History: Back injury, March 30, 1955, with severe low-back and left leg pain. Routine myelogram (prone) (9 c.c.) considered negative, Dec. 1, 1955. Decompression of roots of L4-5 and S1, June 7, 1956. Examination May 1, 1957: Pain persisted in lower back, and became bilateral to heels. Numbness of right foot and left foot and calf.

A. Upright dynamic myelogram (21 c.c.), May 14, 1957, with spine flexed.

B. Upright dynamic myelogram (21 c.c.), May 14, 1957, with spine hyperextended.


Iliac crest. The first film is now exposed (Fig. 1). For the second exposure, the patient arches his back as far as possible. The centering is readjusted and the second exposure made (Fig. 2). During this maneuver, the patient steadies himself by grasping the edge of the table with one hand; with his other hand he holds firmly to the wrist of the anchor hand.

With the patient still seated, the stool is carefully shifted away from the table, the footboard is replaced, and the patient, properly assisted, steps upon it, again facing the table in upright position. The table is then slowly returned to a moderate Fowler's position. It is not returned to horizontal position because of the danger
A. Upright dynamic myelogram (18 c.c.), June 27, 1957, with spine flexed.
B. Upright dynamic myelogram (18 c.c.), June 27, 1957, with spine hyperextended.

of the large volume of Pantopaque passing upward beyond the dorsal curve and entering the cranial cavity.

When it is ascertained that the films are satisfactory, the Pantopaque is withdrawn through the original needle or through a second needle placed at a lower level if this is thought to be more expeditious. If the needle is gently pushed to a depth approaching the anterior wall of the subarachnoid space, successful aspiration is more easily accomplished. The use of the tubing previously described makes it possible to recover the smaller residual droplets more quickly under fluoroscopic control.

The quantity of contrast material re-
Fig. 6. Case IV. No fusion. Visible anterior and posterior defects at L3-4. History: Back injury, April 1950. Myelogram (3 c.c.) July 7, 1950, demonstrated defect at L3-4, left. Laminectomy, L3-4, left, showed minimal disk herniation; no fusion. June 16, 1957, complaint of spasms in low back, with pain radiation to posterior knees and large toes.

A. Upright dynamic myelogram (18 c.c.), June 24, 1957, with spine flexed.

B. Upright dynamic myelogram (18 c.c.), June 24, 1957, with spine hyperextended.


Figures 1-5 have illustrated, for the most part, the results obtained in various cases with the upright large volume dynamic myelography. The results shown are in agreement with those obtained with the use of low volume myelography; however, the upright large volume myelography is more accurate and indicative of nerve root involvement. The advantages of this method are: (1) higher contrast, (2) ability to study the neural canals, (3) ability to study the dura mater, and (4) the use of large volumes of saline solution makes it possible to study the spinal fluid pressure and to obtain a clearer picture of the nerve roots.

Sensory Code

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required varies with each case. High lesions and large neural canals require more than other types. We have used as much as 36 c.c. in one case and as little as 12 c.c. in others. We have found that the average patient requires approximately 15 to 18 c.c. No untoward symptoms have been encountered in any of the patients thus far examined by this method, although no additional spinal fluid is removed.

These studies have provoked considerable interest concerning those patients in whom numbness of the feet and other evidences of cauda equina compression have developed. We find that this prob-
LEM is more frequently present following successful fusion of L-4, L-5, and the sacrum than following successful fusion of only L-5 and the sacrum. We believe this to be due to the greater leverage applied to the midlumbar region as a result of the longer distal segment of the fused spine. In these cases we have been able to demonstrate impingement upon the posterior aspect of the column by the so-called cephalic ledge of the lamina and perhaps to some extent by the ligamentum flavum. The hyperextended attitude of the low back appears to produce a localized decrease in the anteroposterior diameter of the neural canal. Buckling of the annulus at times contributes to the decrease in anteroposterior diameter. Sometimes these two conditions can be demonstrated at the same level, producing a pincers-like encroachment upon the contrast column.

We have found Pantopaque (ipophenylate injection U.S.P.) to be quite satisfactory for routine myelographic studies. We believe that a medium of lesser density would prove advantageous in the larger volume technic. The manufacturers are well aware of this problem and have been attempting to produce such a substance. We are most grateful to them for their unselfish assistance to us throughout these studies. We must also acknowledge the valuable assistance given this study by the orthopedic staffs of various hospitals and particularly the orthopedists of the Emanuel Hospital, Portland, Oregon.

SUMMARY

Encroachment upon the subarachnoid space from pathological processes arising posteriorly can be shown only when the posterior surface of the canal is visualized. Intermittent impingements brought about by weight-bearing and bending motions of the spine may be entirely missed in routine prone myelography.

A combination of upright, large-volume myelography with studies of the spine in flexion and hyperextension will reveal lesions not detected by routine methods.

REFERENCES


SUMMARIO IN INTERLINGUA

Myelographia Dynamic In Position Erecte, A Grande Volumines De Substantia De Contrasto

Ingressiones in le spatio subarachnoide, emanante ab processos pathologic de origine posterior, pote esser demonstrate solmente si le superficie del canal vertebral es visualisate. Impingimentos intermittente que es causate per ponderation e motiones flexive del columna vertebral es apte a escappar completamente al observazione in myelographia routinari a decubito ventral.

Un combination de myelographia in position erecte e a grande volumines de substantia de contrasto con studios del columna vertebral in flexion e hyperextension va revelar multe lesiones que non es detegite per medio de methodos routinari.