MYELOGRAPHIC STUDY ON LESION OF THE LUMBAR INTERVERTEBRAL DISC

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In Japan. systematic investigations upon causes of intractable low back pain and sciatic pain have been carried out by Kondo, Yamada, Ito and others since 1941. Recently great advances have been made especially in the study on protrusion of the lumbar intervertebral disc. However, there are many traumatic lesions of the lumbar spine, such as disc lesion without protrusion, traumatic meningitis spinalis adhesiva, fracture or dislocation of the lumbar spine, spondylolysis and spondylolisthesis which play important role in causing severe low back pain or sciatic pain. In these diseases, epidural myelography give definite findings where routine mylelography fails, and throw light on their obscure pathological changes.

The purpose of this paper is: (1) to crystallize the results of our experiences on causes of sciatica, especially with reference to myelographic findings; and (2) to discuss the causative factors of sciatica and their pathological changes.

The records of patients treated for sciatic pain include 139 cases. In this series, intervertebral disc protrusion far outnumbered all other causes of sciatic pain; next in frequency is disc lesion without protrusion; then traumatic meningitis spinalis adhesiva and finally dislocation of the lumbar spine (Table I).

Of these cases 133 were operated upon, the remaining six were cases of dislocation.

TABLE I

	Cases	Per cent
Intervertebral disc protrusion	100	71.9
Disc lesion without protrusion	17	12.2
Meningitis spinalis adhesiva	10	7.1
Dislocation of the lumbar spine	6	4.5
Spondylolysis	5	3.5
Spondylolisthesis	1	0.8
Total	139	100.0

I. TECHNIQUE OF EPIDURAL MYELOGRAPHY AND ITS NORMAL ROENTGENOGRAM

Technique of Epidural myelograpy

The radiopaque medium is injected into epidural space just above the affected segment. Ordinarily, the site between second and third spinous processes is chosen for puncture, because most lumbar lesions occur in the lower lumbar spine.

At first, the lumbar puncture needle is inserted into the subarachnoid space as in routine lumbar puncture. When spinal fluid begins to flow out by drops upon withdrawal of stylet, the needle is gradually withdrawn until the spinal fluid ceases to drop, and the liquor in the hole of the needle is seen to move with the respiratory movements of the patient.

In this condition, the point of the needle is situated exactly in the epidural space.

3 cc of Moljodol is now slowly injected. Several hours after this roentgenograph is taken.

Normal Roentgenoram

Although a part of the contrast medium injected into the epidural space extends upward for one vertebral segment above the injected site, the most of medium begins to descend along two routes in the epidural space.

First Route

A greater part of the contrast medium descends along two long venous plexuses which pass longitudinally in contact with the wall of the spinal canal and, at each intervertebral foramen, a small quantity of medium passing through it flows down along the blood vessels and peripheral nerves to the lumbar muscles. Roentgenographically this main route forms two longitudinally coursing parallel lines with small infero-lateral branches (Fig. 1).

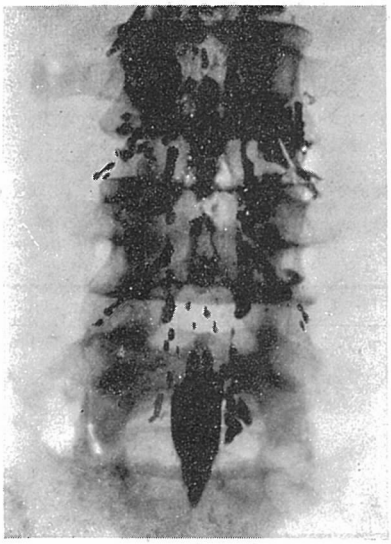

Fig. 1

Fig. 2

Fig. 1. Normal epidural myelogram. First route–Two longitudinally coursing parallel lines with infero–lateral branches. Second route–Small drop-like shadows which equally scattered in the spinal canal.

Fig. 2. Resin cast of the intraspinal venous plexuses of rabbit, showing course of the venous plexuses exactly similar to the first route.

Fig. 2 represents resin cast of the intraspinal venous plexuses of rabbit, showing the course of the venous plexuses exactly similar to the first route above described.

Second Route

A lesser part of the contrast medium flows down through the lymphatic spaces in the epidural fatty tissue.

In consequence, roentgenogram shows many small drop-like shadows which are equally scattered in the spinal canal (Fig. 1).

In practice, the technique of epidural myelography is not always so easy. If the site of injection of the contrast medium happens to deviate from the median line of the epidural space, the medium descends along the corresponding side, and never extends across the median line to the opposite side (Fig. 3).

