*(FROM THE ORTHOPEDIC CLINIC OF ST. GÖRAN'S HOSPITAL AND THE NOBEL-INSTITUTE FOR NEUROPHYSIOLOGY, KAROLINSKA INSTITUTET, STOCKHOLM)*

# HISTOLOGIC CHANGES IN SPINAL NERVE ROOTS OF OPERATED CASES OF SCIATICA[1]

*By*

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A survey of the recent literature relative to sciatica reveals that opinions as to the pathogenesis of the disease, are still manifold.

The view that sciatrica is due to pressure on the lumbo-sacral spinal nerve roots is being more and more accepted, however. Sciatica with root symptoms is assumed to be brought about by manifest ruptured disc compression and in the absence of root symptoms by slight or intermittent pressure. On the other hand, the pain may possibly be of the type "referred pain" from the posterior surface of the disc or ligamentum longitudinale posterius. In reference to changes in the nerves themselves, two conceptions are discernible, (1) that pathological changes in the nerves either never, or very seldom occur (Symonds, 1943, et al), (2) that pathological changes, maybe, are relatively common but, if so, they are secondary, and a result of the effect of disc-hernia on the nerves (Dandy, 1943, et al).

An opinion which is being increasingly abandoned is the assumption that sciatica is an independent disease of rheumatic nature either in the sciatic nerve or its roots, and that the disc rupture is a secondary phenomenon (Thiébaut, 1947). As a middle course between older and newer conceptions, O. Lindahl (1947) put forward the theory that, in the majority of cases, the sciatic symptoms are brought about by the co-operation of mechanic pressure from without and abnormal reaction to this pressure on the part of the nerve roots, due to already existing pathologic changes in them.

As the occurrence and type of these pathologic changes are so variously evaluated, it seemed important to obtain actual facts regarding them. For this reason we have histologically investigated biopsies from the nerve roots in operated cases of sciatica.

Earlier literature relevant to the neuropathology of the disease is

[1] Lecture at the Svensk Ortopedisk Förening in Stockholm 26.11.1949.

comparatively scarce. In 1905, Hunt collocated 11 previously published cases in which the sciatic nerve had been examined post mortem. In 8 of these, pathologic changes in the form of redness, thickening and edema were macroscopically verified. Two, microscopically investigated, revealed no signs of inflammation. Hunt also gives an account of a case of his own who died of pneumonia during the course of typical

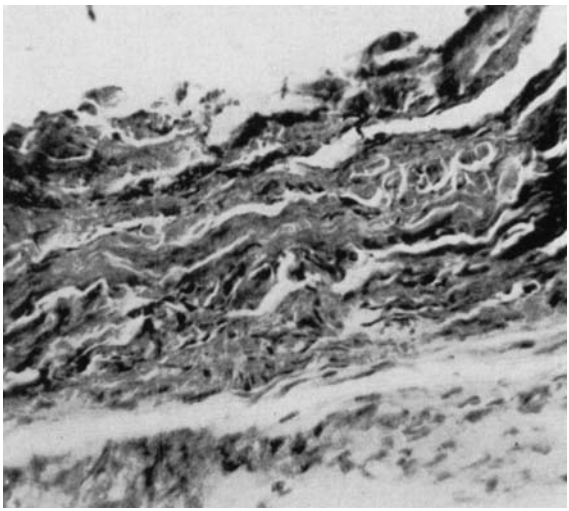

*Fig. 1.*

Normal connective tissue surrounding the root fascicles central to the spinal ganglion. Collagen in thin bundles with connective tissue cells interposed. Hematoxylin-Weigert-Hansen. Case 8.

sciatica. Inside the sheath surrounding the nerve, on the diseased side, was a jelly-like substance which, under the microscope, appeared quite structureless and without inflammatory changes. Hunt interprets the changes as a form of "nerve gout" and considers that elucidation of the same should probably be sought within the domain of chemical pathology.

