Positive contrast (Pantopaque) myelography: with a note of its current status

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IT IS MORE than 50 years since Dandy (1919) first attempted the visualisation of spinal cord tumours by introduction of air into the subarachnoid space. The development of positive contrast myelography, however, came about by accident, when Sicard and Forestier (1922) accidentally introduced Lipiodol into the subarachnoid space and observed free movement of the contrast material. Before long, investigators were using Lipiodol in the investigation of spinal cord lesions. By about 1934, positive contrast myelography achieved widespread popularity and replaced air myelography as the method of choice.

Lipiodol has its inherent drawbacks in that globules formation makes interpretation difficult and its irritant effect on the pia arachnoid could eventually lead to adhesive arachnoiditis. The introduction of the relatively non-irritating Pantopaque in 1944 was a major step in the development of this procedure. The current accepted practice is to use quantities ranging from 10 to 20 c.c., depending on the site of examination. As a rule, use of such large amount necessitates removal of as much of the contrast material as possible after the examination, although in some instances, it may be desirable to leave it behind should a re-examination is contemplated.

Pantopaque Arachnoiditis

Also marketed as Myodil in some countries, Pantopaque is a mixture of ethyl esters of isomeric iodophenyundecylic acid, and contains 30% of organically bound iodine. It has a specific gravity of 1.260 and is much less viscous than Lipiodol, enabling it to flow more freely and does not globulate as easily. It is a relatively inert substance and when left behind in the subarachnoid space is slowly absorbed at the approximate rate of 1 c.c. per year. Very rarely a low-grade arachnoiditis is reported (Grainger 1960). However, arachnoiditis following repeated diagnostic lumbar punctures alone is a common enough observation for one to reflect that Pantopaque by itself should not be readily incriminated as the causative factor. In the two fatalities reported in the literature (Erickson and Van Baaren 1953; Mason and Raaf 1962) cause of death was thought to be due to extensive basal adhesive arachnoiditis. Mason and Raaf postulated

that the initiating factor was a hypersensitivity reaction to Pantopaque leading to an aseptic meningitis. Both Epstein (1969) and Gass (1963) stated that fear of severe or fatal sequelae, following spill of Pantopaque into the cranial cavity, had been unjustifiably overstressed.

Animal experiments have shown that blood has a potentiating action in the production of moderately severe or very severe arachnoiditis in company with Pantopaque (Howland and Curry 1966). These severe reactions were observed more consistently than those produced by Pantopaque alone. Therefore, it may not be advisable to carry on with a Pantopaque myelogram if bleeding had occurred following a spinal puncture. Equally important is the care exercised to avoid subarachnoid bleeding during removal of the contrast material. Some workers advocate the administration of steroids in such cases to forestall the onset of arachnoiditis but results have not been persistingly encouraging. The whole question of pathogenesis of Pantopaque arachnoiditis still awaits clarification. As a whole, it is a satisfactory agent matching the ideal myelographic medium in many ways.

Technique of Examination

The examination can be performed via a lumbar or cisternal puncture. It is not intended to deal in any detail on the former except to stress the importance of a non-traumatic puncture before introducing the contrast. The patient should not be subjected to a diagnostic lumbar tap for at least a week prior to the examination to avoid creating a communication between the subarachnoid and the subdural space. A subdural injection of contrast renders the whole examination uninformative and makes interpretation of future examinations difficult. It is wellknown that sciatic pain can be produced by abnormalities as high as D9 and D10 levels. In investigating suspected lumbar disc herniation, it is mandatory to run the contrast up to at least the mid-dorsal region. The patient should also be examined supine, particularly in suspected arachnoid diverticula and vascular anomalies which are located usually in the dorsal aspect of the cord.

Cisternal Puncture

Because of the adequate information obtained by the lumbar route using large amount (18 to 24 c.c.) of Pantopaque in the investigation of high cervical and thoracic lesions, the cisternal route is infrequently employed unless for the following reasons:

(i) To demarcate the superior margin of an obstructive lesion particularly when obstruction is complete.

(ii) When lumbar puncture is contra-indicated, as in cases of infection or in conditions where a low termination of the spinal cord is suspected.

The patient is preferably examined prone on a tilting X-ray couch. The head is slightly flexed and the couch inclined at approximately 20° with the patient's feet down. This allows the contrast to gravitate towards the cervical spine. The use of fluoroscopy with image intensification and television monitoring aid the procedure considerably as the examiner can determine the position of the needle in relation to the spine. The direction of flow of contrast when introduced into the subarachnoid space can also be observed.

