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THE PROTRUDED INTERVERTEBRAL DISK
AND ITS RELATIONSHIP TO
THE SCIATIC SYNDROME

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SENIOR THESIS

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INTRODUCTION

It is the purpose of this paper to discuss the Protruded Intervertebral Disk and its relation to the so-called "Sciatic Syndrome". It is now not considered proper to make a diagnosis of "Sciatica". Taylor has said, "To me the word Sciatica means no more than a bad pain in the back of the lower limb. It does not even mean a clinical state because the symptoms vary greatly and the supposed pathology seems quite unconvincing". (1) To be sure all cases of low back pain and sciatic radiation are not cases of protrusion of the intervertebral disk. However, it is the opinion of Reynolds, and that of the majority of the men interested in cases of this type, that "All cases of intractable low back pain with sciatic radiation that do not respond to conservative means in a reasonable period of time should be considered cases of protrusion of the disk until proven otherwise". (2)

It is as yet too early to evaluate the frequency with which the Protruded Intervertebral Disk is the cause of "Sciatica". At the Mayo Clinic it has been possible to arrive at a diagnosis of Protruded Disk in only 300 of 10,000 consecutive cases of low back and sciatic pain. (3) Fincher, in a radiologic study

of 31 consecutive cases of chronic low back pain and sciatic pain, found that 24 of the cases had displacement of the intervertebral cartilage. (4) Barr states that in a single 10 month period in a hospital of moderate size 20 cases were operated and verified. (5) These reports indicate little concerning the incidence of the lesion but they do show that this entity is certainly not rare and that in the past it has been overlooked or wrongly diagnosed.

HISTORY

In 1911 Goldwaithe reported the case of a patient, age 39, who had a history of hypertrophic arthritis of the lumbar spine seven years before. This had necessitated the use of a support for several months. This patient had strained his back in lifting a heavy object and had produced an obvious displacement of the sacro-iliac joint on the right side. This condition was recognized at once and properly treated. Three months later, the previous symptoms having disappeared, the man became fatigued from carrying a heavy suitcase for some distance following a long car journey. His back became painful and sensitive, and Goldwaithe was called to see him. He found the sacro-iliac joints strained

but no displacement of the bones. The symptoms and signs found were intense pain, the body held forward and to the left, complete paralysis of the bladder and rectum, and complete paraplegia except on the anterior part of the thighs where sensation had returned. The pain was stated to be of a lancinating character and was referred to the legs and feet. There was a particularly constant and severe pain referred to the upper part of the rectum. Cushing operated and found nothing except a narrowing of the osseous canal at the lumbo-sacral junction. Following the operation there was a gradual improvement much to the distention of the surgeon. Goldwaithe went on to explain the probable lesions that could cause the findings in this case and in doing so brought forth the probability of a protrusion of the disk as well as a bony displacement.(6)

In 1925 Adson in a discussion of the Tumors of the Spinal Cord included Fibrochondromas of the Intervertebral disks.(7) Stookey, in 1928, reported seven ventral extradural cervical chondromas and summarized that they presented a definite clinical entity.(8) Dandy reported in 1929 two cases in which a diagnosis (presumptive) of Carcinoma of the Vertebrae had been made. At operation he found that in both cases loose cartilage was the cause of the symptoms. Roentgen stud-

ies had disclosed nothing in either case. He believed that trauma had undoubtedly been the cause of the lesion. (9)

In 1928 Elsburg, in discussing extradural spinal tumors operated in his clinic, stated he had found seven cases of Chondroma derived from the intervertebral disk. This he found in the cervical region only and they were pressing the dura from the midline or more to one side or the other. Elsburg summarized that these Chondromata were probably much more common than formerly believed. (10)

Peet in 1934 reported a case with a syndrome of cauda equina involvement in which was found a complete cerebrospinal fluid block. The lesion was located with iodized oil and a laminectomy was performed, with a removal of a nodule from the intervertebral disk and complete recovery of the patient. The patient had complained of pain in the back, which radiated down both thighs. The onset had been $1\frac{1}{2}$ years before with pain and tingling in the right leg. Both legs eventually became weak and for three months there was difficulty in emptying the bladder, sexual impotence and some rectal incontinence. There was no history of trauma. The nodule was exposed attached to the disk between the 2nd and 3rd lumbar vertebra. (11)

In the same year Mixter and Barr, in an investi-

gation of cases of spinal cord tumors treated at the Massachusetts General Hospital and in their private practice, reported the following: "In a surprisingly large number of cases the lesions classified as chondromata were not tumors of cartilage but prolapses of the nucleus pulposus or fracture of the annulus". They concluded that, "in reality rupture of the disk is more common than neoplasm; in our series 3 to 1". (12)

Thus the role of the Intervertebral disk in producing back pain and sciatic pain has gradually come to the attention of the Neurologist and the Orthopedists. For many years the lesion had been seen but the true knowledge of the pathology of the disk had been obscure. Various names had been given the lesion; among them Chondromas, Eochondromas, and Endochondromas were widely used. True, there are neoplastic tumors of the intervertebral disks but they are rare and in all probability many of the nodules were taken to be neoplastic in origin because of lack of any alternative. (13)

THE ANATOMY, PHYSIOLOGY AND MECHANISM OF THE DISKS

"Our ideas concerning the anatomy, physiology and mechanism of the human spinal column have undergone revolutionary changes in the past few years. Our conceptions of injuries and diseases as they affect this part of our bodies have been even more profoundly altered.

Only recently have we come to the knowledge that the structures which make up the disks are by all odds the most important parts of the spinal column, the most important, the most dynamic, and the most dangerous to the individual. We now know that the spaces between the boney bodies represent the strongest section of the spine and the bones, stalwart as they appear, represent the weakest part". (14)

The disks have origin in part from the remnants of the primitive notochord and in part from the mesoderm between the successive blocks of rapidly chondrifying tissue which establish the true vertebral segments. The nucleus is derived at first from the notochord but is extended by a mucoid change which occurs in the surrounding tissue of the so-called notochordal sheath, together with multiplication of the original chordal cells. In the last 2 or 3 months before birth there is a dispersal of the cellular groups together with the appearance of fibrocartilagenous elements from the peripherally differentiation annulus. The annulus differentiates later than the nucleus into fibrocartilage, and the progressive development and thickening of the bundles extends well into the post-natal period. That portion of the notochord passing through the center of the vertebral body is early transformed into a relatively cell free ligament

and, together with its canal is obliterated during chondrification and ossification of the centrum. (15)