Moreover, we may meet with variations in the normal pattern of epidural myelogram, such as a rupture of first route or a defect of the infero-lateral branches of the first route (Fig. 4).

II. Epidural Myelogram of Intervertebral Disc Protrusion

In certain cases of disc protrusion the contrast medium injected into the epi-

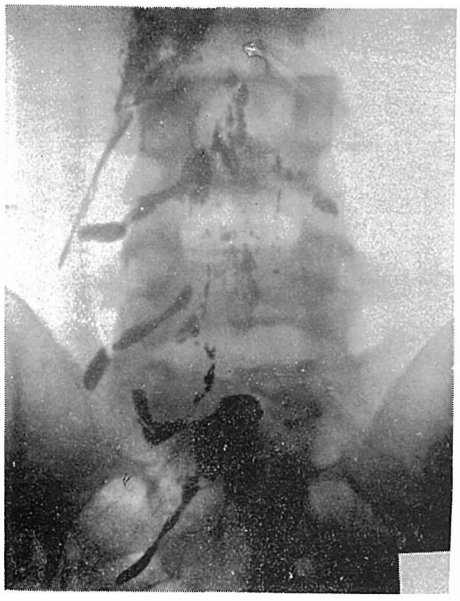

Fig. 3

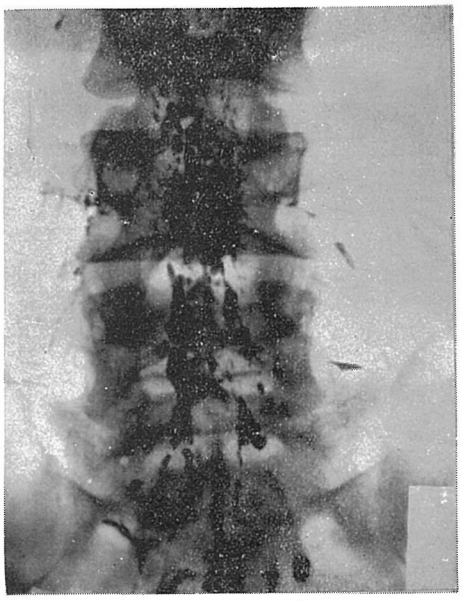

Fig. 4

Fig. 3. Epidural myelogram. If the site of injection of the Moljodol happens to deviate from the median line of the epidural space, the medium descends along the corresponding side. Protrusion of the fourth lumbar disc.

Fig. 4. Epidural myelogram. Defect of the infero-lateral branches of the first route.

dural space may stagnate above the affected area and never flows through it, while in other cases, a lesser part of the medinm may pass around the affected area (Fig. 5).

Consequently, the contrast medium immediately above the lesion overflows peripherally through the related intervertebral foramina (Fig. 6).

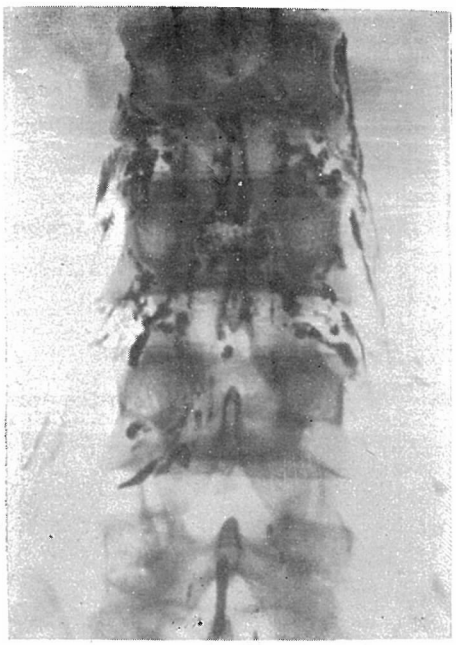

Fig. 5

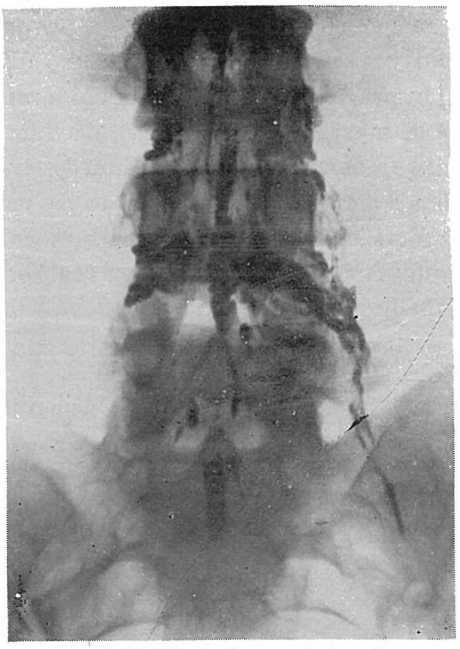

Fig. 6

Fig. 5. Epidural myelogram of disc protrusion. Indistinctly outlined filling defect around the fourth lumbar disc.