In 1932, Koeppen rendered an account of 37 cases in which autopsy investigations of the sciatic nerve were made on both sides. In 4 of these, the patients had had sciatica which, in 3, had a chronic recurrent course. The sciatic nerve, in all 3 cases, revealed in the pertinent arteries, on the afflicted side, a severe sclerosis of the intima and advanced calcification of the media. The arteries on the unaffected side were normal. As regards the fourth case, where the patient died only 6 days after the attack of sciatica, a fresh thrombosis was found in the vena femoralis. There were also thromboses right in the small

nerve veins on the diseased side. Of the 33 cases without sciatica, 8 had suffered from polyarthritis, and 3 had revealed unspecific, perivascular infiltration round the small vessels of the nerves.

Döring (1939) described a case of chronic recurrent sciatica. The patient suddenly died of cardiac weakness during the illness. The spinal ganglia corresponding to the plexus lumbo-sacralis showed a

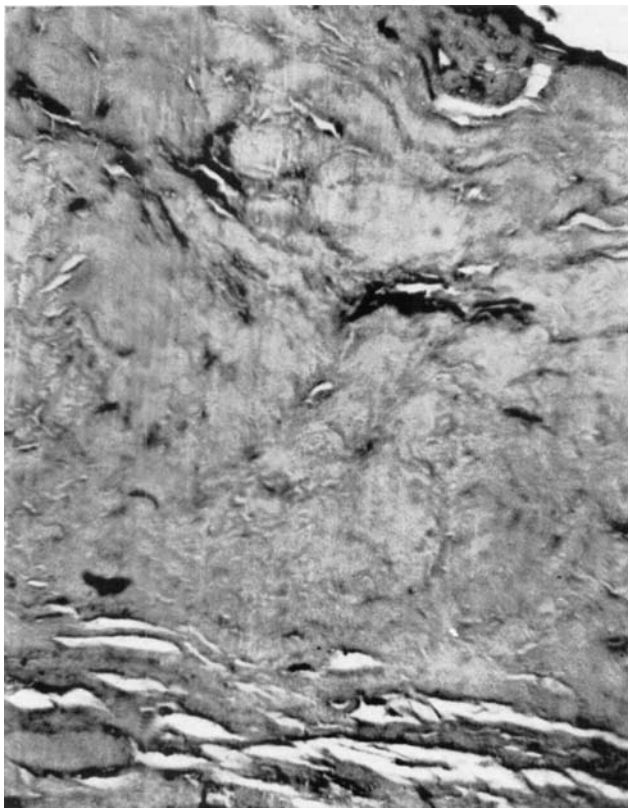

*Fig. 2.*

Pathologically thickened connective tissue sheath, central to the ganglion. Collagen bundles very thickened, structureless. The intervening connective tissue cells have almost vanished. Hematoxylin-Weigert-Hansen. Case 6.

pronounced inflammatory process which even involved short stretches of the nerve roots. The changes consisted in limited cell infiltrations between the nerve cells and nerve filaments, without any connexion with the vessels. The cells were mostly of lymphocyte type, but there were also plasma cells. According to Döring the changes must be interpreted as signs of real inflammation.

Haberman (1949) reported 6 cases where, when operating for sciatica, he had excised the entire dorsal root for histologic examination. In 4 of these cases he found positive inflammatory changes. They took the form of lymphocyte and leukocyte infiltration perivascularly with edema in the endo- and perineurium. The nerves were histologically normal in the two other cases, although in the one, the nerve sustained severe pressure laterally due to a large disc protrusion.

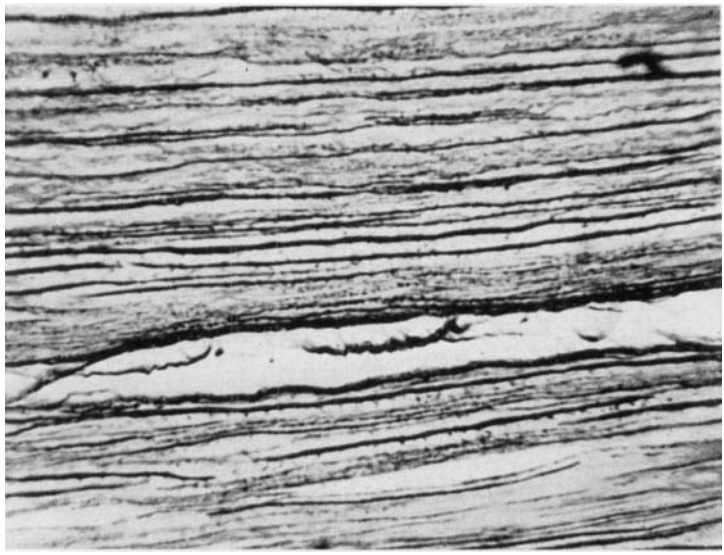

*Fig. 3.*

Normal spinal nerve root with axis-cylinders of even thickness. Davenport silver impregnation. Case 2.

