OBSERVATIONS ON THE DIAGNOSIS OF SPINAL BLOCK BY MEANS OF LIPIODOL.

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A VALUABLE addition to the diagnosis of nervous disease was made by Sicard and Forestier when in 1922 they¹ successfully injected lipiodol into the cisterna magna in order to demonstrate spinal block.

In a fresh unaltered state lipiodol is a transparent oil of an amber yellow colour and of high specific gravity (1350); it is completely opaque to X-rays owing to the high atomic weight (127) of its iodine component, while its density causes it to fall by gravity from the cisterna magna to the lumbar cul-de-sac. If heated to 100° F. it becomes less viscid and therefore more easy to inject, but if it is exposed to a high temperature or to light and air it may turn a dark brown or greenish colour and iodine may be liberated in a free state. Lipiodol which has turned this colour should be discarded as the free iodine may irritate and give rise to untoward effects.

Rate of absorption and of elimination.—The rate of absorption and of excretion of lipiodol injected into the subarachnoid space is extraordinarily slow and even after two or three years some of the oil may still be seen in the subarachnoid space. After lipiodol has been injected into the cisterna magna it falls by its own weight to the most dependent parts but remains free to move up and down the space according to the position of the body. In the course of a few days it becomes fixed to the meninges, the oil is gradually absorbed through the lymphatics, and its iodine component is excreted through the kidneys. The excretion of iodine in the urine is relatively rapid during the first week and then falls considerably but continues as long as lipiodol remains visible. It has been calculated that after an injection of 2 cc. of lipiodol 2-3 mgm. of iodine are excreted in the urine the first week and thereafter the quantity gradually diminishes to 1 mgm. or less a day. In chronic inflammatory conditions such as luetic meningomyelitis, tabes dorsalis, and general paralysis of the insane the absorption of lipiodol may be more rapid.

Dangers.—The value of any one method of diagnosis must primarily depend upon its absolute safety. Some diffidence is naturally felt in adopting any new procedure until sufficient experience has proved it to be

both efficient and harmless. The enthusiasm of pioneer workers must be tempered by the criticism of later observers. Apart from any dangers which may arise through faulty technique the question naturally suggests itself whether lipiodol is really entirely harmless and non-irritating to the cord and the meninges.

Sicard² claims that there is no immediate reaction and that the passage of the oil along the spinal canal is not accompanied by pain or by any abnormal sensations. However, he goes on to say that in some cases delayed symptoms may occur from four to six hours after the injection, consisting of headache, slight cramps in the lower limbs and a slight rise of temperature. These symptoms last from one to two days but never more than four days and disappear without leaving any trace behind them; they are similar in nature and intensity to those which may follow an ordinary lumbar puncture.

Armour³ states that he has noticed a distinct meningeal reaction in patients submitted to operation shortly after the injection of lipiodol. The meninges appeared thickened, somewhat reddened and agglutinated, while the cerebrospinal fluid was slightly turbid. He states that the following symptoms have been observed to follow a lipiodol injection: an increase in the root-pains at the site of the lesion lasting for some hours, general soreness and stiffness of the back muscles, headache, and a rise of temperature. Less commonly there has been increased difficulty in the act of micturition in cauda equina lesions. In one case, which eventually proved to be one of disseminated sclerosis, injection of lipiodol gave rise to pain on one side of the face, twitching of the left arm and leg with sensation of pins and needles in the left leg, which lasted for 24 hours.

Ebaugh and Mella⁴ found that pains in the legs occurred in 80 per cent. of patients, rise of temperature in 23 per cent., nausea and headache in 7 per cent., leucocytosis in 30 per cent., pleocytosis in 60 per cent., and that sleeplessness and restlessness were 'frequent.' From the cellular increase in the cerebrospinal fluid, the increase in the protein content and the frequent presence of blood on lumbar puncture they concluded that lipiodol gave rise to an aseptic chemical meningitis.

Ayer and Mixer⁵ in some experiments on animals found great cellular increase in the cerebrospinal fluid which reached its height in from 24 to 48 hours; counts of 1,000 cells with moderate increase in the protein content of the cerebrospinal fluid were noticed. Their results may, however, have been due to the use of a much larger quantity of lipiodol than is used in man.

Sharpe and Peterson⁶ have reported a case where such an inflammatory reaction occurred from the arrested lipiodol at the site of the spinal block

that the patient's symptoms and signs were aggravated to a degree necessitating the removal of lipiodol five and a half months after its injection. The lipiodol was found as two encysted globules surrounded by numerous newly formed adhesions. McLaire⁷ also reports a case of compression fracture with incomplete transverse myelitis in which intraspinal damage was definitely increased by a lipiodol injection.