The disks make up a full quarter of the total presacral length of the spinal column. They are thinnest in the region between the 3rd and 7th thoracic vertebrae and are thickest in the lumbar region. They conform to, and are somewhat responsible for, the curves of the spinal column. The disks are composed of three parts; the annulus fibrosis, the nucleus pulposus and the cartilage plates. The latter are composed of hyaline cartilage but near their periphery they become more fibrous and blend with the annulus fibrosis. They cover the end surfaces of the vertebral bodies. The cells of the cartilage next to the bone are irregularly arranged, those facing the nucleus pulposus lie parallel to the surface. Marginally the cellular elements become oriented in the direction of the entering fibers. The plates have an average thickness of 1mm, are thinner at the center, and are applied in direct contact with the marrow of the vertebral bodies. On the surface fine fibers enter the plates and arrange themselves parallel to the surface of the plate. These fine fibers are from the nucleus pulposus. The nucleus is located in the center of the disk a little nearer to the posterior surface than the anterior. It is soft and elastic, somewhat "slimy to the

touch", and has an inherent turgor which causes it to bulge above the cut surface on section. Cavities with a villus-like group of projections are frequently found. A coarse network of fine fibrous strands with cellular elements enmeshed make up the nucleus. Notochordal tissue is found in this region. This tissue consists of large cells in small groups separated from the ground substance by condensations of fibrous tissue. Their rosette grouping is typical. The larger colonies of these cells are above and below in close contact with the thinnest part of the cartilage plates. This indicates that this area is that of the obliterated premature notochord. The fine fibers are more prominent at the outer part of the nucleus, and here the cellular elements are fewer in number. From here there is an increase, gradually, in the size of the fibers out to the annulus. The annulus is made up of coarse collagenous fibers, the coarseness becoming more pronounced at the margins of the disks. This increase in size is gradual from nucleus out. At the edge of the plates fibers from the annulus pass into the cartilage. Intermediate fibers are attached to the bone of the body and the fibers of Sharpey. The outmost fibers blend with the longitudinal ligaments and fibrous periosteum of the centra. (15)

Each disk is thicker anteriorly in the cervical

and lumbar regions and the characteristic convexities of the column are due somewhat to this fact. In the lumbar region the nucleus is dorsal to the center of the disk and moves still more in that direction during flexion.(16)

Important are the intervertebral foramina of the lumbar region. The bony foramen is somewhat the shape of an inverted pear. This is not true of the fifth lumbar foramen which is oblique and irregular. Its upper boundary, formed by the pedicle and, more anteriorly by the lower part of the vertebral body of the upper vertebra, is deeply notched. The spinal nerve, closely applied to the medial surface of the pedicle, grooves this structure and forms the sulcus nervus spinalis. At the fifth lumbar foramen, and also at the fourth but to a lesser extent, the sulcus grooves the root of the pedicle, the base of the transverse process, and the adjacent body. Thus the spinal nerve occupies only the uppermost part of the intervertebral foramen and bears no direct relationship to the lower half of the foramen. The lower half of the foramen is bounded below by the shallow superior vertebral notch on the upper aspect of the pedicle below. This portion of the foramen is narrow and bounded anteriorly by the backward protrusion of the intervertebral disk and posteriorly by the forward bulging of the ligamentum fla-

vum, due to the partial offsetting of the inferior articular process. At this point the nerve may be lying within the dural sac, as is more usual, or be about to emerge from the sac, or may have just emerged enclosed within its own sheath.(16) Around the prolongation of the dura is a rich venous plexus. The nerve is not protected by the cerebrospinal fluid. Because of the above two factors any mechanical irritation would undoubtedly bring on a traumatic inflammatory condition.(17) The nerve is relatively fixed in this region because of its proximity to its point of emergence, although lying within the spinal dura. It is in this position that the nerve is vulnerable to encroachments by either the ligamentum flavum or the intervertebral disk, or both.(16)

The cord ends opposite the disk below the first lumbar vertebral and below this the nerve roots of the cauda equina are freely moveable except as shown above. At the fourth lumbar disk the fifth lumbar nerve is in the subarachnoid space, fixed laterally against the dura one vertebra higher than its exit. The dural sleeve of the fifth nerve emerges below the fourth disk and passes downward beneath the pedicle of the fifth vertebra to its intervertebral foramen. All lumbar nerves hold the same relation.(18) Protrusions from the postero-lateral portion of the disk may encroach upon the inter-

vertebral foramen or protrude posteriorly and involve the nerve passing to the foramen below. In the latter case the spinal theca would be deformed at the level of the intervertebral disk above the foramen of the nerve involved. (16)

Roofe attempted to trace the origin of the nerves which were observed to innervate the annulus fibrosus and the posterior longitudinal ligament. He dissected in a cadaver the recurrent spinal nerves to the above structures and found fibrous-like strands returning from beyond the dorsal root ganglia to the vertebral canal, through the intervertebral foramen. Histological studies did not convince him that the strands were nerve fibers. He did not find nerves from a recurrent branch other than the one passing through the foramen. He also removed the fourth and fifth vertebrae with the intervening disk and these he fixed, sectioned and stained. He observed many fibers in the annulus fibrosus. These were unmyelinated fibers and terminated in naked nerve endings within the annulus. No nerve tissue was observed within the disk itself. In the posterior longitudinal ligament a small number of fine unmyelinated fibers were found. Their position was almost invariably near the annulus fibrosus in the area where the posterior longitudinal ligament fans out to merge with the annulus. They also showed naked nerve endings as well

as glomerulus-like terminations.(19)

Because of the radiation of pain found in "Sciatica" it would be well to review at this time the dermatomes supplied by the lumbar nerves. The first lumbar dermatome or the area of sensibility which remains after the eleventh and twelfth thoracic, and all sacral roots have been divided, occupies the inferior part of the abdomen and upper part of the anterior and lateral surface of the leg. At the dorsal side it forms a band which reaches the spine of the fifth lumbar vertebra. The second lumbar dermatome lies chiefly on the anterior aspect of the thigh but there is also a small band on the dorsum of the trunk which is not continuous with the main area upon the anterior surface of the leg. The third lumbar dermatome has a great extent of overlap. It has a characteristic shape, a central part around the knee, an upper prolongation along the anterior and internal surface of the thigh, and an inferior strip or band along the inner side of the leg reaching below as far as the internal malleolus. Also there is a small band on the dorsal aspect of the trunk not in continuity with the main area upon the lower limb. The extent of this dermatome may present considerable individual variations. The fourth dermatome occupies the anterior side of the leg, the internal part of the dorsum of the foot and the great toe. On the sole its border runs from between the first and second toes

backward behind the internal side of the leg. At the level of the knee it turns forward then bends behind the head of the fibula to the outer side of the leg and finally returns to the dorsal aspect of the foot where it reaches the interdigital space between the hallux and the second toe. The fifth dermatome occupies the anterior side of the leg, and the entire dorsum of the foot and all toes. The border runs along the outer border of the foot behind the external malleolus, up the leg and then turns below the head of the fibula to the anterior aspect from where it runs down along the internal side of the leg to the sole. It occupies the medial part of the sole, and the plantar surfaces of the first, second and third toes, but not that of the fourth and fifth toes. The first sacral occupies the sole and the plantar surfaces of the toes. From the sole it spreads upward along the posterior side of the leg. The second sacral occupies the posterior surface of the thigh and leg, the sole of the foot and the plantar aspects of the toes. (20)