The area of skin in the suboccipital region is shaved and a small amount of xylocaine 1% is infiltrated into the subcutaneous and deep tissues. A small short bevel spinal needle of approximately 7-8 cm. in length is inserted in the mid-line in the depression between the spinous process of C2 and the base of the skull (De Jong 1967). The point of insertion is determined by drawing a horizontal line that joins the tips of the mastoids and intersecting the mid-line at right angles. The direction of the needle is parallel to the cantho-meatal line initially (Fig. 1).

DIAGRAM ILLUSTRATING THE TECHNIQUE OF CISTERNAL PUNCTURE (AFTER R. SHAPIRO).

Fig. 1: Cisternal puncture. Dotted needle shows initial position in relation to skull base. (CM=cisterna magna).

When the needle strikes the skull base it is withdrawn slightly and re-directed a little more vertically. It is now slowly advanced anteriorly and superiorly to skirt the rim of the foramen magnum and pierce the atlanto-occipital ligament. A characteristic "give" is felt by the examiner as the ligament is traversed. The stylet is now removed for cerebral spinal fluid (CSF) to flow out to indicate entry into the cisterna magna. The needle is advanced a further 2 to 3 mm. to ensure its tip is in the centre of the cistern. Failure to do so may result in partial extravasation of contrast into the subdural space during injection. About 3 to 4 c.c.

of CSF are now removed and the same amount of Pantopaque slowly injected. The needle is now withdrawn and the patient asked to extend his neck to facilitate gravitation of contrast into the cervical lordotic curve. Fluoroscopy and spot filming may now be carried out in the usual way.

Complications

These are listed in Table 1. Rare but serious complications of cisternal puncture include subarachnoid haemorrhage and accidental puncture of the brain stem.

nation showed Protein: 240 mgm%, RBC: 124/m.m.^{3} and Sugar: 14 mgm%. Plain X-ray of lumbo-sacral spine disclosed slight narrowing of L4/L5 disc space. Myelogram revealed a partial block at L3/L4 and a disc lesion at L4/L5 level. There was a serpentine shadow in the upper lumbar region extending cranially to the mid and lower dorsal spine. Findings were in keeping with a vascular anomaly (Fig. 2).

Comments

The above case illustrates a typical myelogra-

TABLE 1

LIST OF 4 SIGNIFICANT COMPLICATIONS OF PANTOPAQUE MYELOGRAPHY

Complications	Authors	Clinical Manifestations	Remarks
(1) Venous Intravasation (following sudden rise in C.S.F. pressure)	Hinkel (1945)	Pulmonary embolism.	Recovery
(2) Adhesive Arachnoiditis	Davis (1956)	118 cases of myelography reviewed. Symptoms include: chronic headaches, back pain, incontinence, intercostal neuralgia, paraesthesia of 4 extremities.	8 confirmed cases of arachnoiditis (5 at laminectomy, 3 at post-mortem, patients dying from unrelated causes).
(3) Severe meningeal irritation	Taren (1960)	Patient developed cranial nerve palsies and stupor.	Recovery
(4) Aseptic Meningitis and Death	Erickson and Van Baaren (1953)	Patient had hypersensitivity reaction the next day. Progressive illness of 15 months.	Death. Basal adhesions hydrocephalus.
	Mason and Raaf (1962)	Hypersensitivity reaction immediately after procedure. 7 months of progressive illness.	Death. Extensive exudative basal adhesions.

Indications

Indications are numerous and varied. It is difficult to outline a comprehensive set. The following are some conditions selected with a view to bring its value and limitations into better perspective.

I. Congenital: Vascular Malformations

Case 1

A 39-year-old male Indian patient complained of low back pain, and urinary and faecal incontinence for one month. Physical examination disclosed a positive Kernig's sign with saddle anaesthesia over S2 to S4 dermatomes. Knee and ankle jerks were diminished. Cerebral spinal fluid examiphic picture of the condition. The myelographic features in some respects are dependent on the morphology of the lesions. Pathologically, they are divided into four categories (Teng and Papatheodorou 1964), the commonest being the venous anomalies followed by the arterial, arterio-venous and the telangiectatic varieties. Myelography is an indirect means of visualisation of these lesions and, where possible, should be supplemented by selective aortic or vertebral arteriography, if ligation of the arterial feeders is contemplated (Houdart, Djindjian and Hurth 1966). Contrary to popular belief, these anomalies are not rare but are often overlooked because of inadequate examination and