FIG. 1. Anatomical relations of the cisterna magna. The arrow indicates the position of the needle as it punctures the cistern.

A, cisterna magna ; B, atlas ; C, axis ; D, pons ; E, fourth ventricle ; F, cerebellum ; G, vermis ; H, occipital bone ; I, skin. (Diagram drawn from a photograph taken from Sicard and Forestier).

In the writer's series of cases, transient systemic and local symptoms, which rapidly disappeared, have been noted in a few cases. In some there was slight rise of temperature not exceeding 100° F. and lasting for a day or two. In two cases the rise of temperature was higher and more prolonged, but could be accounted for by a urinary infection already existent. Some patients complained of stiffness of the neck muscles and of headache, but these symptoms were not more severe than those following an ordinary lumbar puncture. In two cases there was definite increase of sphincter trouble and in one there was complete retention for several days following the injection.

TECHNIQUE OF CISTERNAL PUNCTURE.

The cisterna magna is the portion of the subarachnoid space which lies between the inferior surface of the cerebellum and the posterior surface of the medulla and in front of the occipitoatlantal ligament. It is a triangular space $1\frac{1}{2}$ - $2\frac{1}{2}$ cms. deep, and the dura is therefore sufficiently distant from the medulla to allow a safe margin of play when making a cistern puncture (see fig. 1). The point of the needle reaches the occipitoatlantal ligament at a depth of 4-5 cm. in an adult of normal size. In obese patients or in muscular subjects with a thick neck the depth at which the cisterna magna lies from the surface may be greater and as much as 7 cm., while in children the space may be reached at a depth of less than 3 cm.

FIG. 2. Position of the operator and of the patient when performing a cistern puncture; the operator stands behind the bed while the patient is made to sit upright with his shoulders resting against the back of the bed and his head well flexed forwards.

The patient's hair should be shaved as high as the external occipital protuberance, and the skin of the neck sterilized. The patient should be sitting in bed or in a chair with his shoulders well supported by pillows and the neck flexed. If the patient cannot sit upright he may lie on his side with his head and shoulders slightly raised. The former position, however, is preferable and should be adopted whenever possible (see fig 2). A point is selected immediately above the axis process on the mid-line. The spinous process of the axis is easily felt in most cases and can be recognized without

difficulty as it is the first process to be felt (the first vertebra having none). The selected point is marked by injecting novocaine (2 per cent. solution) intradermally and forming a small bleb; the subcutaneous tissues are then infiltrated with novocaine down to a depth of 2-3 cm. After an interval of a few minutes to allow the anæsthesia to become complete, a lumbar puncture needle or a stout exploring needle 1 mm. in diameter and about 7 cm. long is fitted on to an ordinary Record syringe and is introduced through the

FIG. 3. *Faulty technique.* The needle was introduced too obliquely; consequently lipiodol was injected into the recess between the tonsils of the cerebellum, and was retained there by surface tension; the needle also slipped out of the cistern and lipiodol is seen infiltrating the soft tissues of the neck; two faults which must be avoided. No ill effects followed this injection but the cistern puncture had to be repeated.

selected point; the direction of the needle should be slightly upwards and in line with the external auditory meatus; care must be taken not to direct the needle too obliquely as in this case it may hit the occipital bone; or should it miss the occipital bone and enter the cistern, lipiodol may be injected into the recess between the tonsils of the cerebellum and in virtue of surface tension be retained there (see fig. 3). The needle can be introduced without fear for a depth of 3 cm., but thereafter must be pushed forward more cautiously; and its progress should be frequently checked by exhausting the syringe. As soon as the occipitoatlantal ligament is pierced

and the needle enters the cistern, cerebrospinal fluid will flow into the syringe. Once the needle has been correctly inserted it should be kept perfectly steady and great care should be taken to prevent it from slipping out; after withdrawing about 2 c.c. of cerebrospinal fluid, the syringe containing the lipiodol (which has been kept warm in a water bath) is gently attached to the needle and $1\frac{1}{2}$ -2 c.c. of lipiodol are slowly injected into the cistern. It is very difficult to predict the depth at which the cistern lies and therefore the use of a partially exhausted syringe is of great value in ascertaining whether or not the needle is correctly inserted into the cistern. It is not safe to rely on a spontaneous flow of cerebrospinal fluid through the needle, as, if the pressure happens to be too low, the flow may not occur in spite of the correct insertion of the needle. Sometimes the resistance felt by the operator on piercing the occipitoatlantal ligament may give the necessary information although the toughness of this ligament may vary considerably; in some cases the ligament is extremely hard to pierce while in other cases it may not offer any resistance at all.