Not only the anatomy but the physiology and the mechanism of the vertebral disks must be understood before the production of a protrusion or herniation can be comprehended. By means of the elastic turgor of the disk a state of equilibrium is established be-

tween the various spinal ligaments and the expansil force of the disk. This equilibrium tends to resist deforming forces and to restore the normal state of the column when deformity has occurred. The expansil force is due to the compression of the nucleus pulp- osus within the confines of the annulus and the cart- ilagenous plates. (15)

Petter, using calaver spines of individuals dying of Tuberculosis at the Glen Lake Sanatorium and studying them four hours after death, marked the verte- brae and found a definite expansion of the disk occur- red upon removal from the body. He noted further ex- pansion when the annulus fibrosus was sectioned. The amount of pressure required to reduce this expansion was found to be on the average 32 pounds. (21) In the erect living subject the weight of the trunk and upper extremities must raise this pressure in the lower lumbar area well over 100 pounds. During the transi- tory phases of spinal movement, as when the back is ex- tended from the flexed position with no resistance but that of gravity, estimates indicate the pressure to be in excess of 200-300 pounds. The ability of the disk to withstand such pressure is in all probability related to its high water content. "Pascal's law says that liquids transmit in all direction, and without diminution, any pressure that is applied to them and

for all practical purposes may be considered incompressible".(15) Naffziger, taking the spinal column as a lever of the third class, has estimated that the lumbar region carries the brunt of the pressure and that the pressure on the disks, when the subject lifts a weight of fifty pounds under average conditions, to be about 500 pounds. He goes even further in saying that under other conditions there are fleeting periods during motion in which the pressure is considerably in excess of this rough estimate.(16)

The axis of movement between adjacent vertebral over a limited range pass through the nucleus pulposus. Any change in the size of the disk is very small. However there is a change of shape on movement. There is compression of the anterior part of the disk and expansion posteriorly during flexion. In extension there is anterior elongation and posterior compression. Should extension progress to where the spinous processes touch each other this point of contact becomes the fulcrum and further extension results in elongation of the entire disk with narrowing of its diameter. This alternating compression and extension of the disk produces displacement of the nucleus pulposus posteriorly in flexion and anteriorly in extension.(15)

If tension is thrown upon the posterior portion of the annulus in flexion and if some rotation should

accompany flexion, the annulus is further subject to torsional stress. Further, in reaching forward to one side, the anatomical arrangement in the lumbar region is such as to limit that rotation which so freely occurs in the thoracic segments. This limitation forces lateral bending in the lumbar region, which puts the major stress on the postero-lateral portion of the annulus and the ligamentum flavum of the contralateral side. (16)

THE PATHOLOGY

It is difficult to determine what is a normal disk and what is pathological. This is because of the changes in the structure of the disk throughout life. Because degenerative changes are found so commonly in supposedly healthy spinal columns at middle age it must be assumed that these changes are the result of age processes in an organ made susceptible because of its functional activity. These changes may vary greatly. Solution of the continuity of the cartilage plates allows escape of nuclear material and hence loss of the elasticity. As age advances the nucleus progressively loses its distinctiveness and the disks become more homogenous. At this time the cavities and the villus-like projections are found. Thereafter the disk undergoes progressive dehydration and fibrosis. Blatts found that in an examin-

ation of 50 spines found that 20% of them had herniations of the nucleus into adjacent vertebral bodies, 16% had a rupture of the nucleus posteriorly into the neural canal and 6% had anterior protrusions.(22) Schmorl, who lead the work on the intervertebral disk, found these nodules in 56 of 368 investigations of the spine.(23)

There has been much discussion as to whether the lesions are herniations of the nucleus pulposus or protrusions of the disk. Saunders and Inman are of the opinion that both varieties may be found.(15) Spurling and Bradford state that disease of the disk is rarely responsible for nerve root compression except when the annulus fibrosus has ruptured and allowed the nucleus pulposis to extrude through the defect.(18) Deucher, in a pathological study of 100 cases of protruded intervertebral disk found not a single specimen in which annular parts of the disk were not also present. The relationship of the annulus and the nucleus was found to be variable, in some specimens the annulus being the predominating tissue and in others the nucleus predominating. But at this age, the age that the lesion is most frequently found, the demarcation between the annulus and the nucleus is not very definite. (24)

A typical rupture is a discrete circumscribed mass projecting from the posterior margin of the disk

to one side of the midline. It not infrequently is loose. (25) The extruded nuclear material has a marked tendency to become transformed at its periphery into cartilage or pseudocartilage. This may even go on to calcification. In some specimens the structure is characteristically that of the nucleus although as a rule the cellular elements are increased and there is a true inflammatory reaction. In others, and perhaps the majority, there is a mixture of the pulposis and annulus showing a varying degree of cartilagenous metaplasia, inflammatory reaction and necrosis. (15)

Grossly Deutcher distinguishes two different types of protrusion. The single dense piece, which characteristically is that of "wet rolled-up blotting paper", and the fragmented protrusion. The fragments of the latter vary greatly in size and shape but this factor is meaningless. This worker also found that in 22 cases of the 100 there was a definite edematous swelling of the protrusion. He found the same thing, but to a more varying degree, in the other cases. This point will be considered later in this paper. (24)

The protrusion is most likely to occur in the posterior-lateral aspect of the disk. This is because of the poor lateral development of the posterior longitudinal ligament in this area. The posterior ligament reinforces the annulus. (26) At the 4th lumbar disk a protruded

disk would press on the 5th lumbar nerve but might also press on the 4th nerve at the intervertebral foramen. Medially the lesion might also press on the thecal sac with the 1st and 2nd sacral nerves.(26)

