TECHNIQUE OF PANTOBAQUE MYELOGRAPHY

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Pantopaque myelography is basically a simple procedure, consisting of the injection of contrast material into the subarachnoid space, fluoroscopy with spot films of the indicated levels, and removal of the contrast medium. Those who have had experience with the procedure, however, will agree that it involves many pitfalls and possibilities of error, all of which, it is believed, have been experienced by the authors. These misfortunes include bloody taps, formation of possible hematomata or collections of cerebrospinal fluid in the epidural or subdural spaces, elicitation of root pain, injection into the subdural instead of the subarachnoid space, failure to obtain films of diagnostic quality, failure to include landmarks for indentification of levels on the films, difficulty or failure in removing the contrast medium, and in cervical myelography, spilling of the contrast medium into the basal cisterns.

A constant attempt has been made to reduce the incidence of failures and to increase the speed and accuracy of the examination. The procedures outlined below represent a compilation of the written and personal communications of Hampton, Kubik, and Spurling, and the experiences of the authors and the other medical officers who have done over 675 myelographic examinations with pantopaque at the Walter Reed General Hospital.

The general technique of myelography is well known and is in daily use in most clinics. The purpose of this paper, however, is to stress a number of details that the authors and co-workers have found to markedly reduce the difficulties mentioned above.

EQUIPMENT USED AND PREPARATION OF PATIENT

An autoclaved myelogram tray is available for each patient. This includes the usual setup for a lumbar puncture except that a short bevel 18-gauge Luer-Lok needle with stylet is used. In most instances the patients are able to walk to the X-Ray department; no premedication is used, and no meals are withheld. In fact, the procedure is given only casual consideration in the presence of the patient. Clothes are removed to the waist and the trousers are dropped down over the hips. The patient gets on the table and lies prone, with a folded pillow under the lower abdomen and pelvis to eliminate partially the lumbar curve and widen the spaces between the spinous processes. The prone position has been found preferable to the lateral position for two reasons: First, because it is easier to place the needle directly in the midline, and secondly, because it avoids possible changes in the depth of the needle point brought about by alterations of the skin-muscle-bone relationships attendant on turning the patient for X-Ray examination. The skin is then prepared, with gauze on a sponge stick, by vigorous scrubbing with some colored antiseptic solution from about L-1 to the sacrum with about 3- or 4-inch margins on each side. A sterile towel is then placed over the trousers and upper buttocks. No other drapes are used because of their tendency to slide when tilting the table. Extensive drapes contaminate the field, give a false sense of security, and also obliterate the outline of the back, thus obscuring the spine for accurate alignment of the needle. The head of the table is tilted up about 25 degrees in order to increase the pressure in the lumbar sac. This gives more resistance to the needle on the part of the dura and arachnoid and permits more nearly perfect penetration of the needle through these membranes, thereby diminishing the chances that a portion of the bevel of the needle may rest in the subdural space.

The spine is then palpated with gauze and the spine of the 3rd lumbar vertebra is identified. The interspace below this spine is selected to avoid having the hub of the needle obscure the 4th or 5th interspace, at which, in our experience, practically all of the ruptured discs
have occurred. By the same token, any defect created by the needle point will be removed from the site of likely pathology and the chances of the needle striking a protruded disc are minimized.

A small amount of some local anesthetic has proven adequate. A small wheal is made over the interspace and not more than $\frac{1}{2}$ cc. is injected into the subcutaneous tissues since greater amounts have been found to obliterate the landmarks.

The location of the bevel in relation to the lock on the stylet of the needle is noted, since the use of the bevel in directing the point of the needle has proved to be important. While the lateral borders of the 3rd spinous process are identified by the left hand, the needle is inserted directly in the midline with the bevel placed caudal. The angle toward the patient’s head varies with the inclination of the spinous processes, but the needle must never deviate even slightly to either side. The interspinous ligament is then engaged and with the needle held firmly by this structure, the operator’s hands are removed and careful inspection is made from the midline to guard against lateral deviation. Further insertion of the needle is not carried out until this alignment is satisfactory. If a tendency to lateral deviation occurs during further progress of the needle, it may be corrected by use of the sheering action of the bevel of the needle, since the point of a needle passing through resistant tissue curves away from the side of the bevel. No pain will be elicited if the needle is in the midline. When the interspinous ligament has been pierced and it becomes evident that the needle is perfectly straight and in the midline, the stylet is removed and the hub of the needle filled with novocain. As the dura is approached, the bevel of the needle is turned laterally in order that the cutting edge of the needle may pierce the dura in the direction of its fibers. It is noted that as the needle point indents the dura, the fluid in the hub of the needle is sucked in by the slight negative pressure created in the epidural space. Careful further insertion pierces the membranes and a free flow of spinal fluid is obtained. The bevel of the needle is then turned caudal and this usually results in a more brisk flow of fluid since the bevel opening now lies between the roots instead of against them. A simple glass-tipped syringe containing one ampule (3.0 cc.) of pantopaque is carefully attached to the hub of the needle. The plunger is withdrawn slightly to aspirate a drop of fluid to insure the presence of a free flow and the pantopaque is then injected with gentle pressure.