The use of a good needle will make all the difference between a successful and an unsuccessful puncture and it is essential to use a very sharply pointed needle. The writer prefers to use an ordinary exploring needle with a short bevel and very sharp point. The needle should be about 7 cm. long and carry a mark 5 cm. from the point: an easy way of marking this point is to thread the needle through a small rubber disc cut from rubber tubing and to leave the disc at the required point. Lipiodol which is used for cistern puncture should be perfectly clear and transparent and free from air bubbles as these tend to hold up the lipiodol along the sides of the spinal canal. Only a small amount of cerebrospinal fluid (not more than 2 c.c.) should be drawn off in order to avoid collapsing the cisternal space by an excessive lowering of the pressure. For the same reason a lumbar puncture should not be made immediately before a cistern puncture.

Radiograms are taken shortly after the injection and when temporary block is suspected may have to be repeated in 24-48 hours' time. It is best to X-ray the patient in the upright position, but should the patient be unable to stand or to sit upright the couch on which he is lying can be tilted so as to have the shoulders well raised. It is inadvisable to X-ray him in the horizontal position as the normal curvature of the spine allows the oil to flow back and may thus give an erroneous impression of obstruction.

INTERPRETATION OF RESULTS.

Lipiodol which has been injected into the cisterna magna in the absence of any block passes straight down the spinal canal and falls into the dural cul-de-sac, where it can be seen at the level of the second sacral vertebra.

It collects there in the form of a large globule which varies in shape according to the position of the patient. If the patient has been X-rayed standing or sitting upright the globule will take the shape of a radish (see fig. 4), while if the radiogram has been taken with the patient in the prone position it will assume the shape of a rounded mass at the level of the third lumbar vertebra (see fig. 5).

FIG. 4. *No arrest.* Lipiodol injected into the cistern has fallen down to the lumbar cul-de-sac. Patient X-rayed in the upright position.

Sometimes a few drops of lipiodol may adhere to a nerve-root, or the lipiodol may move down slowly and be temporarily arrested, even when there may not be any actual cause for this. According to Laplane⁸ this temporary arrest occurs most frequently between the seventh cervical and the fifth dorsal vertebræ; it may, however, in the writer's experience also occur between the eighth dorsal and the first lumbar vertebræ; at this level the spinal canal has to accommodate the lumbar enlargement and a number of nerve-roots forming the cauda equina, and so the spinal canal is narrower and lipiodol may easily be held up. Lipiodol adhering to nerve-roots takes the shape of small blobs or of exclamation marks, and as a rule this false arrest can be easily differentiated from true spinal block (see fig. 6).

I. *No arrest*.—The question of the reliability of negative findings (no arrest) has been raised. Can medullary compression be excluded when lipiodol passes straight down the subarachnoid space? Armour³ states definitely that it cannot. He mentions a case on which he operated only three months after the onset of root-pains. Here the very small size of the tumour could not possibly have interfered with the descent of the lipiodol. Babinski⁹ reported a case in which spinal compression was suspected and

FIG. 5. *No arrest*. The unusual rounded shape of the lipiodol shadow is due to the patient having been X-rayed in the prone position.

in which a first injection of lipiodol did not reveal any spinal block. A second injection two to three months afterwards demonstrated, instead, complete block, and at the operation an extramedullary tumour was found. On the other hand, De Martel¹⁰ has reported four cases with lipiodol arrest for which he could not find any adequate reason at the time of operation. In two cases it appeared that the lipiodol arrest had been the only indication for an operation. Sicard though admitting that lipiodol block may be absent in some early cases of spinal tumour quite rightly argues that in such cases other methods of demonstrating spinal block would have failed likewise.

II. *Partial arrest*.—Lipiodol may partly be held up by an incomplete obstruction and some of the oil may be seen to trickle through the site of

obstruction and to fall down to the lumbar cul-de-sac. This may occur at the beginning of extradural or intradural compression and particularly in cases of intramedullary tumours. Whenever a partial obstruction is suspected the patient should be X-rayed again one or two days after the injection and sometimes after an interval of a week or more, and the progress

FIG. 6. *False arrest.* Some lipiodol is seen adhering to the nerve roots of the cauda equina. (Case of disseminated sclerosis).

of the oil checked along the spinal canal. Cases showing incomplete arrest often offer the greatest difficulty in diagnosis. In the case of intramedullary tumours the condition may sometimes be recognized by the shape of the lipiodol shadow, which outlines the fusiform enlargement of the cord in the form of narrow slips at either side of the cord. The same appearance may, however, be given by syringomyelia, as the following case shows.

