CLINICAL PATHOLOGY IN GENERAL PRACTICE

LUMBAR PUNCTURE

BY

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Lumbar puncture was first used as a clinical method by Corning in 1885. Within a few years Quinke in Germany and Wynter in England developed improvements for the relief of raised intracranial pressure. Quinke devised a technique generally similar to that used to-day, and was the first to measure pressures and have the spinal fluid analysed.

In adults the spinal cord ends at the level of the lower border of the first lumbar vertebra. In children it ends at a lower level, and in infancy may reach the level of the third lumbar vertebra. The arachnoid membrane continues down to the level of the second sacral vertebra. There is therefore in the cavity of the lower lumbar vertebral canal a sac containing cerebrospinal fluid (C.S.F.) and the lower spinal nerve roots. Into this sac a needle may be inserted without danger of injuring the spinal cord. The sac is surrounded by a venous plexus. In lumbar puncture the needle enters the sac posteriorly. After passing through skin, interspinous ligaments, and posterior vertebral muscles the needle is guided between two adjacent spinous processes (usually lumbar 3 and 4) through the posterior longitudinal ligament of the vertebral column into the lumbar sac.

The C.S.F. has a circulation in and about the central nervous system. A sample taken from the lumbar region will, with a fair degree of accuracy, indicate the conditions throughout the pathways of circulation. Being so closely related to the central nervous system, the spinal fluid reflects changes in nervous tissue and its accessory parts, the meninges and blood vessels.

From consideration of abnormalities in pressure, cellular content, and chemical composition it is often possible to establish a diagnosis which could not be otherwise made.

Lumbar Puncture in Diagnosis

Lumbar puncture provides *direct* information from the pressure and composition of the spinal fluid; *indirect* information is obtained by the injection of air or opaque media into the subarachnoid space. Lumbar puncture may be combined with puncture of the C.S.F. system elsewhere (ventricles, cisterna magna).

Direct information may be obtained in:

(a) *Infectious Diseases*: meningitis; abscess; encephalitis; myelitis.

(b) *Neoplastic Diseases*: benign tumours; primary or secondary malignant tumours. (Note that lumbar puncture may be dangerous in cases in which the intracranial pressure is significantly raised.)

(c) *Vascular Diseases*: haemorrhage; thrombosis or embolism; haematoma.

(d) *Neurosyphilis*.

(e) *Demyelinating Diseases*.

(f) *Degenerative and Congenital Conditions*. In this group, which includes such conditions as Friedreich's ataxia, amyotrophic lateral sclerosis, and the lipoidoses, curiously enough the spinal fluid is usually normal.

Lumbar puncture should be used only to settle definite questions of differential diagnosis. Routine lumbar puncture is to be deplored. Certain conditions are sometimes aggra-

vated by lumbar puncture: cerebral or spinal tumours when the local pressure and circulation are reaching critical levels; disseminated sclerosis; and psychoneurosis, "hysteria," depression, and cases in which compensation is a factor.

Lumbar puncture may be of special importance in those cases of difficult and obscure illness in which it is all too easy to label the condition as functional or hysterical. The presence of definitely abnormal C.S.F. findings very strongly supports a diagnosis of organic disease.

Lumbar puncture may be used for injection of air, other gases, or opaque substances into the subarachnoid space. By appropriate manœuvres the medium can be used to show abnormalities within the skull or vertebral canal. Growths and other obstructive lesions give positive findings. Cerebral atrophy is shown by air in dilated ventricles or widened sulci.

For Therapy

Prognosis in the "malignant" forms of meningitis, such as pneumococcal, tuberculous, and influenzal, has greatly changed for the better since intrathecal antibiotic therapy began. Penicillin and streptomycin are now in general use. The maximum intrathecal dose of penicillin is 20,000 units; of streptomycin, 0.1 g. The use of fibrinolytic agents is at present considered hazardous.

The injection of saline under moderate pressure has been advised for those cases of subdural haematoma in which, after the removal of the clot, the brain does not regain its normal shape and position.

The intrathecal use of anaesthetics is a well-established specialized practice. Occasionally serious spinal cord damage occurs after spinal anaesthesia.