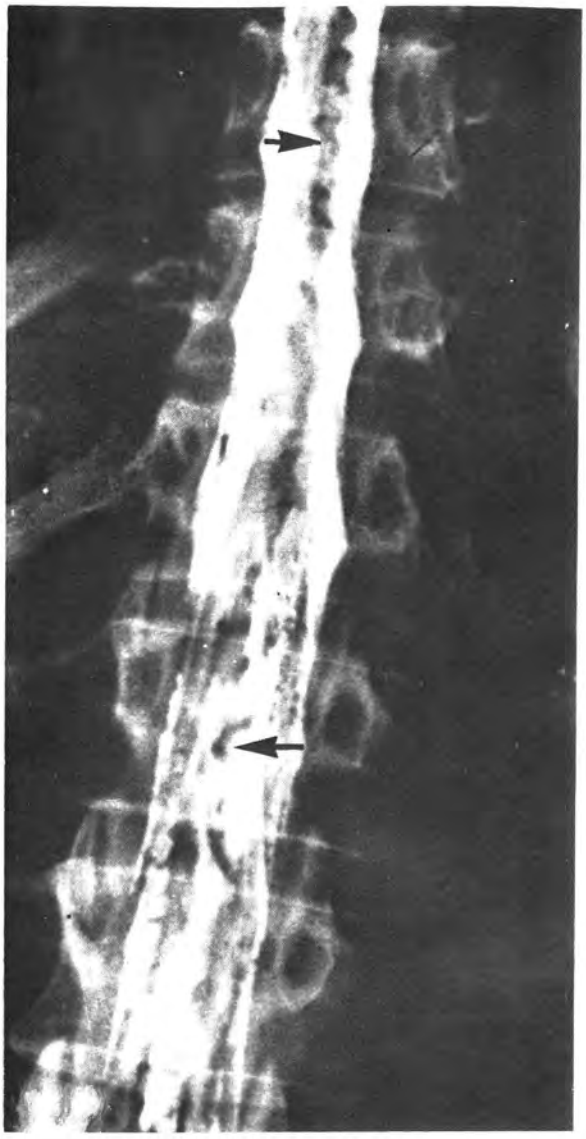

Fig. 2: Angioma of the spinal cord. Serpentine shadow extending from lumbar to lower dorsal region (arrows).

atypical presentation at myelography. In Teng and Papatheodorou's series, only two of their 15 cases had a correct preoperative diagnosis. In the remaining cases, the myelographic features were bizarre and provided no indication of a vascular lesion. A few cases with irregular filling defects were mistakenly labelled as arachnoiditis preoperatively.

II. Post Traumatic Sequelae: Brachial Plexus Injury

Case 2

A 23-year-old male Indian patient sustained an injury to his left shoulder and upper arm following a motor vehicle accident two years ago. He was unable to move his left upper limb ever since and

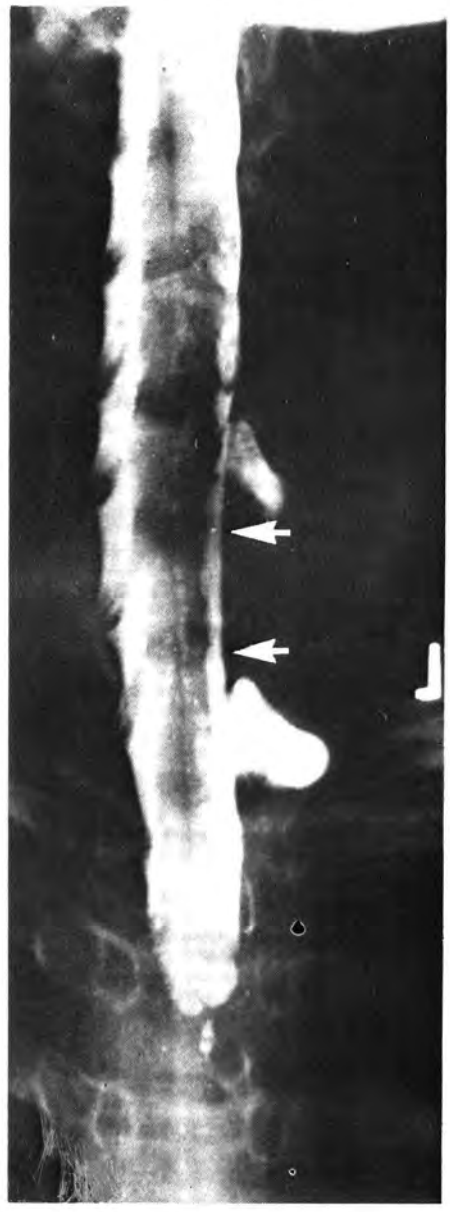

Fig. 3: Characteristic appearance of post-traumatic brachial plexus injury. Contrast filling of dural sacs with smooth indentation on contrast column (arrows).

there was also loss of sensation. Examination showed wasting of the deltoid and supraspinatus muscles. Motor power of the left upper limb was absent. There was loss of sensation below the left elbow joint. Reflexes were also absent. Plain X-rays disclosed an old fracture of the left clavicle. Myelogram showed contrast filling of the dural sacs at D1/D2 and C6/C7 levels (Fig. 3). Here, the cord shadow was slightly indented on the left. Filling of the normal root pouches was absent. The findings pointed to a traumatic spinal meningocoele situated extradurally, displacing the cord slightly.

