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 3-inch 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 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 caudad. 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 caudad 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