Female, æt. 33. One year's history of pain in the right knee followed by stiffness of the right leg. Later she complained of stumbling and of frequent desire to micturate but without realization.

Examination showed spastic paraparesis with exaggerated deep reflexes, ankle clonus and bilateral extensor response. Some dissociated sensory loss of the syringomyelic type was present below the level of the knees. Lipiodol was partially held up in thin lateral slips at the level of the ninth thoracic vertebra. A laminectomy was performed and the cord exposed for a length of four inches. No tumour was found (see fig. 7).

FIG. 7. *Case of syringomyelia.* Partial arrest of lipiodol along the side of enlarged segments of the cord.

Partial arrest may also be due to adhesions between the dura and the cord or to discrete strands passing across the subarachnoid space. These adhesions and strands occur from many different causes; they may be traumatic, the result of contusion of the pia-arachnoid and of extravasation of blood at the site of a fracture-dislocation of the spine. In such cases lipiodol is held up not so much by pressure and obstruction caused by the

bony deformity as by the presence of adhesions, the oil being arrested in the form of large globules along a fairly large segment of the cord. Similar findings are found in cases of traumatic myelitis and of traumatic hæmatomyelia.

FIG. 8. *Case of traumatic hæmatomyelia.* Lipiodol has been partially arrested in the form of large droplets in the lower dorsal region. An x-ray of the spine did not show any sign of bone injury.

Male, æt. 53. Two days after having been knocked down by a motor car he suddenly became paralysed in both lower limbs.

Examination showed flaccid paraplegia with loss of deep reflexes and dissociated anæsthesia of syringomyelic type of both legs. The X-ray of the spine did not reveal any bony deformity. Lipiodol was arrested all along the lower dorsal cord (see fig. 8).

Meningeal adhesions may occur in extensive subacute or chronic forms of syphilitic meningitis and in tuberculous infections of the epidural space associated with an intravertebral abscess and with paraplegia. These cases, however, are usually easily diagnosed without the aid of a lipiodol examination as they present serological and radiological features which are sufficiently distinctive for a diagnosis to be made.

In the case of Pott's disease some interesting observations have been made by Mme. Sorel-Dejerine¹¹; she noted that the arrest persisted as long as the paraplegia was stationary and that the lipiodol progressively fell as the compression regressed and the subarachnoid space became freer. On the other hand, there is a real diagnostic difficulty in differentiating spinal tumour from hypertrophic pachymeningitis, syringomyelia, and meningitis serosa circumscripta. The syringomyelic enlargement of the cord may so tightly fill the theca as partially or completely to obstruct the spinal flow of the cerebrospinal fluid and so give rise to partial or complete lipiodol arrest. Two cases of syringomyelia have been observed showing partial lipiodol arrest; in one case the lipiodol was held up along the side of the enlarged segments of the cord, while in the other it was partially held up transversely in the shape of a comb. The history of one case has already been given.

Male, æt. 43. Twelve years' history of progressive weakness and of wasting of both legs. In 1926 sores appeared on the right ankle and on the dorsum of the left foot which were quite painless. Wasting and loss of power of peronei, tibialis anticus and quadriceps. Dissociated anæsthesia. Loss of deep reflexes of lower limbs. Lipiodol was partially held up at the level of the first lumbar vertebra but in 18 hours it had all descended to the lumbar cul-de-sac. The patient four years after was reported to be much in the same condition as he was when discharged from hospital (see fig. 9).

Hypertrophic pachymeningitis may completely obliterate the subarachnoid space and so hold up the lipiodol in exactly the same manner as a spinal tumour which is causing complete obstruction. The following case is an interesting example of hypertrophic pachymeningitis with localized hydromyelia of the upper dorsal cord causing complete lipiodol arrest.

Female, æt. 23. Four years' history. Onset with typical root-pains across the lower abdomen and radiating down the front of the left thigh and knee. Subsequently she became paralysed in the left leg and after a short time also in the right one.

On examination there was an extreme degree of spastic paraplegia in flexion together with dissociated anæsthesia below the level of the fifth dorsal segment. Lipiodol was completely arrested at the level of the fourth thoracic vertebra (see fig. 10).