Comments

The characteristic contrast filling of the dural sacs was observed by Murphy, Hantung and Kirklin as early as 1947. Since then, Davis and Sutton (1966) reported 11 cases and reviewed 70 more in the literature. The common important myelographic features are as follows:—

(i) A dural or extradural sac forms opposite the intervertebral foramen of the torn root extending sometimes through it. Contrast usually fills the sac and demonstrates unequivocally its extent.

(ii) Obliteration of the root pouch by healing of the tear. The lateral margin of the myodil column in such instances will be straight or convex medially due to a loculated cystic collection of CSF.

(iii) The width of the partially torn root will be less than the normal as it crosses the subarachnoid space. In the myelogram, it shows up as absence of the root shadows in the contrast column.

The features described under (i) and (ii) are found in the present case. The prognosis in common with so many of these conditions is poor. If more than two nerve roots are torn, the injuries are invariably irreversible. Myelography has the advantage of examining the nerve roots involved without recourse to operation. It gives a precise picture as to the site and extent of the injury although at times it may underestimate its severity. Once diagnosis is established, laminectomy is rarely indicated except to exclude an intraspinal cause for intractable pain which may sometimes be the primary presenting symptom. The contrast filled dural sacs have to be differentiated from non-traumatic diverticula of the subarachnoid space (Fig. 4) which have smooth, rounded contours and exhibit normal radiolucent outlines of intact nerve roots.

Fig. 4: Small subarachnoid diverticula (arrows), an incidental finding at myelography.

III. In the Investigation of Atrophic Cord Lesions: Syringomyelia

Case 3

A 28-year-old Malay man gave a history of numbness of the right little finger for two years and progressive weakness and sensory loss of both upper limbs for six months. He was found to have

dissociated anaesthesia of temperature and pain at dermatomes C3 to D4 on examination. Other positive findings include wasting of the shoulder girdle muscles, the thenar, supraspinatus and deltoid muscles bilaterally. Involuntary tremors of fingers and fasciculation of the right shoulder girdle muscles were present. The clinical impression was syringomyelia. Plain films of the cervical spine showed an increase in the sagittal diameter of the lower cervical canal. A myelogram demonstrated unequivocally smooth and diffuse enlargement of the cord shadow from C2-D2 (Fig. 5). The subarachnoid space was narrowed. The findings were consistent with syringomyelia, although an extensive intramedullary tumour was considered in the differential diagnosis. Laminectomy confirmed the radiological diagnosis of syringomyelia.

Comments

The plain X-ray findings of the cervical spine in these patients consist of an increase in the transverse or sagittal diameter of the canal or a combination of both. This is the rule in the males whereas female patients may show normal looking canals despite characteristic clinical manifestations (Bradley and Banna 1968).

Fig. 5: Characteristic appearance of syringomyelia. Smooth symmetrical enlargement of cervical cord shadow.

There may be cervical lordosis and thoracic kyphoscoliosis due to muscle imbalance. Rarely, abnormalities of the craniovertebral junction are encountered. Myelography usually demonstrates smooth symmetrical enlargement of the involved segments. The main differential diagnosis is from an intramedullary tumour, usually a glioma. The problem is made more complex by the occasional association of these two conditions in the same patient. Indeed, McRae (1966) considered intramedullary glioma with cystic formation as a cause of what he termed "secondary syringomyelia". Other common associated features include a small collapsing spinal cord when the patient assumes the erect position, subarachnoid adhesions and Arnold-Chiari malformation.

IV. Tumour Localisation and Diagnosis

Case 4

A 12-year-old female Indian patient gave a history of progressive weakness of both lower extremities for one year. At the time of admission to the University Hospital, she was unable to walk. Examination revealed the motor power of both lower limbs to be weak. Knee and ankle jerks were brisk and plantar response was extensor bilaterally. Tenderness over the lower dorsal region was elicited on palpation. The clinical impression was cord tumour with spinal compression.

Radiological examination: Plain films of the dorsal spine showed pedicle erosion and scalloping of the posterior border of body of D10. The intervertebral foramen was also enlarged and pressure erosion of the vertebral end of the right ninth rib was noted. A myelogram via the lumbar route showed a complete block at D9/D10 disc space and smooth deviation of the contrast column and the cord shadow towards the left (Fig. 6). An extradural mass at the lower dorsal spine was thought to be responsible for her disability.