Contraindications.—Lumbar puncture is contraindicated: (1) If the practitioner has no positive problem which may be solved as a result of the findings. (2) If there is no prospect of a successful puncture owing to spinal deformity or disease. (3) If it is judged either on the history of the illness (headaches, vomiting, visual blurring) or physical signs (papilloedema, slow pulse, lowered state of consciousness) that the patient has an expanding cerebral lesion (tumour or abscess) which will, if the intracranial tension is suddenly altered, cause complete and irreversible obstruction to the C.S.F. or blood circulation (pressure cone). Occasionally the patient in such a state may die while the puncture is being carried out. Often death is delayed for some hours and the connexion between death and lumbar puncture may escape the unobservant. In these difficult circumstances, ventriculography is necessary. (4) If there is a gross spinal lesion already causing obvious nervous and vascular damage. A complete transverse lesion may rapidly follow puncture. In doubtful cases a neurosurgeon should first be consulted.

Apparatus

At the National Hospital for Nervous Diseases a standard set of instruments, dressings, and towels is provided. The set consists of a cloth container folded in two and tied with tape. The tape is undone by an assistant with sterile forceps. The operator then turns the upper fold back to expose towels on the right, and the instruments and dressings on the left (Fig. 1).

The instruments are kept in a row of pockets. The manometer lies in the centre of the package. Instruments available are: two Greenfield needles with three-way taps and stylets—they are best kept in a metal tube to prevent pene-

tration of the cover and subsequent sepsis; a glass manometer reading up to 300 mm., with a short rubber tube for attachment to the needle; one 2-ml. and one 10-ml. hypodermic syringe, with hypodermic needles to fit the small syringe. A specimen bottle may be included. The package is laid out on a sterile cloth on top of a trolley, with a sterile kidney dish, pair of forceps, pair of gallipots for antiseptics,

FIG. 1.—Standard set of instruments for lumbar puncture.

and a bowl for extra dressings. On the lower shelf of the trolley are kept: Cheate's forceps in antiseptic; 1-ml. ampoules of 2% procaine hydrochloride; bottles of methylated spirit and 2½% iodine in methylated spirit; and specimen bottles.

Technique

The following method has proved reliable in the hands of a large group of operators over many years, but satisfactory modifications are well known. Before starting, the physician or surgeon should remind himself of a few simple but important facts.

(1) Lumbar puncture is unpleasant and frightening, not usually from the pain of the procedure but because of apprehension, ignorance, and "old wives' tales," and because the patient cannot see what is happening. He should not be kept in suspense for hours or days. It is best to carry out the puncture as soon as consent has been obtained and the outline of the process explained. Patient and simple explanation repeated as often as necessary, with quiet warning of each move in good time, help greatly in decreasing the strain of the investigation.

(2) Lumbar puncture may result in an infected spinal fluid, even if the operator is scrupulously careful. If anything is to be injected into the subarachnoid space, the operator is advised to use full aseptic surgical technique, including cap, mask, gown, and gloves.

(3) The most important single detail in the procedure is the patient's position.

(4) Haste and force indicate lack of experience and sympathy. They contribute to failure.

(5) Consideration should be given to the convenience of the pathological services so that specimens arrive in good time for examination.

After due warning to the nursing staff, the operator should carry out his work punctually. He should expect to find the patient behind screens, suitably clothed, and not in a draught. Incontinent patients should be in clean beds. All concerned with the actual puncture should wear masks.

Reliable nursing assistance is essential. If the patient is violent, restless, or confused it is useless to attempt lumbar puncture until an adequate amount of restraint can be provided. Colleagues, students, male nurses, porters, and even other patients may on occasion be required. Many sisters and nurses are efficient in holding restless patients, but if possible they should be spared from duties beyond their physical

powers. The operator should never find himself in the middle of a scrimmage. In extreme cases the patient will have to be overpowered until an anaesthetic can be administered intravenously. The operator should explain the need for the patient being rendered quiet and placed in the right posture for puncture. He should not start at the lumbar puncture until he is sure of a reasonable time for safe work. Calm and deliberateness are essential. Happily, the great majority of punctures are carried out simply and uneventfully.