A laminectomy was performed and on dividing the dura the opening led straight into a cystic dilatation of the cord. The patient died soon after the operation. At autopsy the upper dorsal cord was found to be the site of a localized hydromyelia and of adhesive pachymeningitis completely obliterating the subarachnoid space.

In the case of meningitis serosa circumscripta lipiodol is held up by the presence of strands of translucent membrane passing across the subarachnoid space. The radiological appearance is often quite characteristic as the oil is held up in large droplets along a large segment of the cord and there is no clear cut line of arrest (see figs. 11 and 12).

FIG. 9. Case of *syringomyelia*. Lipiodol has been partially arrested at the level of the first lumbar vertebra.

FIG. 10. Case of *pachymeningitis with hydromyelia*. Complete lipiodol arrest at the level of the fourth thoracic vertebra. Condition confirmed at autopsy.

The following are two such cases which have both been confirmed by operation.

Male, æt. 43. In March, 1930, while at work was seized by severe stabbing pain in the lower part of his back. In August, 1930, he complained of weakness of the right leg, which two months later was followed by weakness of the left leg.

Examination revealed a spastic paraplegia with sensory loss below the level of the first lumbar segment. Lipiodol injected into the cistern was arrested at the level of D6-8. In October, 1930, a laminectomy was performed and the cord exposed from the sixth to the tenth thoracic vertebra. The cord was found to be adherent to the dura by some fibrous adhesions but no tumour was found. The pain was somewhat relieved after the operation but the paraplegia remained unchanged. In March, 1931, another laminectomy was performed and this time the cord was exposed up to the fifth thoracic vertebra. The meninges were found

to be thickened to about three times their normal size. Lipiodol was released at the level of D6-8 (see fig. 11).

Male, æt. 26. At the age of 16 had an attack of cerebrospinal meningitis from which he apparently recovered completely. He went to Canada and worked on a farm. Five years ago he began to complain of pain in the right hip-joint and radiating down the front of the right thigh and leg. The pain was continuous and lasted for ten months and was followed by weakness and stiffness of the right leg. Two years ago the left leg became also affected.

FIG. 11. Case of *meningitis serosa circumscripta*. Lipiodol has been arrested in the form of large elongated droplets between the sixth and ninth thoracic vertebrae. Diagnosis confirmed by operation.

FIG. 12. Case of *meningitis serosa circumscripta*. Partial lipiodol arrest all along the dorsal and lumbar segments. Condition confirmed by operation.

On examination there was spastic paraplegia in flexion with exaggerated deep reflexes, knee and ankle clonus and a bilateral extensor response. The sensory loss was variable from day to day. Lipiodol was partially arrested at the level of the eleventh thoracic vertebra, and after 48 hours most of the oil had gravitated down to the bottom. A laminectomy revealed numerous adhesions between the dura and the cord (see fig. 12).

It is most unusual for osteoarthritis of the spine to cause compression of the cord. Some observers have reported cases in which this has occurred. Bailey and Casamajor¹² in 1911 published five cases of patients suffering from damage of the cord and its roots due to chronic inflammatory disease of the spine. Parker and Adson¹³ in 1925 have also reported eight other cases. These authors maintain that in cases of osteoarthritis of the spine causing pressure symptoms the X-ray findings may be entirely negative as the overgrowth of bone in the early stages is soft and contains little calcium. In all their cases the condition was focal and confined to from one to four vertebræ. The symptoms and signs were similar to those of an extramedullary tumour but the pain produced was less spontaneous and more affected by posture, movement and exertion. Partial or complete spinal block was diagnosed in six of their cases by serological examinations, but in none of the cases was a lipiodol injection carried out. The following is a case of osteoarthritis of the spine with pressure symptoms and showing partial lipiodol arrest.

Male, æt. 53. Seven months' history of pains in the groins shooting down the legs and of difficulty in walking. The patient presented a spastic paraplegia with increased deep reflexes, ankle clonus and a bilateral Babinski sign. There was also some sensory loss below the level of the eleventh dorsal segment. An X-ray of the spine showed marked osteoarthritis of the tenth and eleventh thoracic vertebræ with 'parrot-beaking.'

Lipiodol was partially and temporarily held up at this level. A laminectomy was performed and the cord exposed between the tenth thoracic and the first lumbar vertebræ. Some extradural fat was present but no tumour was found.