A descending myelogram showed a complete block at the lower border of D8, again with deviation of the contrast column and the cord shadow to the left. The lateral films pointed to a posterior situation of the mass. The radiological diagnosis was an extradural tumour, most likely a neurofibroma. Laminectomy showed a large extradural neurofibroma 2" x 2½" in size situated on the right of D9 spinal segment, compressing and displacing

Fig. 6A: Extradural neurofibroma. Lumbar myelogram shows smooth tapering of head of contrast column and deviation cord shadow to the left: characteristic appearance of extradural lesion. Note pedicle erosion of D9 and D10.

the cord to the left. Part of the tumour was extraspinal extending through the intervertebral foramen along the right 9th intercostal nerve. The tumour was removed and histopathology confirmed the diagnosis at operation.

Comments

This case illustrates the distinct value of myelography as a means of localisation. That the tumour had an extraspinal component was shown by the presence of rib erosion. Because of the size of the tumour, a complete obstruction was present. A cisternal myelogram was conclusive in demarcating its superior margin. A completely extradurally situated neurofibroma is relatively rare. According

Fig. 6B: Descending myelogram of same patient. Shows similar tapering appearance, indicating tumour at D9 level.

to Shapiro (1968), only 16% of neurofibromas are thus situated as compared to 67% of the intradural varieties. Another 16% occupy an intradural position with an extradural component. The great majority of neurofibromas are situated in the thoracic (43%) and lumbar (33%) regions. Bone changes, as shown in this case, are about four times as frequent when compared with meningiomas. This observation was also made by Elsberg and Dyke (1934) who stated that "enlargement of the interpedicular distance and erosion of the inner border of the pedicles occurred much more often in neurofibromas than in the meningiomas."

Although the small intradural neurofibromas do not characteristically erode adjacent bones, the larger intradural and extradural varieties commonly cause bone changes ranging from vertebral scalloping to thinning of the neural arches. Two or more vertebral bodies may become involved at the same time. On purely radiological grounds, differentiation from an extradural meningioma, lymphoma, granuloma and metastatic tumour could be problematical. Taking into consideration the age, the location and characteristic bone changes, a correct preoperative pathological diagnosis is often possible.

V. Investigation of Cervical Spondylosis

This is done in patients with severe radicular symptoms and cervical myelopathy (Jackson 1966) and as a preliminary assessment before operation (Logue 1957).

Case 5

A 64-year-old female Chinese complained of numbness over the right index and middle fingers, and severe pin-prick pain over the lower right scapula radiating down the right arm and fingers for 3-4 weeks prior to admission to the University Hospital. The pain was more marked on exertion. Examination disclosed slight wasting of the thenar muscles. There was sensory deficit over the palmar and dorsal aspects of the right index and middle fingers.

Radiological examination: There were degenerative changes in the cervical spine. The sagittal diameter of the canal was within normal limits. A cervical myelogram showed poor filling of the subarachnoid root sheaths on the right. Multiple transverse radiolucent shadows were seen corresponding to the disc spaces at C_3/C_4, C_4/C_5, C_5/C_6 and C_6/C_7 levels (Fig. 7). The impression was moderate to marked cervical spondylosis.

Case 6

A 48-year-old male Indian patient presented with a four-month history of progressive weakness of the left arm. There was associated paraesthesia affecting the left shoulder and the fingers. Examination showed gross wasting and loss of tone of the left upper limb. There was sensory deficit over the distribution of C_5 to D_1 dermatones on the left. The clinical impression was motor neurone disease. A myelogram was done to rule out an intraspinal

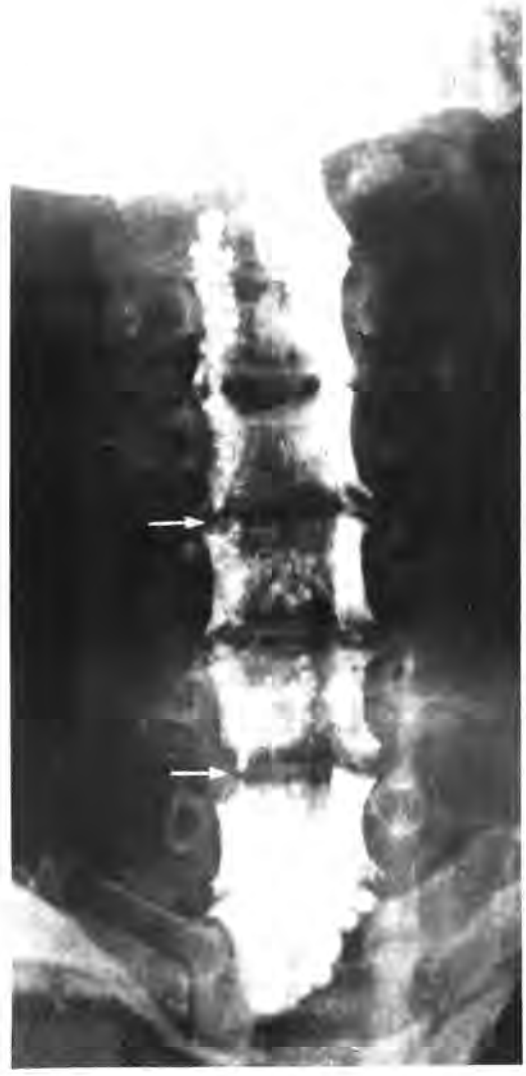

Fig. 7: Cervical spondylosis. Multiple transverse radiolucent shadows at C_3/C_4, C_4/C_5, C_5/C_6 and C_6/C_7 interspaces. Root sheaths on the right are poorly filled (arrows).