Fig. 6. Epidural myelogram of disc protrusion. The contrast medium above the lesion overflows peripherally through the related intervertebral foramina.

In most cases, roentgenogram shows a larger indistinctly outlined filling defect than that obtained by routine myelography (Fig. 7, 8 and 9). This fact suggests a development of chronic inflammation in the epidural tissue around the protruded disc, resulting in hindering of passage of the contrast medium. Moreover, a subsequent operation revealed cicatricial changes in the epidural fatty tissue and a strong adhesion between the nerve root and the protruded disc.

Histological examination of the epidural fatty tissue showed hyperaemia, congestion of the veins, cellular infiltration and cicatricical changes.

It is not very rare to find this adhesive process in the epidural tissue to extend over to the meninges.

In such cases, routine myelogram shows multiple, complicated filling defects

peculiar to meningitis spinalis adhesiva, lacking clear, round defect indicating disc protrusion.

The following case (Case 1) illustrates a picture of disc protrusion accompanied by meningitis spinalis adhesiva.

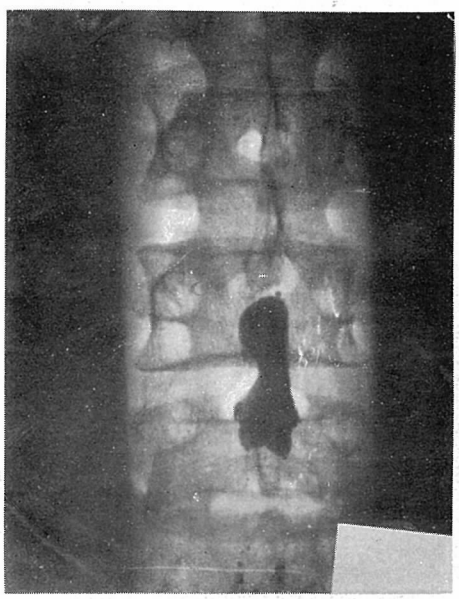

Fig. 7

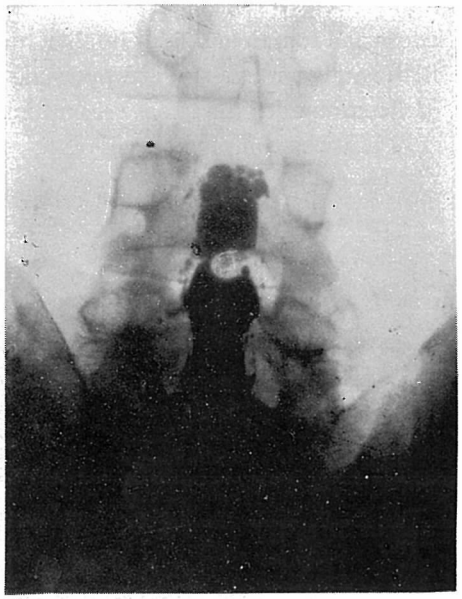

Fig. 8

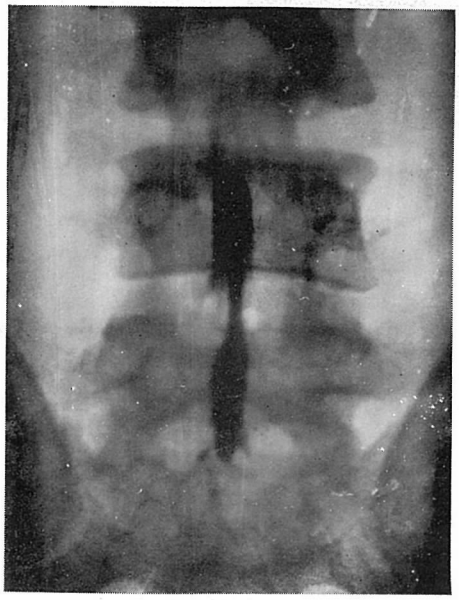

Fig. 9

Fig. 7. Routine myelogram of disc protrusion. Clear round filling defect.

Fig. 8. Routine myelogram of disc protrusion. Clear round filling defect.