Marked deviation of the spinal column does not usually cause pressure on the cord sufficient to hold up lipiodol, and if any obstruction be present some other cause should be suspected, such as spinal caries or a cancerous deposit. Of two cases with marked deformity of the spine in which a lipiodol examination was carried out, one did not show any lipiodol obstruction while the other showed some lipiodol arrest; in the latter, however, the patient had had a fall in childhood and the lipiodol arrest may have been due to the presence of meningeal adhesions.

III. *Complete arrest.*—This is characteristically seen in cases of spinal cord tumours. The shape of the lipiodol shadow at the site of the obstruction may vary. The lower border may be straight and horizontal, but it is more frequently irregular in shape, indented and somewhat ragged (see fig. 13), or may assume a typical crescentic or cupped appearance (see fig. 14). Sometimes lipiodol may be seen to encircle the tumour and to outline its shape, while a little of the oil may pass through and may be seen in the form of droplets below the level of the tumour. In other cases it may be held up for a considerable distance above the level of the obstruction by adhesions due to arachnoiditis accompanying the presence of a tumour. In cases of tumours involving the cauda equina lipiodol may be seen to infiltrate between

the matted nerve-roots and the shadow may take the shape of a comb with its teeth pointing downwards.

It is rarely possible to determine the nature of the tumour by the shape of the lipiodol shadow. Mixer¹⁴ maintains that a cup or crescent, complete or incomplete, indicates an extramedullary tumour, while narrow lines at either side with an irregular mass above suggest a fusiform enlargement

FIG. 13. *Case of extramedullary tumour.* Complete lipiodol block at the level of the third thoracic vertebra. The lower border of the lipiodol shadow is irregular and indented; at the operation a cystic tumour the size of a pea was enucleated and the cord was found to be flattened underneath it.

FIG. 14. *Case of extramedullary tumour (dural endothelioma).* Complete lipiodol block at the level of the fifth thoracic vertebra with typical crescentic appearance. An ovoid tumour was successfully removed. The patient seen five years after the operation had completely recovered.

of the cord from an intramedullary tumour. This, however, has not been confirmed by other observers, and it is often quite impossible to form a definite opinion on the nature of the tumour from the lipiodol shadow alone. Nevertheless, a lipiodol examination has its definite field of usefulness as it provides a direct means of demonstrating spinal block and of accurately localizing the level of obstruction. The surgeon is given a definite level on which to centre a laminectomy, as the site of the lipiodol block nearly always corresponds accurately to the position of the tumour. In each of six cases of spinal tumour, which were all confirmed either by operation or at autopsy,

the lipiodol block accurately localized the position of the tumour, whereas there had been a tendency to localize the tumour neurologically below its actual level (see table). This may be explained by the fact that in early cases sensory changes may only be slight and the extreme upper limit of sensory loss may be ill-defined and lost; moreover even in cases presenting a complete or almost complete interruption of the cord the level of total anæsthesia is only a guide to the lowest segment which is completely interrupted and gives no indication of the vertical extent of the lesion (Armour).

TABLE.		
Case	Lipiodol arrest (vertebra).	Neurological level (segment).
I	D5	D7
II	D8	D9
III	D3-4	D9
IV	D9	D10
V	D11	D9
VI	L5	S1

It will be seen from this table that if suitable allowance is made for the obliquity with which the afferent sensory fibres cross the cord and for the position of each segment of the cord with regard to its corresponding bony segment, the neurological localization in the above series of cases was fairly accurate. In one case, however, the tumour was localized neurologically below its actual level (Case III), while in another the level of sensory loss was above the level of spinal block (Case V).

CONCLUSIONS.

In conclusion it may be remarked that the injection of lipiodol into the cistern is a valuable adjunct to the diagnosis of spinal block. Although manometric and serological examinations of the cerebrospinal fluid may often give all the information which is required, a lipiodol examination provides additional and unequivocal evidence of spinal block, and is a means of accurately localizing the level of obstruction. A negative finding (no lipiodol arrest) can usually be taken as sufficient proof that there is no spinal block. Partial or even complete obstruction to the lipiodol flow may be brought about by conditions other than spinal tumour, and among the conditions which offer the greatest difficulty in the differential diagnosis are pachymeningitis, syringomyelia and meningitis serosa circumscripta. As a rule a lipiodol injection into the cisterna magna, if properly carried out, is a perfectly safe procedure and does not give rise to any marked or lasting symptoms of reaction. Caution, however, should be taken in inflammatory conditions of the cord and meninges, as in these cases the iodine component of lipiodol may have a congestive action and may lead to an aggravation of symptoms.

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