tumour. There was no evidence of blockage to the flow of contrast material cranially and the cord shadow appeared normal throughout. However, transverse filling defects were noted in the contrast column at C_4/C_5 and C_5/C_6 levels, the appearance being suggestive of annular protrusions at these levels. Lateral views (Fig. 8) confirmed these findings. In addition, there were minimal indentations on the posterior aspect of the opacified subarachnoid space indicative of thickening of the flaval ligaments. The final impression was mild cervical spondylosis which was not considered responsible for his marked neurological deficit.

Fig. 8A: Cervical spondylosis. Transverse radiolucent shadows at C_5/C_6 and C_6/C_7 interspaces. Arrows indicate non-filling of axillary root sheaths.

Case 7

A 51-year-old male Indian patient developed progressive weakness and numbness of both upper and lower extremities three months prior to admission to the University Hospital. A history of antecedent injury was not obtainable. Examination showed motor power of all four limbs to be slightly decreased. Sensation was diminished below C4 level. Co-ordination was poor and all reflexes were brisk. The plantar response was extensor bilaterally.

Fig. 8B: Lateral view of same patient in Fig. 8A showing ventral indentations by posterior osteophytes and dorsal indentations by flaval ligament (arrows).

Radiological examination: Plain films of cervical spine showed a decrease in height of the C_3/C_4 intervertebral space with a light posterior displacement of C_3 and C_4. The sagittal diameter of the canal was narrow at this point. Myelogram showed a marked transverse filling defect at C_3/C_4 intervertebral space. The opacified ventral subarachnoid space was indented at this level (Fig. 9). The changes pointed to either a focal cervical spondylosis or a posterior disc protrusion.

Viewed together with the clinical findings, the provisional diagnosis was cord compression at C_3/C_4 level.

Fig. 9: Focal cervical spondylosis. Cervical myelogram (lateral view) shows ventral indentation of opacified subarachnoid space at C_3/C_4 level (arrows).

A decompression laminectomy of C_3, C_4 and C_5 segments showed sclerosis and calcification of the ligamenta flava and the posterior spinal ligament. A bony or cartilaginous bar was felt at the posterior surface of the C_3/C_4 disc space. The spinal cord was pale and not pulsating.

Post-operatively, the patient made a satisfactory recovery and had no neurological deficit except some residual weakness of the right shoulder on discharge six weeks later.

Comments

In essence, clinical cervical spondylosis, be it diffuse or focal, is caused by the encroachment of abnormal degenerative tissues upon normal nervous tissues. Although plain X-rays are able to some degree to estimate the severity and extent of the degenerative process, the changes in the soft tissues that constitute part of the cervical canal can only be accurately assessed by positive contrast myelography. This particularly applies in cases where the plain film changes do not correlate with the clinical manifestations (Brain 1954) (Penning 1968). As a rule, Pantopaque myelography gives reasonably accurate information as to nerve root impingement by root sleeve fibrosis or by uncovertebral and posterior apophyseal osteoarthritis. Posterior annular herniation and fibrocartilaginous bar protrusions may similarly be demonstrated. The lack of adequate filling of the root sheaths on the right in Case 5 are characteristic of uncovertebral osteoarthritis which is the most likely explanation of the patient's symptoms. These findings are substantiated by the plain radiographs which showed moderate degrees of osteophytic encroachment on the exit foramina on the same side. The multiple radiolucent defects present in the disc spaces from C_3 down to C_7 represent cartilaginous bar impressions but in the presence of a roomy cervical canal symptoms of cord compression may not necessarily arise (Burrows 1963).

Case 6 is an example of how a myelogram can help in excluding a suspected case of intraspinal tumour. No tumour could be found and the appearance of mild cervical spondylosis was just incidental and may be considered a physiological degenerative process (Smith 1968).