Patient's Position.—Great care should be taken in ensuring correct posture before anything further is done. The spine must be horizontal and fully flexed. The patient is drawn to the right side of the bed for right-handed operators. His back is exposed. He is told to lie on his left side with his knees up to his chin, his head well bent, and his arms below his knees. One pillow for the head may be useful (Fig. 2). The operator should be prepared to play an active part in this positioning until he is satisfied. The patient is requested to keep quite still in this position. The operator then masks himself and scrubs his hands for five minutes with soap and running water. He returns to the bedside and satisfies himself that the patient is still in the correct position. The assistant undoes the fastenings of the instrument packet and opens it with sterile forceps taken from the lower shelf of the trolley. Small amounts of methylated spirit and 2½% iodine are poured into the sterile gallipots. An ampoule of procaine hydrochloride 2% is opened. Specimen bottles are kept in readiness and material for intrathecal injection should be easily accessible. The operator dries his hands on a sterile towel. (Those experienced in medico-legal work advise the use of sterile gloves, but many operators do not use them for single diagnostic punctures.) The patient is draped in sterile towels, one over his back to the left of the exposed lumbar area, one between his left loin and the bed, and one over his right (upper) loin, hip, and buttock. He is then warned that his back is to be rubbed with methy-

FIG. 2.—Position for lumbar puncture.

lated spirits and that this may be cold. The lumbar region is carefully cleansed, especially in the central area.

Site of Puncture.—The space between the third and fourth lumbar vertebrae is most commonly used. A space higher or lower may be used if difficulties are encountered or if previous use of a space has made the patient's back tender. A line joining the highest points of the iliac crests normally passes between the third and fourth lumbar spines. If necessary the iliac crest can be felt through the sterile towel and the landmarks emphasized by a dab of iodine. A small syringe is filled with local analgesic and fitted with a short fine sharp needle. The patient must be warned that a local analgesic "to make the skin numb" is about to be used and that a prick, in the skin only, will be felt. The skin over the

third and fourth vertebral spines is then firmly stretched by the fingers and a small $\frac{1}{2}$ -inch (1 cm.) diameter subcutaneous weal is raised. A longer needle is slowly inserted through the weal into the deeper tissues, local analgesic being expelled throughout the needle's progress. The patient should be told that one of the worst parts of the procedure is now over.

The Puncture.—The spinal needle is inserted through the centre of the weal. A little firm pressure is sometimes needed to get the point through the interspinous ligament. Subsequent greater pressure on the needle should never be used, for resistance means bony obstruction which must be by-passed and not penetrated. The needle should then be pressed forward, its cutting edge in the same plane as the longitudinal (head to foot) fibres of the dura and ligaments. The point should be directed *slightly* upwards (towards the head). Usually the needle goes in to a depth of about 4.5 cm. with a firm smoothness. Then a ligamentous resistance is easily overcome, with a feeling of a slight "click." If the stylet is withdrawn, C.S.F. may flow from the butt of the needle. If it does not, the stylet must be reinserted and the needle gently and slowly advanced up to 0.5 cm. more. Another "click" may be felt, and C.S.F. then be easily obtained. If none appears, rotation of the needle through a quarter or a half turn may be effective. Lack of immediate success should not dismay the operator. On occasion he may prick a strand of the cauda equina, causing the patient pain

FIG. 3.—Taking the pressure.

in the foot. He may at times repeatedly encounter a vertebral bone. He may find pure blood instead of C.S.F. coming from his needle. Under such circumstances he should not use force or advance the needle further. (The needle should never be inserted so deep that less than 1 cm. remains between the skin and the connexion with the tap.) It must be withdrawn 2–3 cm. and a slightly different line taken. If the patient has complained of pain in the right leg or foot the point has clearly been too far to the right of the midline. If the needle is not withdrawn far enough before reinsertion it is likely to take

Pressure Readings

the same course twice. Rarely it may be advisable to try an insertion slightly lateral, or in a space above or below, after suitable analgesia.

As soon as a free flow of fluid is obtained the manometer should be attached to the needle and the tap turned so that the fluid passes up the tube held vertically (Fig. 3). The patient may be told to relax his tension slightly but not to move his back. The initial pressure may now be read. A slight oscillating rise and fall is normally seen. This variation is due to cardio-respiratory effects. If, with the patient relaxed, the pressure is over 200 mm. of fluid the tap should

be turned further so that the manometer fluid escapes into the specimen bottle, but no further C.S.F. is withdrawn from the theca. The needle should be removed.