Of 100 operated cases Love and Walsh found 113 protruded disks. There were 12 cases of multiple protrusions and 88 cases of single protrusion. Of the single cases 76 were in the lumbar region and of the multiple cases all were in the lumbar region with the exception of one case which had a 11th thoracic lesion. 39 of the cases had the lesion in the 4th disk and 47 had the lesion in the 5th disk.(27) Hampton found that in 39 protruded disks of the lumbar area 92% were at the 4th or 5th disk. Of these cases 24 were lesions at the 4th and 11 were lesions at the 5th.(28)

ETIOLOGY

There has been two main theories as to the etiology. The early workers believed the lesion to be neoplastic in origin. Here again let me quote Hawk. "One gets the impression that Chondromata as a diagnosis was made not because the workers were certain, but because they knew of no alternative". Hawk goes on to say that it may be impossible to differentiate a chondroma from a normal fibrocartilage.(13)

The most recent theory, and the one adhered to by

the majority of the workers, is that of trauma. As shown in Table I some men have found a definitely associated history of trauma in as high as 80% of their cases. Fincher found a specific history of injury in 70% of his 50 proven cases of protruded intervertebral disk.(4) Skinner believes that trauma was present in all cases but, because of its insignificance, was not remembered. He also believes that repeated minor trauma is of the greatest importance.(29)

Naffziger, when he discussed the pressure attendant upon use of the spinal column, stated that the magnitude of the pressure was sufficient to account for herniation in a normal disk from a single traumatic incident.(16)

Chamberlain and Young, in their studies of the disk by means of intraspinal injection of air, found that in every normal case the maneuver of hyperflexion flattened the contours of the ventral surface of the thecal sac, while hyperextension produced visible bulging of soft tissue into the canal opposite each disk. In a few cases of protrusion they were able to obtain evidence of accentuation of the disturbance during extension and partial reduction of the protrusion during flexion.(26) A traumatic incident occurring while the subject was in a position of hyperextension would clearly enhance the chance for rupture of the annulus.

It has been brought forth before in this paper that lateral bending in the lumbar region places a great deal of strain on the annulus and posterior longitudinal ligament of the contralateral side. This position also would predispose the annulus to rupture if a traumatic incident should occur.

Saunders, in his discussion of the cavities and villus-like projections of the nucleus, stated that he believed them to be an indication of an early degree of dessication. They were found in the older subjects with great frequency, especially on dehydration by alcohol during the process of sectioning. The cavities were found with the greatest frequency during the middle decades. (15) As seen in Table 1 the average age of cases with this lesion is between 37 and 41. Thus it is logical to assume that with dessication and loss of the normal elasticity, the nucleus and annulus are more predisposed to the effects of trauma.

Indirect evidence that trauma is the etiological factor is shown in that the lesion predominates in the male (3-1). The type of work performed by the male subjects him to a greater chance of traumatic insult than does the work of the female. The distribution of the lesion to the curvatures of the spine, the areas of greatest mechanical stress, is another factor point-

ing indirectly to trauma. (27)

SYMPTOMS AND SIGNS

Macy, in a review of 100 cases, states that it is very difficult to draw any definite conclusions as to the symptoms found in the sciatic syndrome. He associates the following manifestations: Recurrent backache with recurrent sciatic pain; Continuous backache with recurrent sciatic pain; Continuous backache with continuous sciatic pain; Continuous sciatic pain without backache; Recurrent sciatic pain without backache. (30)

A fairly typical case was that of Mrs. P. E., a white divorced female, age 39, who entered the University Hospital on March 5, 1941, with the complaints of:

- 1) Three attacks of "sciatic rheumatism", the last attack being in May, 1940;
- 2) The rheumatism characterized by pain in the right hip and down the lateral side of the leg into the two small toes;
- 3) Pain and tenderness in the lower back and the right buttock.

The first attack had been 11 years ago, the 2nd had been 3 years ago, and the present attack began in May, 1940. During the last attack the pain had been so severe that she had spent one half of the time in bed. The only in-

jury she could recall was 3 years ago when she had slipped and struck her back against a show case. The sole of her right foot had seemed numb. The pain had been very sharp and of a "twisting" nature. She stated that the pain became worse if she tried to raise her leg without bending her knee. Coughing would cause her a twinge of pain down the leg. She was able to relieve the pain somewhat by lying on her abdomen and propping herself up on her elbows.

She had been treated by various medical men and by Chiropractors. One of the latter gave her some relief by manipulations of her leg and spine. She stated that during these manipulations she would feel a catch in her back following which the pain would be relieved. Frequently, however, before she left the elevator of the building something in her back would snap and the symptoms would return again.

Examination showed tenderness in the region of the greater sciatic notch, and positive Laseque's sign, but no sensory changes. The ankle jerk on the right was markedly decreased. Thus she presented a history of recurrent pain in the low back, gluteal, posterior thigh, and postero-lateral calf, paresthesia extending to the lateral two toes, a positive Laseque's sign and absent ankle jerk.

No roentgen studies with contrast medium were done

and she was subjected to a partial hemilaminectomy. Complete recovery was obtained.

The Pain

The most severe pain is referred to the root involved. There is, however, no way of excluding painful stimuli overflow into segmentally adjacent spinal nerves.(31) It may be referred to the peripheral distribution of the spinal-nerve root, or it may involve more than one peripheral segment, depending on the size and the location of the protrusion. It is usually referred to as "root pain". Root pain is defined as "pain which begins within or near the spinal cord and is projected peripherally to that part of the body or extremity innervated by the nerve fibers which leave the cord through the spinal-nerve emerging at that level. The pain is often described as 'sharp', 'shooting', or like an 'electric shock' ". (32) This causalgia is an irritative phenomenon and it is encountered in incomplete nerve lesions.(33) It may be the only complaint.(34) In order of frequency the painful areas are usually the posterior and lateral thigh, the posterior and lateral calf, the lumbosacral region, the gluteal and sacral-iliac region and the lateral border of the foot.(35) The pain is found to be unilateral in from 68%-85% of the cases.

cases. (27) (36) The probability is that the pain is due to pressure on the posterior longitudinal ligament. (27) Attention is again called to the work of Roope who has shown definite nerve fibers in the annulus but not the nucleus pulposus. (19)