Complications of the above procedure are dealt with as follows: A bloody tap or failure to obtain a free flow of fluid makes it imperative that the procedure be discontinued because it has been found that continuation under these circumstances almost invariably results in the oil going into the subdural or epidural spaces. Any degree of blood stain in the spinal fluid is considered a bloody tap. When an examination is discontinued for the above reasons, it is postponed for at least ten days, since examination at shorter intervals has resulted in recurrent failure or false defects due to unabsorbed blood or fluid in the subdural or epidural space.

If root pain is obtained, the needle is withdrawn about an inch, the bevel turned to the side of that root and the needle reinserted, using the sheering action of the bevel to direct the needle point toward the midline. If root pain persists, the patient is fluoroscoped and the needle is withdrawn and reinserted to correct any lateral deviation observed.

**X-RAY EXAMINATION**

The fluoroscopic and radiographic settings that have been found most satisfactory are: 85 kv. with 4 ma. for fluoroscopy, with a change to 50 ma. for spot films. No stationary grid is used because it increases the exposure time, shortens the life of the X-Ray tube and results in no better quality of film than can be obtained without the grid if a small field is used. This field includes the width of the vertebral bodies and varies in length according to the level being examined. On one film both the needle and the top of the sacrum are included for orientation, and all other films include one or the other unless the vertebrae are identified by lead numbers placed under fluoroscopic control. The exposure time varies from 0.3 to $\frac{1}{2}$ second according to the thickness of the patient. A lead letter L is fastened to the back of the fluoroscopic screen at the left margin of the field. The pillow is removed and the fluoroscopic
screen is placed as close to the patient as possible without striking the needle, which is left in place throughout the examination. Some means should be provided to maintain this level if the screen is not provided with a lock. The pool of pantopaque is located fluoroscopically and the table is then tilted head down about 10 degrees. If the pantopaque is in the subarachnoid space, it will flow rapidly and freely, while if subdural the flow is slow and limited. The patient is rolled slightly to one side or the other, if necessary, to align the spinous processes to the center of the vertebral bodies. This requires complete accommodation of the radiologist’s eyes, particularly with heavy patients. The patient is not allowed to cough when the table is tilted foot down because this seems frequently to render removal difficult, due, theoretically, to escape of oil or fluid around the needle under the sudden increase of pressure. Examination is started at the 3rd interspace unless a higher lesion is indicated clinically, and the 4th and 5th discs are then examined. The root sheaths seem to fill more completely when the pantopaque is running caudally instead of cephalad. Two views are taken of each disc, one with it partially covered, and the other with it completely covered by the pantopaque. The central extension of a disc may be obscured by the center of the pantopaque column but outlined by the thinner end of the column. Oblique views are taken of the suspicious levels and give added courage in making a diagnosis but have in no instance disclosed a disc not demonstrated by the above views. Lateral views were taken in about 100 cases but added no additional information and were discontinued.

On completion of the roentgenological examination, the table is tilted until the needle point is in the center of the pantopaque column for removal. If the pantopaque obscures the needle, the patient may be rolled slightly to one side to ascertain the level of the point. If the point is not in the midline, the patient is rolled 10 to 20 degrees toward the side of the point before removal is attempted.

**REMOVAL**

The pantopaque syringe is again carefully attached to the needle and withdrawal is accomplished by gentle suction. This may be best described as enough pull on the plunger of the syringe to overcome the effects of gravity. This gentle pull is continued until fluid streams up through the pantopaque without further increase in the volume of pantopaque in the syringe. The patient is again fluoroscoped and any remaining oil centered to the needle point. It may be necessary to again roll the patient to one side or the other to accomplish perfect centering. The aspiration procedure is repeated, until no further oil can be seen fluoroscopically. The needle is then withdrawn and the needle site slightly massaged. If there is any bleeding at the needle site, a square of gauze is applied with adhesive. The patient then gets off the table, puts on his clothes and walks back to his ward. It has been our experience, as that of others, that this regime has resulted in fewer post-lumbar-puncture headaches than when the patient is treated as a litter case. The rare headache that develops is treated symptomatically by bed rest.

Complications of withdrawal are dealt with as follows: *If the patient has root pain*, the bevel of the needle is rotated either 180 or 90 degrees away from the side of the pain. *If no flow is obtained*, the needle is rotated very freely for several turns and suction is applied with the bevel at a different angle. *If the pantopaque runs past the needle or is divided* at the level of a prominent disc, sometimes it may be collected around the needle point by placing a pillow under the chest or upper thighs to increase the concavity of the lumbar curve. *If clear fluid is obtained* when the needle point is in the midline and centered to the pantopaque column, it must be assumed that it lies in the spinal fluid supernatant to the pantopaque pool. Under this circumstance, the pantopaque may be reached by very slight further insertion of the needle. *If there is a filling defect* around the needle point, presumably due to blood or fluid in the adjacent subdural or epidural space or due to a disc, there may also be a free flow of fluid without pantopaque. Under this circumstance, the patient is rolled 45 degrees toward the side of the needle point and pantopaque is occasionally obtained. *If the above maneuvers are unsuccessful*, time is saved by inserting another needle at a lower interspace that is free of a filling defect. The first needle, under these circumstances, is never taken out until removal
is completed, because if the needle is withdrawn, oil or fluid frequently escapes through the needle hole into the subdural or epidural space and renders success of the second tap less likely.