Fig. 9. Routine myelogram suggests hypertrophy of ligamenta flava. Operation revealed hypertrophy of ligamenta flava and disc protrusion.

Case 1—Man, aged 40.

Admitted with severe low back pain. About five months before admission twisting of the low back caused severe sciatic pain. Since then, the pain has gradually increased. A routine myelogram showed multiple irregular filling defects in the lower lumbar region (Fig. 10). Operation revealed a small protruded disc between the fourth and fifth lumbar vertebrae and an excessive adhesion between the fifth lumbar nerve and the protruded disc. Division of the adhesion and excision of the protruded disc were accomplished. The subarachnoid cavity was not opened.

Pain was completely relieved.

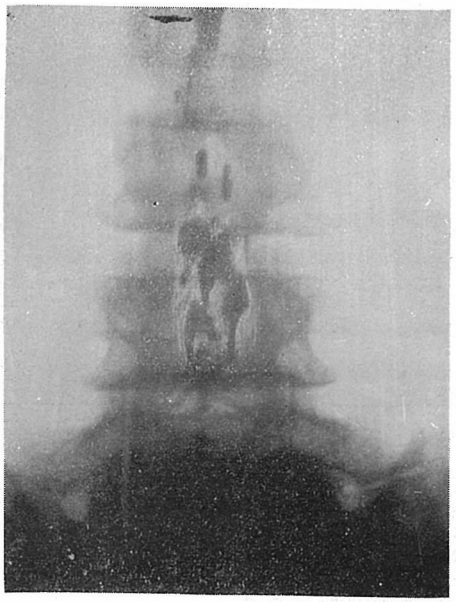

Fig. 10. Routine myelogram showed adhesive process in the subarachnoid cavity. Operation proved protrusion of the fourth lumbar disc and strong adhesion between the disc and the nerve root.

III. Epidural Myelogram of Disc Lesion Without Protrusion

R. H. Young[2] (1951) reported a study of 957 patients operated on for back pain.

In the 913 cases with operative treatment in this series, the following findings were recorded: disc protrusion, 750 cases; disc lesion without protrusion, eighty-two; osteoarthritis causing root irritation, twenty-two; abscess, three; tumors, two; epidural adhesion, twelve; negative exploration, forty-two. The disc lesions other than protrusion included (1) a bulging, spring annulus with a degenerated and fragmented disc; (2) a soft area in the disc; (3) "scarred disc," meaning a inelastic narrowed disc to which the nerve is often adherent.

O'Connell[3] (1951) reported a clinical review based on 500 cases treated by excision of the protrusion. In this series, 400 cases of protrusion and 91 cases of concealed ruptured disc were recorded.

In our clinic, of 133 cases operated on for typical radicular sciatica, 17 cases of concealed ruptured disc were recorded. In these cases, although routine myelography failed, epidural myelogram showed characteristic filling defects which is similar to that in disc protrusion (Fig. 11 and 12).

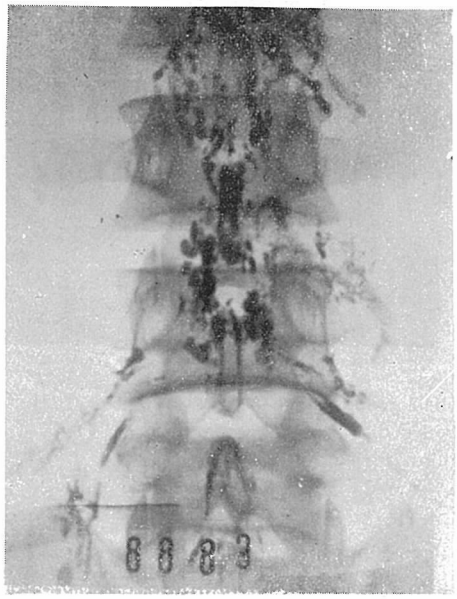

Fig. 11

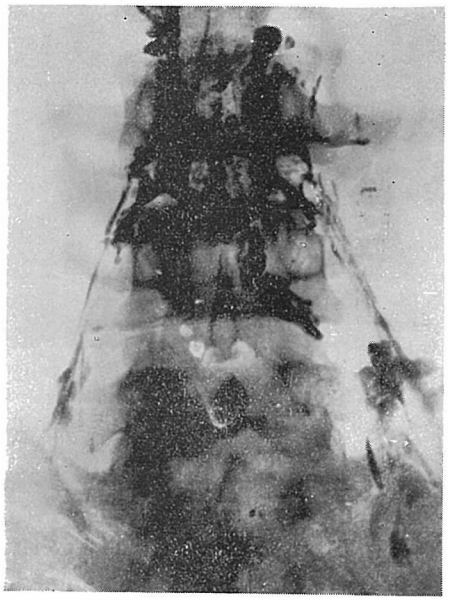

Fig. 12

Fig. 11. Epidural myelogram of disc lesion without protrusion. Characteristic filling defect which is similar to that in disc protrusion.