Intermittancy

Intermittancy is a common finding. There are several varied theories to account for this. Deucher reported the following: "In 20 of 22 cases in which the pathological specimen showed marked evidence of edematous swelling attacks of pain lasting for from 3 weeks to six months had occurred immediately before registration at the clinic. Attacks of varying degree prior to these had ceased. In the other 2 cases the history was somewhat indefinite, but there had been symptoms for three and two years, respectively. These facts lead to the supposition that edema may be the cause of the recurrent attacks or exacerbations of pain. In many cases in which repeated painful attacks occurred over a period of years, a relatively small protrusion was found at operation, so that it seems likely that in some cases at least the repeated attacks were the result of recurring edema of the protruded portion of the disk. Edematous swelling and its subsidence under altered conditions, such as rest in bed, seem to offer one explan-

ation of the intermittency of pain in these cases". (24) Love and Walsh, and also Macy, believe that the explanation is a change in the position of the herniated nucleus. The former two men believe that the nucleus may in some cases return to its normal position and be extruded again. (27) Macy believes that the displaced nucleus changes its position beneath the annulus fibrosis. (30) It has been stated before that Chamberlain and Young were able to observe, by means of contrast medium and roentgen rays, the partial reduction of a herniated disk during flexion of the spine. (26) Woodhall found a history of intermittency in 96% of his cases. (36)

Paresthesias

Well localized paresthesias occur in many patients with single root involvement and are of great diagnostic value. (31) Numbness, tingling, and feelings of heat and cold are some of the paresthesias experienced by the patients. These perverted sensations are usually referred to the distal ends of the extremities and are spoken of as acroparesthesias. (33) Paresthesias can and do occur with involvement of only one root and also they usually precede sensory changes. If the sensory division of the posterior divisions of the nerve is involved the pain and the paresthesias should be referred

to the small dermatomes about the gluteal region. (31)
In the cases reported paresthesias have been present in
over 50%.

Sensory Changes

On the subject of sensory changes many of the men disagree. In the reported cases the percentage of sensory changes varies from 35% to 68%. Sensory change is not as a rule present because of the overlapping of the cutaneous nerves. As Foerster has shown it is necessary to cut three adjacent posterior nerves in order to produce an area of anesthesia. (20) Hypesthesia or anesthesia would not be expected in a very large percentage of the cases since the protrusion usually involves only one nerve root. (37) Barr reports regarding sensory changes that at operation one half of his cases had the disk fragment pressing on only one root, and in no instance in these cases was there any sensory change present. (35)

More important in diagnosis than actual sensory loss is the causalgic-like discomfort which is often produced by stimulation in the hypesthetic zone. Stroking the skin of the involved dermatome may produce a "needle and pin" or an "electric shock" sensation sharply limited to the involved segment. This hyperesthesia

"may overshadow the hypesthesia". (38)

Reflex Change

A diminished or absent ankle jerk was found in 23% of Skinner's cases and in 72% of Woodhall's cases. (39)(36) Here again the incidence of this sign as reported by the various men varies greatly. Bradford's cases indicate a greater incidence of diminished ankle jerks when the lesion is at the lumbosacral disk than when it is at the 4th disk. This sign was found in only 3 of 21 cases in which the lesion was at the 4th disk, but it is found in 10 of 13 cases with the lesion at the 5th disk. Bradford states that as a rule the reflexes return when true neuritis subsides. In case of subsidence of an enduring sciatica with residual neurological findings there is an indication of the possibility of painful disability from a disk disappearing with complete physiological destruction of the involved nerve. (31)

The reflexes are not of assistance in accurately locating the interspace because several nerve roots frequently supply the same muscle or may be responsible for the integrity of a certain reflex. (27)

Laseque's Sign

This test is accomplished with the patient lying supine. The thigh is raised to right angles with

the trunk, the knee being flexed. The leg is then extended on the thigh until pain begins along the course of the sciatic nerve. The foot is then dorsi-flexed to see if additional pull on the sciatic nerve exaggerates the pain. (18) This test is of significance in that it puts the sciatic nerve on the stretch and accentuates or precipitates the pain radiation. Macy and Naffziger have developed tests which are similar to this test in their principal.

Scoliosis and Loss of Normal Lordosis

Among the signs is the constant one called the "spinal symptom". Next to the pain, this is one of the most dominate features of "Sciatica". It is not a special symptom for it exists in every case of irritation of the lumbar spine. It does acquire special significance when associated with sciatic radiation of pain.

In the early stages when sciatic pain is not severe, the spinal column remains straight in the frontal plane, but complete forward flexion is impossible without aggravation of the pain. In other words, the lumbar spine is rigid but not deformed. This rigidity may persist throughout the course of the disease and disappear when the pain ceases. Soon after the onset of pain and while the pain is increasing, the spine curves laterally, displacing the trunk to the side away from the pain. This is the so-called contralateral sciatic scoliosis. Less frequently

the contracture bends the spine in the reverse direction, thus displacing the trunk towards the painful side. This is the homolateral scoliosis. This scoliosis is due to muscular contraction, which is due to a reflex induced by the pain to diminish the pain. The loss of the normal lumbar lordosis is of the same mechanism. The contralateral scoliosis is an attempt to separate the articular surfaces of the intervertebral joints on the painful side, and also to widen the intervertebral canals and to immobilize the joints. The homolateral scoliosis relaxes the joints and makes the nerve cord relax on the painful side. (40)

Barr found a list of the spine in 26 of 40 cases. In 15 cases the list was away from the site of the lesion and in 11 cases the list was toward the site of the lesion. In 27 of these cases a lumbar kyphosis was present. Barr also attributes this to the muscle spasm. (35)

Localized Tenderness

This sign was present in all of Fincher's cases. In these cases there was present a tenderness on pressure in the interspace between the posterior spines at the level of the site of protrusion. This he found to be a maximal painful area and in most cases it was the only point of interspinal pain. (4) Padula also brought forth this point when he stated that his cases consis-

tantly showed tenderness over the spines of the lower lumbar area. He does not, however, go as far as Fincher, and say that there is a maximal point of tenderness over the involved interspace. (41)

Motor Weakness, Atrophy, and Fibrillation

Fibrillary twitchings in the calf and the peroneal muscles occur in a small number of cases (4% -8%). They are most frequently found when there is also muscular atrophy. They are probably explained by the root irritation. (27) The muscle atrophy, paralysis or one or more extremities or of the vesical or anal sphincter are usually late developments. Sphincter incontinence occurs in a low percentage of the cases, and diagnostically they are not of major importance. Caution should be exercised in judging motor weakness and atrophy. These signs must not be confused with disability because of the pain. Atrophy can occur from disuse. (18)

There are no physical, neurological, or orthopedic signs which are found alone in cases of protrusion of the intervertebral disks. All of the known signs may also be found in other condition, (32) but many of the men interested in this lesion feel that the signs definitely aid in the location of the disk. Spurling and Bradford say definitely that the neurological symptoms and signs

are reliable. " During the past three months we have successfully removed nine consecutive herniations without confirmation with contrast mediums". (Spurling-18) On the other side of the fence are Love and Walsh. They believe that it is impossible to locate the interspace involved by neurological means; there are no sensory or motor changes characteristic enough for physical examination alone to accurately locate the lesion. (27)

In a personal communication Keegan has pointed out that the important areas in location of the lesion by neurological means are the big toe, the two lateral toes, and the heel. As has been stated before in this paper the paresthesias usually precede the sensory changes, or in other words, the subjective symptoms precede the objective symptoms. True, there are cutaneous sensory overlaps but if the above three areas are kept in mind and a good history is obtained as to paresthesias, the neurological diagnosis will be made more simple.