Case 7 is an example of focal spondylosis affecting essentially the C_3/C_4 intervertebral space. Here, myelography underestimates the pathologic anatomical changes found at operation. Radiologically, the findings show a reasonably healthy cervical spine apart from the slight malalignment and disc space narrowing. At laminectomy, the cord exhibits changes of marked ischaemia resulting from circumferential thickening and sclerosis of the flaval and posterior spinal ligaments. That neighbouring soft tissue changes are mainly responsible for his symptoms is proven by a rapid recovery following a decompression laminectomy. Stoltmann and Blackwood (1964) have shown experimentally a very "tight fit" of the cervical canal at C_4, C_5 and C_6 levels and there is just adequate room for the cord to move freely under normal circumstances. Pathological changes, such as thickening of the flaval ligaments in particular, can further narrow the canal and produce compression on the posterolateral columns, with resultant demyelination. Although this view is not universally accepted, there is enough evidence to justify surgical decompression if the patient is sufficiently incapacitated clinically.

In summary, myelography in cervical spondylosis serves the following purposes:

(i) It affords a functional study of the CSF dynamics with the patient's neck in flexion, extension and neutral position. This technique is enhanced by the use of cinemyelography.

(ii) Soft tissue changes are demonstrable indirectly. These findings may then be correlated with abnormal features on the plain films.

(iii) Demonstration or exclusion of co-existing lesions giving rise to a similar clinical picture is an absolute indication. The line of management adopted is dependent on the result of such studies. Thus, a high cervical cord tumour or an acute nuclear prolapse will require surgery, whereas mere presence of mild to moderate diffuse spondylosis may only require conservative treatment.

VI. In the Investigation and Management of Adhesive Arachnoiditis

This condition was extensively reviewed by Epstein (1969) and Lombardi and Pessarini (1962). The clinical picture is often confusing and when acute, may simulate a spinal tumour. Myelography is used to exclude an intraspinal lesion and to define the extent of the arachnoiditis. This is necessary if a more aggressive approach to this problem is adopted. Teng and Papatheodorou (1967) listed six forms of myelographic appearances in an analysis of 12 cases and noted satisfactory response to surgery in half of them.

In general, there are no clear-cut myelographic features as the changes are dependent on the underlying causative pathology. The common causes are inflammatory disease, post-traumatic and

spontaneous bleeding into the subarachnoid space. Other factors include repeated diagnostic lumbar punctures, spinal anaesthesia and the effects of spinal surgery. In almost half the cases, a definite causative factor cannot be traced. The myelographic appearances are polymorphous and bizarre.

Fig. 10: Myelographic features of arachnoiditis. Myelogram in June 1968 shows partial block beginning at D10 level and extending cranially to D8. Irregular, streaky appearance of contrast column and tortuous vessels (arrows). Cord shadow not shifted.

The contrast column breaks up into multiple irregular loculated pockets and movement of the contrast column is extremely slow to the point of complete obstruction in areas where the subarachnoid space is completely obliterated. Because of the extensive adhesions, the surrounding venous plexuses become congested and serpentine like shadows, representing either dilated vessels or thickened proliferative arachnoid tissues, may be seen. Where areas of the cord cavitate as a result of ischaemia local segments of cord enlargement may easily simulate an intramedullary tumour or syringomyelia.

Figure 10 is the myelogram of a female Chinese patient in her early thirties, with symptoms and signs suggestive of a cord tumour two years ago. A myelogram done in June 1968 showed an almost complete block of the contrast column at D8/D9 level. The upper border of the contrast column was irregular and streaky and there was no sign of cord displacement. The diagnosis then was arachnoiditis. Her symptoms showed no change over a period of two years. Just prior to admission in August 1970, she noticed some aggravation of symptoms. On re-screening the D8 region, a similar myelographic appearance was observed. A descending myelogram showed slight enlargement of the cervical cord shadow from C3 to C7 in the AP projections. On manoeuvering the contrast into the lower dorsal region, a partial block from D8 to D10 level was redemonstrated (Fig. 11). On the basis of the protracted course of the illness and the bizarre myelographic features, the final diagnosis was arachnoiditis affecting the lower dorsal and the cervical spinal cord with possible cavitations in the dorsal segment.

Discussion

In the light of recent development of soluble contrast material and refinement in technique, the status of the conventional myelographic procedure may warrant reappraisal. The case reports have clearly illustrated its diagnostic accuracy and simplicity of operation without causing undue discomfort to the patient. Throughout the spine, there is a great range of abnormalities in which demonstration and interpretation of the lesions could be readily accomplished by the general radiologist.

The use of soluble contrast media as Cunray 282 has the advantage of improving the quality of myelograms (Praestholm and Lester 1970). Side-effects, such as headache and clonic muscle spasms, can be disturbing to the patient. Escape of this contrast into the lower dorsal region can precipitate severe myoclonia of the lower extremities. Its use is confined therefore exclusively to examina-

tion of the lumbar spine under experienced hands.