Fig. 12. Epidural myelogram of disc lesion without protrusion.

Operation revealed a soft area in the disc (3 cases), a scarred disc (12 cases) and a calcification of the disc (2 cases) to which the nerve root is adherent, as shown in Case 2. Pathological changes in the epidural tissue, such as hyperaemia, congestion of the veins, cellular infiltration and cicatricial changes were seen, just like those in disc protrusion.

In Case 2, a calcified disc without protrusion was demonstrated.

Case 2—Man, aged 30.

Six months before admission, low back pain developed. Routine myelogram showed round filling defect in the third lumbar intervertebral area and a dense round shadow in the related disc (Fig. 13). Operation proved a calcified disc without protrusion and adhesion between the nerve root and the affected disc.

One month after operation the clinical symptoms completely disappeared.

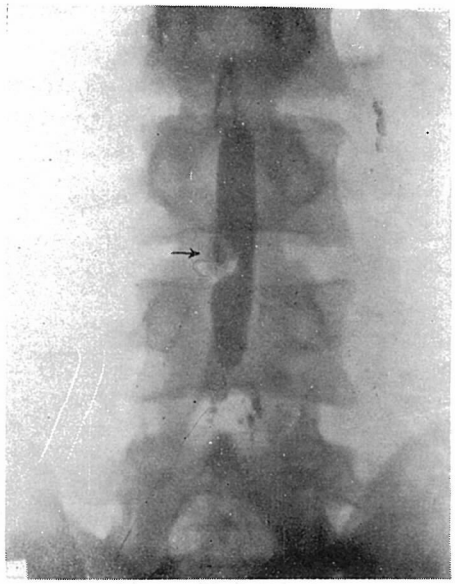

Fig. 13

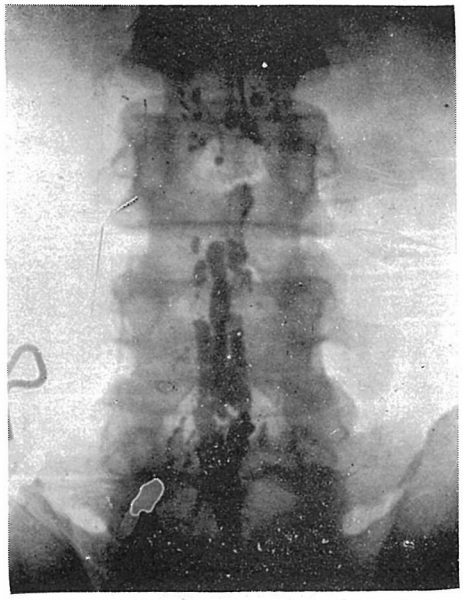

Fig. 14

Fig. 13. Routine myelogram shows clear round filling defect. Arrow indicates calcified disc. Calcified disc without protrusion.

Fig. 14. Routine myelogram. Irregular filling defects peculiar to meningitis spinalis adhesiva. Scarred disc without protrusion.

In certain cases of disc lesion without protrusion, routine myelogram shows typical findings indicating adhesive processes in the subarachnoid cavity, as in Case 3.

Case 3—Man, aged 32.

Admitted with severe low back pain. Ten years ago, patient fell down upon the buttocks. After that he had suffered from severe low back pain and cold feelings of the right leg. Routine myelogram showed multiple irregular filling defects in the lower lumbar region (Fig. 14). Operation proved a scarred disc and excessive cicatricial adhesion between the nerve root and the scarred disc.

The subarachnoid cavity was not opened. On reexamination pain was much improved.

This case may suggest that epidural adhesive processes spread to the subarachnoid cavity, as in disc protrusion.

Moreover, in a case operated on for disc lesion without protrusien, one year after operation, a typical disc protrusion developed.

From these facts, it is clear that disc protrusion and disc lesion without protrusion are closely connected with each other, and the latter includes an immature form which may be followed by disc protrusion and a cured form as shown in Case 2.