Another point brought out by Keegan is the fact that so many of the men concerned with cases of sciatic pain speak of the pain as being a "referred pain". Keegan believes it should be brought to the attention of these men that "referred pain " is a type of visceral pain. (42) "The visceral afferents carry the impulses to the spinal cord via the posterior root; they are car-

ried upward and reach the thalamus and cerebral cortex; instead of being localized in the diseased viscus these pains are referred to definite skin areas. The latter become hyperalgesic to stimuli while the patient is experiencing pain or in the interim. The location of the skin area to which the visceral pain is referred is determined by the fact that the visceral afferents reach the same cord segment which innervates the particular skin zone.

(33) The pain of the sciatic syndrome is due to direct irritation of the nerve root. It is not visceral pain and therefore "projection" or "radiation" of pain should be the descriptive terms used.

SPECIAL DIAGNOSTIC PROCEDURES:

The Reverse Queckenstedt Test

Love is the most energetic advocate of this test. He places a caudal needle in the sacral hiatus. A lumbar puncture is then inserted into the lumbar arachnoid space, a manometer is attached and then 10 cc fractions of a 1% solution of Procaine Hydrochloride are injected into the caudal epidural space through the caudal needle. Normally there should be a progressive rise in the manometer readings as the caudal sac is compressed by the extradural Procaine. Four fractions of 10 cc each or a total of 40 cc of the 1% solution of Procaine are injected extradurally. If a tumor or protruded disk of sufficient

size to obstruct the caudal sac is present, no increase in manometer readings will be found. In case the sciatic pain is not caused by a tumor or extruded disk the pain is usually exaggerated and then relieved on injection of each fraction. The order of events is first, pain from the irritation of the nerve roots and posterior ganglia, and then relief as the fluid diffuses and its anesthetic properties become manifest. In cases of compression by a tumor or disk the pain is unbearable and injection will have to be discontinued.(43)

Cerebrospinal Fluid Total Protein

Examination for total protein has been of no positive aid in diagnosis of protruded disk. Skinner was able to find no elevation in his cases.(39) Pennebacker did lumbar punctures on 25 cases and found that in 17 cases the total protein content was 45 mg. or less, in 6 cases it was between 45 and 65 mg., and in only 2 cases was it over 65 mg. (44) The total protein in milligrams percent decreases rapidly with increasing distance above the lesion. It is highest below the lesion. Hence in the lumbar rupture the elevation is usually quite moderate. If possible the needle should be introduced below the 5th lumbar vertebra.(25) Robinson considers any increase in the total protein as only an indication for myelograms with contrast medium.(25)

TABLE I

FREQUENCY OF SYMPTOMS AND SIGNS AS REPORTED BY THE
VARIOUS AUTHORS

	LOVE	FITCHER	BARR	SKINNER	WOODHALL	ALLEGAN
No. of cases	76	50	100	13	25	100
Age average	39.8	--	37	39	36	--
Trauma Hist.	71	--	80%	23%	47%	--
Ave. Duration	4 yr	--	--	3 yr	3½ yr	--
Back Pain	95%	--	--	--	100%	70%
Sciatic Rad.		60%		--	100%	--
Unilateral	68%	--	80%	--	--	--
Bilateral	25%	--	20%	--	--	--
Recurrent Pain	88%	--	40%	--	95%	--
Accent. by						
cough, etc.	39%	--	40%	69%	36%	--
Hypesthesia	31%	84%	35%	--	68%	55%
Paresthesia	49%	--	--	61%	48%	--
Localized tenderness	--	50%	50%	--	56%	--
Paravertebral muscle spasm	--	--	60%	76%	72%	--
Change in Lordosis	--	--	90%	76%	40%	--
Laseque pos.	82%	--	100%	76%	100%	--
Sciatic tenderness	63%	--	--	53%	28%	--
Motor weakness, etc.	26%	40%	15%	7%	40%	27.5%
Reflex change	57%	84%	50%	23%	72%	50%
Fibrillar twitchings	--	40%	--	--	3%	--
Sphincter incontinance	8%	--	5%	--	--	7.5%
Disk location						
I	2					
II	1					
III	10		10		3	
IV	40		50		12	
V	47		35		10	
Multiple	12					

ROENTGEN STUDIES

The final word in diagnosis and in the location of the lesion is obtained by the use of Spinograms. Be-rens has summarized the points for and against both air and lipiodol oil in the following manner:

For Oil: It gives a clearer picture, is more accurate, is easier to perform, is not painful, needs no anesthetic and is useful in any part of the canal.

Against Oil: Operation is necessary for removal, inflammatory reaction results if oil is not removed, if not all removed the oil will show in subsequent roentgenograms. Occasionally it is placed extradurally and is material for malpractice.

For Air: It will reveal all medium sized or large deformities of the dural sac such as would unquestionably require surgery. It has no after effects and nothing can be revealed by later examinations. It is not material for malpractice and may be performed several times if necessary.

Against Air: It necessitates a powerful roentgen apparatus, and even then does not always give a clear picture.

It is not accurate for small lesions and is painful necessitating a sedative or anesthetic. It is most useful in the lower dorsal, lumbar and sacral deformities. It takes more time and trouble to perform. (45)

Camp reports that another disadvantage in the use of air

is the difficulty in controlling the position and distribution of the air. (46)

Chamberlain and Young have reported more than 300 spinograms with air. Each operated case verified their results. Their technique is as follows: If the lesion is below the third lumbar vertebra they use the lateral decubitus position with the head of the table lowered to an angle of 20-25 degrees. At the third lumbar and 18-20 gage needle is inserted into the subarachnoid space. Spinal fluid and air is exchanged in 5 cc quantities until air escapes through the needle. The usual amount needed is 40-50 cc. If the lesion is above the third lumbar vertebra the needle is inserted in the same place but the patient is placed in a horizontal position. A Queckenstedt test is then done. If there is a partial or complete block the fluid is replaced with 3-6 cc of air, and the patient is placed in a sitting position. If the Queckenstedt is negative the needle is replaced by a lumbar or cisternal puncture. The patient is placed face down and the table changed to the horizontal position.