CERVICAL MYELOGRAPHY

In cervical myelography several modifications of the above technique are employed. Two ampules (about 6.0 cc.) of pantopaque are used. With this amount of contrast medium a diagnostic quantity can be made to flow into the cervical region with less danger of its entering the basal cisterns. Also the larger quantity gives better delineation of the nerve roots. Injection is made at L-4 or L-5 for greater ease in removal. The pillow is removed from under the patient, the table is tilted to the horizontal position, and the patient is then pivoted on his abdomen until his head is at the foot of the table.

For non-paralyzed patients the following procedure is employed. The foot rest is moved up near the end of travel of the fluoroscopic tube and a small bolster (or sand bag) placed on it as a cushion on which the patient can rest his elbows to support his weight when he is tilted head downward. He is moved up or down the table until he can rest his elbows against the cushion and at the same time rest his chin on his doubled fists, placed one on top of the other to force his head as far back as possible without raising his chest from the table. The degree of hyperextension varies with different patients and controls the angle to which the table can be tipped safely.

After the patient is firmly braced in this position, the table is tilted slightly beyond the point at which the lumbar concavity lies above the dorsal convexity. To increase the speed of flow, the tilt may be increased further but not to the point where the patient's ears are below the level of his shoulders. The flow of pantopaque is observed fluoroscopically past the dorsal curve until the major portion has passed, usually a period of 10–15 seconds. No attempt is made to pass the few drops that usually trail the main mass. Early attempts to prevent breaking up of the pantopaque column by a gradual tilt were discontinued when it was found that the column broke up in any event.

As soon as the major portion of pantopaque has entered the cervical region, the table is tilted back toward the horizontal until the pantopaque reaches the first thoracic vertebra. The patient's head is then lowered manually but kept hyperextended until his chin touches the table top. The patient is never allowed to move his own head, because he is apt to lower it too far and allow pantopaque to flow into the basal cisterns.

Spot films are taken under fluoroscopic control as in lumbar myelography except that the exposure time is shortened to 1/10–2/10 second and larger fields are used to include the first ribs on all films for localization. The spread of pantopaque in the cervical region is such that films taken at two different degrees of tilt will usually delineate the entire region. Oblique views were taken in earlier examinations but have been discontinued since they seemed to offer no additional information over true A. P. views. More clear films can sometimes be obtained by using an overhead tube with fast Bucky technique.

To remove the pantopaque the patient is pivoted back to the position of injection, with the table horizontal and his head held in hyperextension by an assistant. The table is then tilted until the patient is standing. The basal cisterns, cervical and dorsal areas are then inspected fluoroscopically for droplets of pantopaque. Any such droplets can usually be brought down by gently shaking the patient. The patient is told not to cough because this has seemed to make removal more difficult, as previously stated. The pantopaque is globulated after cervical myelography and removal is easier if the needle is at L-5 and the globulated mass can be collected in the caudal sac.

For patients who are paralyzed or badly disabled the same general principles are employed as with active patients, the only difference being that immobilization and manipulation are done by assistants instead of the patient. As in other phases of myelography, the procedure is kept as simple as possible and the use of elaborate or complicated apparatus avoided. The standard immobilizing band which comes with the table is used to prevent sliding of the patient when his head is tilted down. This band is tightened over the patient’s lower thighs,
anchored by wooden pegs or wedges and the patient suspended as from a trapeze, with one assistant holding his legs doubled over the band and another holding the patient’s head.

RESULTS

Difficulties were encountered in approximately 10 per cent of the examinations performed by several different officers in this series of over 675 myelograms. These were usually due to bloody taps or subdural injections. Although these may sometimes occur with the most careful technique, the incidence in this series became markedly reduced as the importance of the various details, described above, became appreciated. In each incidence of failure, a successful examination has been possible at a later date.

The average time required to perform a myelogram should be about 20 minutes. On two occasions, in which the time interval was noted in this series, 13 examinations were performed in 5 hours and 6 examinations in 2 hours, respectively. The shortest measured time consumed to complete one examination was 8 minutes, while a careful cervical myelogram usually requires more than 30 minutes.

Removal is practically complete in nearly all instances. A few minute droplets frequently remain because they cannot be seen fluoroscopically and therefore cannot be centered to the needle point. If removal is difficult, the last 1/2 cc. is allowed to remain rather than to subject the patient to any unnecessary discomfort, since small amounts of pantopaque are absorbed.12 In no instance during the past year has it been found necessary to leave a greater quantity than 1/2 cc. in the subarachnoid space. In some instances, 50 to 90 per cent of the oil injected subdurally has been removed without moving the needle through which it was injected. The approach to and the handling of the examination as routine rather than a formidable procedure has resulted in a marked decrease of the apprehension with which the patients regard the examination and has been associated with almost complete disappearance of post-lumbar-puncture headaches.

REFERENCES