IV. Relation Between Traumatic Meningitis Spinalis Adhesiva and Disc Lesion

As above described, in rare cases, disc protrusion or disc lesion without protrusinn is accompanied by so-called meningitis spinalis adhesiva. Since the studies made on traumatic back pain during the World War I, meningitis spinalis adhesiva due to acute trauma has been generally recognized. Especially fracture or dislocation of the spine is inevitably followed by chronic inflammation in the epidural tissue and meninges, resulting in meningitis spinalis adhesiva. Furthermore, acute trauma to the low-back frequently results in so-called meningitis spinalis adhesiva without any roentgenological findings of destruction of the spine, as shown in Case 4 and 5. In these cases, operation usually revealed the disc lesion.

Case 4—Man, aged 32.

Six months before admission, patient received a violent blow to the low back.

Three months later, low back pain developed and became more and more severe.

Routine myelogram showed irregular multiple filling defects (Fig. 15).

Operation revealed a scarred disc and a strong cicatricial adhesion between the nerve root and the wall of the spinal canal. Division of this epidural adhesion was performed, resulting in a cure.

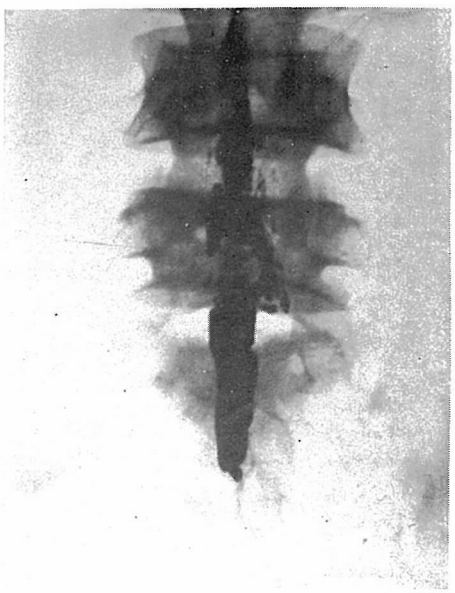

Fig. 15

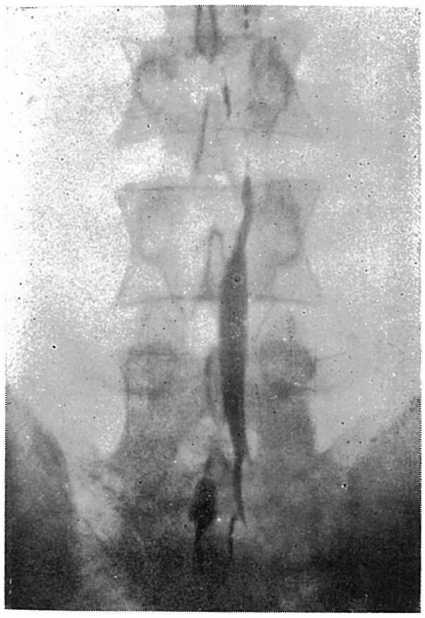

Fig. 16

Fig. 15. Routine myelogram. Irregular filling defect peculiar to meningitis spinalis adhesiva. Scarred disc without protrusion.

Fig. 16. Routine myelogram suggests narrowing of the subarachnoid space. Scarred disc and excessive scar formation in the epidural space.

Case 5—Man, aged 22.

Six months ago, a violent blow to the low back caused severe sciatic pain.

Routine myelogram showed narrowing of the subarachnoid cavity (Fig. 16), suggesting development of cicatricial change. Operation proved a marked cicatricial change in the epidural tissue and a scarred disc.

Furthermore, in a case of sciatica caused by acute violent blow to the low back, calcification of the disc was found (Case 6).

Case 6—Man, aged 53.

One year ago, patient fell twenty feet to the ground. After that he had suffered from severe sciatic pain and right paralytic drop foot. Roentgenogram showed a calcified area in the fourth lumbar disc and lipping of the neighbouring borders of the fourth and fifth lumbar vertebrae (Fig. 17).

Routine myelogram showed an angular filling defect in the fourth lumbar disc region (Fig. 18). Operation revealed a calcified disc and scar formation in the epidural space. Division of the adhesion and spinal fusion were performed.

Three months after operation pain has almost completely disappeared.