They report that over-exposure of the films gives the best results. The minimal views required are stereoscopic, lateral, and antero-posterior projections. The head is kept lowered because if this is not done the air will ascent into the cranium and produce headache. (26)

The diagnosis by roentgen rays depends in the

majority of the cases, upon the indentation or encroachment on the limiting membrane of the subarachnoid sac. A herniated disk carries the posterior longitudinal ligament dorsad so that indentations of the ventral aspect of the air column is usually detected on lateral projections. This defect is usually at the level of the interspace but if it is marked the membrane will be pushed dorsad for a variable distance below. According to these men the advantages of air is that it leaves no unabsorbable and possible irritating substance in the canal. Oxygen and air are completely absorbed. (26)

The indications for Lipiodol are, 1) in case of doubt as to the lesion, 2) when precise anatomical location of the lesion is desired by the neurosurgeon, and 3) when air studies have been inconclusive or unsatisfactory. (46) Keegan believes that intraspinal injection of lipiodol should not be done until conservative measures have failed to give relief and when serious disabilities exist. (47) Robinson considers the use of lipiodol only in those cases that have an elevation of the spinal fluid protein, in whom an adequate trial of orthopedic treatment has failed, in whom some other explanation can not be found for the sciatic symptoms and in whom a sacro-iliac or lumbosacral fusion is contemplated. (25)

Camp states that 5 cc is the optimum volume for accurate and consistent localization. (46) Spurling is in

complete disagreement with this. "Two cubic centimeters is considered to be optimum. In excess of this we consider it a handicap, for if the lesion is small it may be demonstrated only when a thin column of the opaque material is passing the point of involvement.(48) According to Camp if less than 5 cc are used a surprisingly large number of the large lesions and also the multiple lesions may be overlooked.(46) In Table I is shown that the cases that Camp and Love report had among them 12 multiple cases. Camp prefers lumbar injection as he believes it is the safer place and that it keeps the oil in one mass in the lower part of the column.(46)

During the injection of the oil slow continuous pressure on the syringe should be used. This prevents droplet formation in the subarachnoid space. If the examination is negative the column should be examined at a higher level.(46)

The oil must be of a clear and transparent yellow color, and it must be warmed to 105 degrees F before injection. If it has a brownish color it should be discarded for that color indicates deterioration and the undesirable presences of free iodine. Robinson states that the reaction of the meninges to the oil can practically be predicted by the pH of the oil. He believes the reaction to be due to the free fatty acid.(25)

The oil is more or less of an irritant to the men-

and therefore produces a ventral extradural pressure defect on the sac. Lipiodol cannot enter the local area. The root or roots are pushed almost directly backwards against the facets over-hanging the canal. Defects in which the root appears pinched off just below the lower border of the arch of the lamina, and in which the arachnoid outpocketing is obliterated with slight medial displacement of the border of the lipiodol column are not uncommon findings at the fifth lumbar level. (25) The findings are usually characteristically like those above. The factors that influence the deformity are, 1) the position and size of the protrusion, 2) the associated hypertrophy of the ligamentum flavum, and 3) the changes in the nerve roots. (46) The larger the protrusion the more tendency toward bilateral deformity. This Camp found in 35% of the cases he examined. (46)

The findings of the roentgenogram must be carefully correlated with the symptomatology and history. Horwitz studied the lumbar spines of 75 adult male human cadavers. He found narrowed disks in 24 cases, protrusions of the disk into the vertebral bodies in 4 cases, and the posterior protrusions into the canal in 9 cases. He also reviewed the histories of 25 of the cases, but in the histories of these cases backache was an infrequent and minor complaint and in no instance had the patient experienced the sciatic pain syndrome. Horwitz concluded that since the

use of contrast myelograms was usually needed for diagnosis it is important to understand that other lesions, largely the result of degenerative processes and also involving the intervertebral disk and ligamentum flavum and their adjacent structures, may be asymptomatic and yet produce defects in the intraspinal column of air or iodized oil. (51) Spurling reported that in some of his cases severe, persistent sciatic pain with low back pain, rigidity, hypesthesia of the lateral aspect of the leg, and diminution of the ankle jerks, gave positive results at surgical exploration regardless of the type of defect demonstrated by the iodized oil. (48) He goes on to say that on the other hand exploration frequently gave negative results where characteristic defects had been demonstrated but neurological evidence had been less characteristic.

Young has had good results with air myelograms. He states that oil is never justified. His reported cases do not seem to number enough to justify his statement. In 13 cases with the level of the lesion demonstrated by air he was able to confirm the diagnosis at operation. He found five herniations of the nucleus pulposus and eight tumors of the cauda equina. (52)

Johnson has reported 24 operated cases in which lipiodol studies had shown a defect in 22 cases. 6 cases had the lesion at the 5th disk, 10 had the lesion at the

4th disk, and 6 cases with the lesion in other locations.

(53) Poppen reported 2 cases which should serve as a warning to those who have blind trust in the spinograms. These 2 cases were thought to have findings with lipiodol that simulated herniated disk. When they were subjected to laminectomy no evidence of herniation was found. The defect had been produced by a chronic thickening of the arachnoid. (54)

In Table 11 is a brief summary of the cases operated at the University Hospital by Keegan. These are the cases operated during the period of December 1939 to the present date. There were ten cases but one was not included in this table as it was treated by the Orthopedic department with a body cast. A point worth consideration is that of these 9 cases, 5 of them were operated without previous localization by means of spinograms. In 2 of these cases the spinograms were not attempted. In 2 the spinograms were unsatisfactory. In 1 the spinogram was negative. Yet in all 5 cases a protrusion was found at operation. In another case no lesion was found at operation yet lipiodol studies had shown a definite defect. This group of cases, although not large, certainly makes one regard the results of the spinogram with no small degree of skepticism. The necessity of removing the oil from the dural sac does not seem to make its use warranted if the neurological diagnosis can be made.