Queckenstedt's test consists of compression and release of the jugular veins, first unilaterally and then bilaterally. The operator must be sure that he does not get false-positive results from local obstruction by nerve roots. Normally, such compression causes a brisk rise of pressure up to 300 mm., bilateral compression naturally causing a more rapid effect than unilateral. Release is accompanied by a fall in pressure. In cases of obstruction to the C.S.F. circulation, rise and fall in pressure may be slow or absent. In cases of lateral sinus or jugular thrombosis, compression of the jugular vein on the diseased side causes no change; compression on the healthy side alone causes pressure changes equal to those to be expected from bilateral pressure in a normal subject.

When pressure tests have been completed, one or more specimens are collected in sterile bottles. If the outside of the bottle is not sterile, it should be unstopped by the assistant and held below the needle butt to catch the fluid, without touching the needle. For routine examination 5 ml. should be taken. If extensive tests are to be carried out a larger specimen should be bottled.

With the needle still in position, injection of any necessary substance may be carried out, using the 10-ml. syringe. No active agent such as streptomycin should be injected all at once. C.S.F. should be aspirated into the syringe to dilute the injection material. A number of to-and-fro movements of the piston ensure adequate dilution. If air is being injected, a good fit of syringe to needle is essential, if escape is to be avoided.

Pressing the skin firmly through a swab with the left hand, the operator smoothly and swiftly withdraws the needle. If any bleeding is seen the flow should be stopped by firm pressure. No further attention to the site is necessary. (Some like to apply a small dressing, but this often causes slight irritation and inflammation.)

The patient should be informed of the success of the proceeding and allowed to return to a normal position in bed.

The specimens, labelled, dated, and numbered, should be sent for analysis at once.

Aftercare and Complications

To avoid trouble a nursing routine for all cases is advisable. The patient is allowed only one pillow, and stays in bed till the following day. Plenty of fluid should be taken. The following complications may be encountered:

(1) *Headache* is uncommon; it is usually slight and transient. More severe headache in the absence of obvious disease suggests a leakage of C.S.F. through the site of puncture and low intracranial tension. Saline fluids, flavoured with lemonade, are helpful. The foot of the bed should be put on blocks. Analgesics are to be used.

(2) *Backache* at the site of puncture is occasionally noted. The site should be inspected for signs of infection in the skin or muscles.

(3) *Fever* up to 100° F. (37.8° C.) may be seen on one reading in the 24 hours after puncture. It generally subsides without treatment.

The above symptoms very rarely indicate the disaster of meningitis due to septic puncture. Careful watch should always be kept for the possibility. If there is infection it must be admitted so that treatment can be started at once. There may be medico-legal consequences.

(4) Injected solutions too strong for the nervous system may cause *convulsions* or *local cord damage*. Hopeless *paraplegia* may result.

(5) *Ruptured intervertebral disk* may follow too deep a puncture, especially if repeated.

(6) *Subdural haematoma* has been reported after lumbar puncture.

(7) *Collapse and death* may occur during puncture or within 12 hours if the patient's state of disease is advanced (see contraindications).

Lumbar Puncture in Children

Commonsense modification of the above methods is necessary for carrying out lumbar puncture in children. Pre-operative sedation is often of value. An uncooperative child will need to be firmly and expertly held in the fully flexed position by a trained person at the opposite side of the bed. It is best to put one arm round the patient's neck and the other under his knees. The spinal theca is closer to the skin and may, in an emergency, be reached with a suitable hypodermic needle. A needle of finer gauge than is used for adults should be used, especially if pressure readings are not essential. The Harris or Howard Jones pattern is pleasant to use.

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WASHINGTON SYMPOSIUM ON ANTIBIOTICS

[BY A SPECIAL CORRESPONDENT]

A symposium on antibiotics, intended to be the first of an annual series, and sponsored by the Antibiotics Division, Food and Drug Administration, U.S. Department of Health, and by the journal *Antibiotics and Chemotherapy*, was held in Washington on October 28 to 30 in the magnificent auditorium of the Department of Health. Introductory addresses were given by HENRY WELCH, director of the Division of Antibiotics, CHESTER S. KEEFER, now special assistant to the Secretary for Health and Medical Affairs, and by F. MARTI-IBANEZ, international editor of *Antibiotics and Chemotherapy*, who paid a tribute to the pharmaceutical manufacturers, among whom free competition had been the spur responsible for rapid progress. In discussing the impact of antibiotics on medicine, and the profound change resulting in the natural history of disease, he suggested that chairs of chemotherapy should be created in medical schools throughout the world in order that the subject might be more adequately studied. (It may have occurred to other hearers that many distinguished physicians in the U.S.A. are working very much as if they held such chairs without the trouble of their creation or the restrictions which this would imply.)