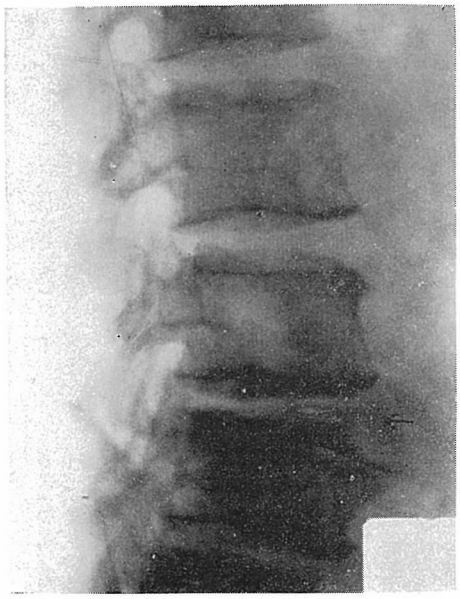

Fig. 17

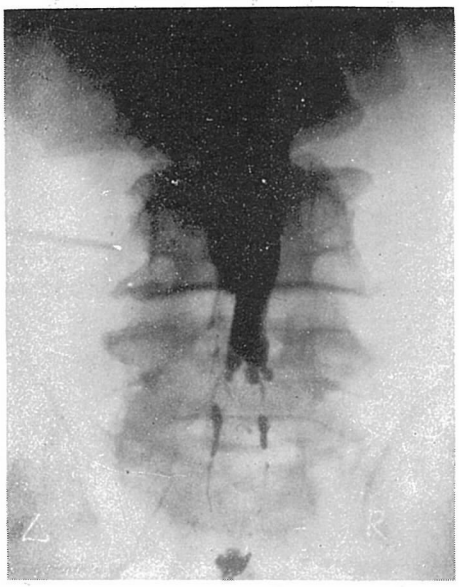

Fig. 18

Fig. 17. Arrow indicates calcification of the fourth lumbar disc.

Fig. 18. Routine myelogram. Angular filling defect and lipping of the fourth and fifth lumbar vertebrae. Calcified disc without protrusion.

These three cases prove that acute violent trauma to the low back usually results in a disc lesion. In our clinic, as extreme examples of the lumbar disc

lesion due to acute trauma, 6 cases of typical dislocation of the lumbar spine were recorded (Fig. 19 and 20). In lumbar spine, typical dislocation occurs much more frequently than compression-fracture. Table II. showed causes and types of these dislocations.

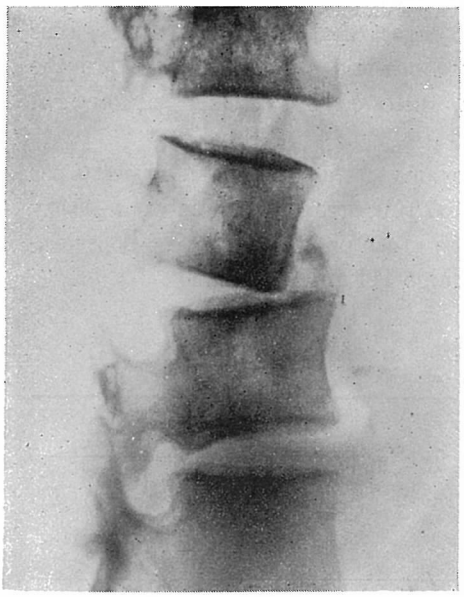

Fig. 19

Fig. 19. Dislocation of the lumbar spine

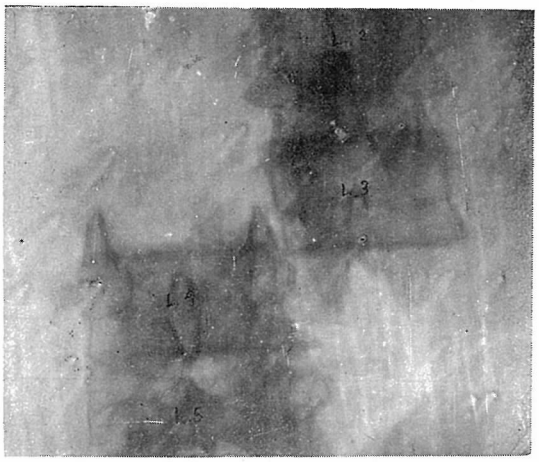

Fig. 20

Fig. 20. Dislocation of the lumbar spine

TABLE II

Dislocation of the Lumbar Spine

Number of Case	Cause	Type	Site
1	Twisting	lateral	III–IV
2	Twisting	lateral	III–IV
3	Twisting	lateral	III–IV
4	Flexion	anterior	III–IV
5	Flexion	posterior	III–IV
6	Flexion	posterior	V–Sacrum

Hattori,[4] in experimental study on human specimen of the lumbar spine, proved that twisting force easily caused a ruptur of the lumbar disc without destruction of the vertebral body.

These facts suggest that the lnmbar disc forms the most vulncable point of the spine and so-called meningitis spinalis adhesiva due to trauma may be caused by disc lesion followed by chronic inflammation of meninges, and have no definite difference from disc lesion without protrusion.