TABLE II

CASES OPERATED AT THE UNIVERSITY OF NEBRASKA HOSPITAL

DECEMBER 1939 TO PRESENT DATE

CASE	1	2	3	4	5	6	7	8	9
Age	31	46	57	27	48	50	22	35	39
Duration	5mo	3yr	3yr	2yr	4yr	12yr	3yr	5yr	11yr
Intermittancy	*	*	*	*	*	*	*	*	*
Backache	*	*	*	-	-	*	*	*	*
Sciatic pain	*	*	*	-	-	*	*	*	*
Muscular tenderness	-	-	-	-	*	*	-	*	-
Loss of Normal Lordosis	-	-	-	-	-	-	*	*	-
Sciatic tenderness	-	-	-	-	-	-	-	-	*
Laseque's sign	-	-	-	-	*	-	*	*	*
Ankle Jerk	ABS.	DIM.	DIM.	ABS.	-	ABS.	ABS.	ABS.	DIM.
Motor weakness or atrophy	*	*	*	*	-	*	-	-	-
Hypesthesia	*	*	-	-	-	-	*	*	-
Paresthesia	-	-	-	-	-	*	-	-	*
Muscle Fibrillation	-	-	-	-	-	*	-	-	-
Sphincter loss	-	-	-	-	-	-	-	-	-
Disk Location	5th	5th	5th	4th	5th	-	5th	5th	5th

* Positive findings; - Negative finding.

Case#8 and#9: Partial Hemilaminectomy at operation. No Myelograms were done.

Case#4: Negative Myelograms; at operation a protruded disk was found at 5th lumbar interspace.

Case#5 and#7: Lipiodol studies were unsatisfactory. At operation lesions were found at 4th and 5th disk respectively.

Case#6: No lesion was found at operation although Lipiodol studies had shown a definite constant defect. The failure was explained on the basis that the protrusion had been reduced during the course of the anesthesia. While on the operating table attempts were made to locate the lesion by placing the subject in hyperflexion, and also in hyperextension, failed.

TREATMENT

The technique and finer details of the treatment of protruded intervertebral disk will not be gone into at great length in this paper. There are a few points in modern day treatment that should be emphasized.

Love and Walsh bring forth the question of fusion. They consider that fusion is not necessary nor indicated in a high percentage of the cases. The Orthopedic surgeons at Mayo Clinic have found it necessary to fuse the spinal column in only 15 of over 500 operations for the protruded intervertebral disk. According to these men each case should be considered individually. Associated spondylolisthesis, extensive lumbosacral arthritis, and a static type of backache in addition to the protruded disk should be indications for fusion. Contra-indications are younger persons whose bones are still growing and persons of advanced age who would have to be immobilized for prolonged periods. (55)

Another point is the amount of bone to be removed at operation, As much of the neural arch should be preserved as is possible. Hemilaminectomy usually is all that is necessary where a unilateral lesion is present. Love has found that resection of the ligamentum flavum suffices in cases of unilaterality of lesion with marked contralateral scoliosis. He has been able to do partial hemilaminectomies in which he removed only the margins

of the laminae without interruption of a single neural arch. (55) Keegan performed this type of laminectomy on Cases #8 and #9 as seen in Table 11.

If lipiodol studies have been done previous to operation the contrast medium should be removed. This is best accomplished by having the head and shoulders of the patient elevated. This position results in the collection of the radiopaque substance into a mass at the level of the lesion and making it more accessible. The use of a suction apparatus facilitates removal. Irrigation with warmed saline solution is also advantageous. (55)

The question of recurrence is often a problem. The entire disk is never removed and it seems very likely that further protrusion could occur. Furthermore it has been shown before in this paper that multiple lesions have been reported in as high as 12% of the cases. Protrusion at some other level could very logically occur. It would seem that careful postoperative instruction to the patient would in a good measure prevent recurrence. (55) Love instructs his patients to do no lifting or straining for a period of three months from the date of dismissal. "It is particularly important to warn the laborer, and all others who are accustomed to hard manual work, to return to their former duties gradually. Such

persons must regain their confidence to carry on". Love has reported only 5 recurrences in over 500 cases. In all of the recurrences the same disk was involved again. (55)

As yet there are few discouraging results of operation reported. Keegan reported the results of 40 laminectomies as follows: 90-100% recovery in 57.5%; 80-90% recovery in 17.5%; 50% recovery in 10%; and failure in 15%. He also reported that in 15% of these cases there was no definite pathology found. (42)

CONCLUSION

An attempt has been made in this paper to correlate the anatomy and pathology of the protrusions of the intervertebral disk in the lower lumbar region with the symptoms and signs produced.

The lesion has been gaining an increasingly large amount of popularity in the past few years. As a pathological entity it has become recognized as a frequent cause of low back and sciatic pain, but in this respect it shares the limelight with many other lesions, all of which may produce the same peripheral symptoms and signs. Among these other lesions are Spondylolisthesis, Chronic Strain of the sacro-iliac and Lumbo-sacral regions, Congenital afflictions such as Spina Bifida and Sacralization of the 5th lumbar vertebra, Neoplastic conditions,

and Tumors of the Spinal cord.

It would be nice at this time to be able to indicate the frequency with which the protruded disks are a cause of low back and sciatic pain. But, as it has been shown in this paper, the reports of the men working with cases of this type have differed widely concerning incidence. Craig and Walsh have found an incidence of only 3%, yet Fincher has indicated an incidence much in excess of this. (3) (4) Pappworth, in a caustic review of the reported cases up to 1939, brought forth the question that many of the operated cases could possibly have been afflictions of the spinal cord that caused the same sciatic symptoms but in which the protrusion of the disk had been an incidental finding, one of Schmorl's 15.2%. (56) The work of Horwitz would tend to substantiate that thought. (51)

With regard to the diagnosis of the protrusion, a complete and detailed history as to onset and association with trauma, intermittancy, the type of pain, the paresthesias, and the previous treatment and effect of such treatment would be of utmost aid.

Perhaps the use of special diagnostic procedures has somewhat eclipsed the benefits of a thorough physical and neurological examination. There is no question as to the diagnostic aid and the aid in localization that may be obtained by such procedures, especially that of the intraspinal myelograms. But such measures are not infal-

libile. In many cases they have been of no value and the subjection of the patient to such measures has seemed unnecessary. In many cases a thorough neurological examination and a detailed history were all that was needed. The work of Spurling and the cases operated at the University Hospital by Keegan support this statement.

At the present the lesion of the protruded disk is in a blazing spotlight of popularity. It may be likened to the up-swing of a pendulum. There have been few reports of poor results. More extensive follow-up reports on operated cases may bring to our attention a few poor results that have put in a delayed appearance. This does not seem very probable for the treatment has been by proven surgical means and the tendency has been to do partial hemilaminectomies with a minimum of disturbance to the neural arch. The popularity of the protruded disk as a cause of "sciatica" may recede and the incidence may be low when eventually established but as a pathological entity, with a definite demonstrable lesion, the protruded disk has become firmly fixed in the minds of the minds of the Orthopedists and Neurologists.

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