The number of papers read during the three days of the symposium was 102, many being contributed by well-known authorities, and together they must fairly represent the latest acquisitions of knowledge and trends of opinion in a country which has advantages over all others in this sphere. The following is some account of what was said on the more important topics.

Misuse of Antibiotics

There seemed to be universal agreement that antibiotics were being grossly misused. PERRIN H. LONG (New York) picturesquely described the American populace as "an enormous sponge with an infinite capacity for absorbing antibiotics." MAXWELL FINLAND (Boston) referred dis-

approvingly to the common practice of administering many drugs successively or together for no more precise indication than fever, and blamed advertising pressure for some of this. SIDNEY ROSS (Washington) described the profession as being "inundated literally with a plethora of drugs," and made a plea for a return, for many purposes, to an earlier, simpler, cheaper, and often no less effective treatment; he asked his hearers not to "write off an obituary of sulpha drugs in the current high-power antibiotic era."

Acquired Bacterial Resistance

A great deal of such need as there is for new antibiotics is due to the waning power of their predecessors, which is a result of the acquired resistance of bacteria to them. As Finland pointed out, penicillin is fortunately unique in its exemption from this defect. The only possible instance, in his opinion, of a general diminution in sensitivity to this drug might be seen in the larger doses required to cure subacute bacterial endocarditis, owing, on this hypothesis, to the effect of ten years' use on the world's salivary streptococci.

It is true that penicillin resistance in staphylococci is now common and disastrous, but this is not the result of acquired resistance. To almost all other antibiotics all susceptible bacteria tend to become resistant and to remain so. Several speakers gave recent figures for the proportion of strains of common organisms found resistant to the principal antibiotics in use: these figures differed little from others recently published. The most disturbing change is evidently a pronounced increase, said by Ross to have been sharply accentuated recently, in the proportion of strains of staphylococci resistant to aureomycin and terramycin (one figure given for this proportion was 40%). An opinion expressed by several speakers was that the danger occasioned by these changes had been exaggerated. HARRY DOWLING (Chicago) took comfort from observations which were said to show that exposure to another antibiotic, or cultivation with a sensitive organism of another species, might render a resistant organism sensitive again: he cited an instance in which the substitution of another antibiotic in a hospital for one to which a high proportion of strains of an organism had become resistant was followed by a fall in this proportion. WALSH McDERMOTT (New York) believed that this problem was important only in connexion with tuberculosis, urinary infections, and infections by staphylococci, and that tissue destruction and the consequently greater difficulty of eliminating the organism was a factor. He also regarded the problem as a "hard core remaining unsolved" rather than as a threatening catastrophe, and believed that it was not one which could in any case be solved by drugs alone.

Combined Therapy

Although, as Dowling said, rapid elimination of the organism is the only certain way of preventing acquired resistance, combined therapy with two or more drugs may delay or minimize it: such treatment may also be indicated for the sake of a synergic effect, or contraindicated because of an antagonistic effect. ERNEST JAWETZ (San Francisco) gave an account of the conditions under which such effects might be expected, as defined largely by his own work, and GLADYS L. HOBBS (Brooklyn) described an extensive series of experiments on combined action *in vitro* which seemed to illustrate the difficulty of laying down any general rules in this connexion. Among combinations recommended for clinical use were the triple combination of penicillin, chloramphenicol, and a sulphonamide for pyogenic meningitis (another author being cited as having lost only 7 out of 80 cases on this treatment), erythromycin and streptomycin for coccal endocarditis (referred to later in connexion with the former drug), and polymyxin with terramycin for *Ps. pyocyanea* infections (this suggestion was based only on an *in vitro* demonstration of synergism, and another speaker had failed to confirm this finding).