V. Discussion

There are many non-infectious diseases of the lumbar spine causing low back pain or sciatic pain, such as disc protrusion, disc lesion without protrusion, traumatic meningitis spinalis adhesiva, dislocation or fracture-dislocation of the lumbar spine, spondylolysis and spondylolisthesis.

Clinical experiences with these diseases suggest that the intervertebral disc forms a structual weak point in the spine and chronic or acute trauma to the lumbar spine easily results in a disc lesion, followed by various pathological changes as above described.

Statistical investigation of lumbar disc lesions revealed that about fifty per cent of the cases had definite history due to twisting strain while lifting a heavy object, and a high percentage occured at an age, when physiological disc degeneration had already advanced to some extent (Table III and IV).

Table III
Causes of Disc Lesion

	Disc protrusion	Disc lesion without protrusion
Twisting while heavy lifting	22	4
Twisting	17	3
Blow to the low back	9	1
Fall on the buttocks	4	1
Unknown	48	8
Total	100	17

Table IV
Age of Patient with Disc Lesion

Age	Disc protrusion	Disc lesion without protrusion
11–20	3	0
21–30	36	4
31–40	41	7
41–50	42	4
51–60	6	2
60–	2	0
Total	100	17

Moreover, in the lumbar spine, typical traumatic dislocation frequently occurs, as shown in Table II.

Roentgenological examination of the range of movement of the lumbar spine proved that the lower lumbar articulation where disc lesion most commonly occurs, have greater mobility than the upper articulation (Table V).

Cinematographic analysis of the posture of skilled labourers at work revealed that, while heavy lifting, they fixed their lumbar spines as straight as possible, avoiding excessive lumbar bending, and this limited motion of the lumbar spine

was compensated for coordinated flexion of the lower limbs at knee and hip joints.

TABLE V
Range of Movement of the Lumbar Spine

Articulation	Range of movement (degree) average (maximum-minimum)		Per cent
I -II	9.5	(13- 7)	15
II–III	9.5	(14- 5)	15
III–IV	11.2	(16- 7)	18
IV–V	15.3	(24–11)	25
V–Sacrum	16.7	(29- 6)	27
Total	62.2	(78–54)	100

These postures serve the purpose of protecting the intervertebral disc from injury.

These facts prove that the intervertebral disc forms the most vulneable point of the spine and mechanical factors have close association with development of acute or chronic disc lesion.

As afore-mentioned, the majority of so-called traumatic meningitis spinalis adhesiva develops on the basis of disc lesion and should be included in concealed ruptured intervertebral disc. This fact was supported by Hayashi's study on experimental disc lesion, in which operative incision in the ventral part of the intervertebral disc caused not only disc protrusion through the incised part of the annulus fibrosus, but also, in spite of no injury to the dorsal part of the annulus fibrosus, more or less inflammatory changes in the epidural tissues, such as wide spread edema, blood vessel engorgement, fibrin exsudation and cellular infiltration.

Kondo and his colleague Yamada,[1] on examination of the nerve roots obtained at autopsy from a case with disc protrusion, demonstrated radiculitis and ganglionitis.

It is thought that these pathological changes in the nerve root may produce the typical clinical features of disc lesion. These clinical and histological facts lead to conclusion that although disc protrusion, disc lesion without protrusion and meningitis spinalis adhesiva show more or less different pathological changes in the disc, nerve root and meninges, they originally develop on the basis of a disc lesion due to chronic or acute trauma and a combination of meningitis spinalis adhesiva and other diseases frequently occurs.

In other words, most cases of traumatic radicular sciatica, including spondylolysis and spondylolisthesis, form a system with disc lesion as center.

VI. SUMMARY

1. Myelographic examination of 133 cases of radicular sciatica were performed.

Especially epidural myelography for disc lesion gave good results where routine myelography failed.

2. The great majority of radicular sciatica, including the cases showing disc protrusion, disc lesion without protrusion, traumatic meningitis spinalis adhesiva, dislocation of the lumbar spine, spondylolysis or spondylolisthesis, develops originally on the basis of a disc lesion.

3. Disc lesion without protrusion (concealed ruptured disc) includes an immature form which may be followed by disc protrusion and a cured form, such as scarred disc and calcified disc.

4. Disc lesion with or without protrusion inevitably results in chronic inflammatory changes in the epidural tissue, meninges and nerve root, which may produce typical clinical features of disc lesion.

5. The majority of so-called traumatic meningitis spinalis adhesiva is one with disc lesion without protrusion.

Grateful acknowlegment I want to make to Prof. Tetsuo Ito for his kind abvice during this study.

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