Air myelography has its advocates in America and the Scandinavian countries. The disadvantage lies in the almost complete replacement of CSF by air leading to post-myelographic headaches. Other factors, such as overlying bowel shadows and the density of the vertebral bodies, make interpretation difficult. Tomography may, to an extent, resolve these difficulties but because of the poor definition of the cord in frontal projections non-obstructive lesions such as vascular malformation, subarachnoid diverticula and arachnoiditis can be easily overlooked. Minor defects may escape attention because this procedure does not afford the use of fluoroscopy. It has distinct value in the detection of lesions at the cervical and foramen magnum regions and the study of atrophic lesions of the cervical and thoracic segments of the cord.

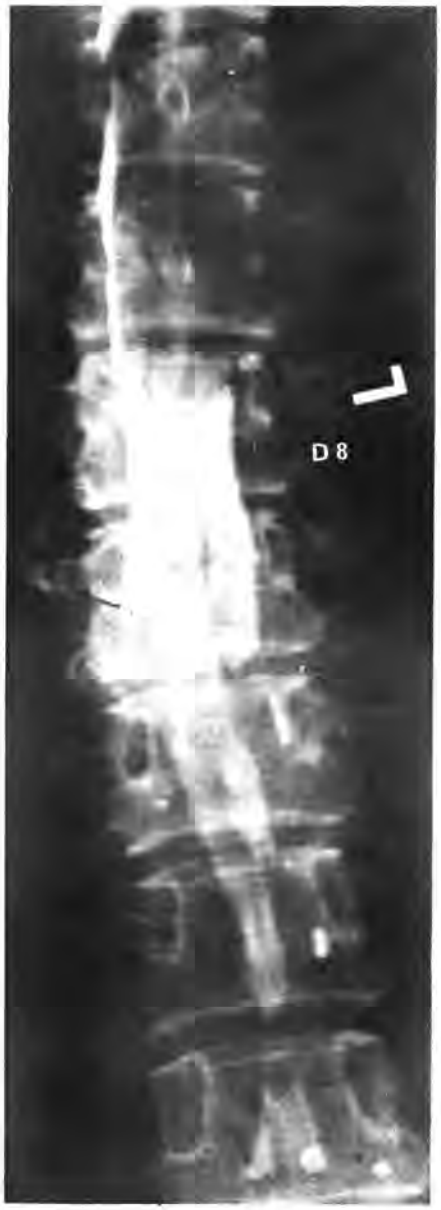

Fig. 11: Myelogram in August 1970 of same patient as Fig. 10. Redemonstration of partial obstruction at D8 level. Non-filling of subarachnoid space on the left at D6 and D7 levels with very narrow subarachnoid space on the right. Possible explanation is local cavitation of the cord or obstruction due to thickened arachnoidal tissue.

Pantopaque myelography has now reached a stage when additional enhancement technique can transform it into a more effective diagnostic tool. Cinemyelography (Epstein 1967), the instillation of large amount of contrast under image intensification-television control and the use of less dense Pantopaque have brought about less technical error and a more thorough and exhaustive search for lesions.

Cinemyelography

This technique has added ease and accuracy to the procedure. It provides a total recall of the movement and behavior of the contrast material especially in the cervical spine. It enables a physiological and dynamic study of the subarachnoid space to be carried out.

Use of less dense Pantopaque

This technique was studied by Heinz, Brinker and Taveras (1966). In their comparative studies, using large volumes of Pantopaque of different Iodine concentrations (30%, 22% and 15%), they concluded that in the detection of lesions in the cervical spine, Pantopaque 22% had a distinct advantage over Pantopaque 30%. Whereas the use of Pantopaque 30% necessitates a higher kilovoltage technique to increase the visibility of the cervical cord shadow, this is achieved at the expense of loss of neighbouring bone detail. Using a conventional technique, the same good visibility could be obtained with 22% Pantopaque without sacrificing bony detail. In the lumbar spine, small extra-dural impressions could be detected more readily with the use of Pantopaque 15%.

Urea in Positive Contrast Myelography

Calabro and Smaltino (1966) examined nine cases by this method. The rationale of this procedure is the shrinkage of the spinal cord following intravenous administration of a hypertonic urea solution in doses of 0.8 gm. per kilogram of body

weight. Where a complete block was noted, the administration of this substance changed it into an incomplete one, making it possible to visualise the extent of the lesion responsible for the obstruction. In their small series, the exact level of each of three cases of intraspinal tumours was thus located. No serious side-effects were reported apart from a transient headache. This method is invaluable if for any reason a combined cisternal myelogram is contraindicated.

Thus the enhancement techniques supplement and do not supplant the conventional procedure, which will continue to occupy an important place in the armamentarium of the diagnostic radiologist.

Summary

(1) The question of Pantopaque arachnoiditis is briefly discussed.

(2) A technique of cisternal myelography is described.

(3) Various complications pertaining to myelography are listed.

(4) Examples are presented to illustrate the main indications of Pantopaque myelography.

(5) Some recent enhancement techniques are briefly reviewed.

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