Put together, these cases of sciatica with post-mortem examination of the nerve, number 23. Eighteen or 78 % revealed pathologic changes, whereas in only 5 cases was the nerve normal.

Other neuropathologic investigations of the spinal nerves and their roots have also yielded results which are of interest in connexion with the pathogenesis of the sciatic disease.

Rexed (1947) described pathologic changes in the nerve roots and dural root pockets. The changes included cystic formation and proliferation of the arachnoid which, at times, compressed the nerve roots to half their size or less. Relevant to the etiology of these root cysts Rexed wrote (1949) that meningeal reactions in banal infections are possibly involved, and that they may presumably constitute a locus minoris resistentiae in the event of new irritations.

In 1948 Lindblom and Rexed gave an account of 17 cases. They

had carefully examined, with serial section, 44 nerves, nerve roots and root sheaths from post-mortem cases in which the nerve had been exposed to compression by a disc-hernia in the intervertebral foramen. Additionally to the purely mechanic deformation, the changes in the nerves, due to the compression, consisted of a slight increase of connective tissue elements in the perineurium, and of a mixture of degeneration and regeneration phenomena of the nerve fibres themselves,

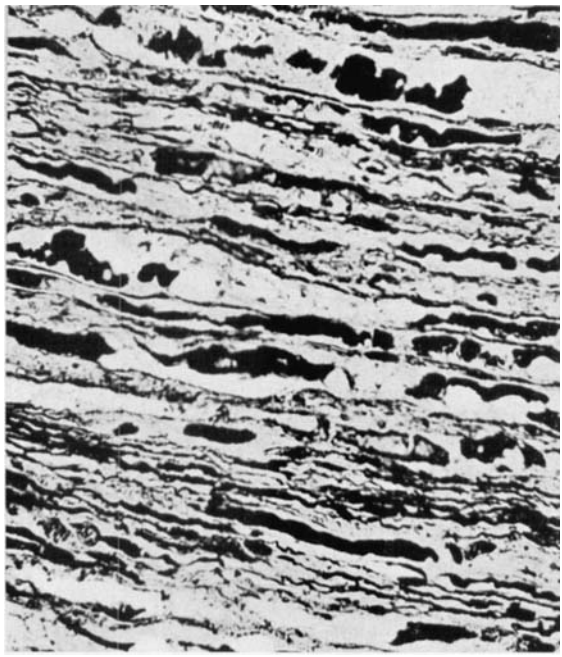

*Fig. 4.*

Nerve root fascicle, cut longitudinally with degenerated nerve fibres. Numerous nerve fibres are decomposed and the thickened remains of the axis-cylinders lie very distorted in the section. Davenport silver impregnation. Case 7.

but no single case showed any cell infiltration. Where the spinal ganglion was subjected to pressure the formation of connective tissue was more abundant than when the nerve was compressed. These changes were similar in type, but varied in degree according to the severity of the compression. Hence, from this material it is possible to estimate the histological reaction of the segmental nerves in the event of pressure.

In a preliminary publication of 1949, Veith gave the results of a systematic investigation of spinal roots in the cervical, thoracic and lumbo-sacral regions of a large number of cases in which the patients

had died of various diseases. Practically every case of death from an infectious disease revealed nerve root changes, the lumbo-sacral roots being particularly involved. On the other hand, the peripheral nerves were intact. Proliferative inflammation, mostly in the perineurium, connective tissue cells and lymphocytes as well as edema in the endoneurium were the findings. The vascular changes, especially in the arteries, took the form of mural thickening and intimal proliferation,

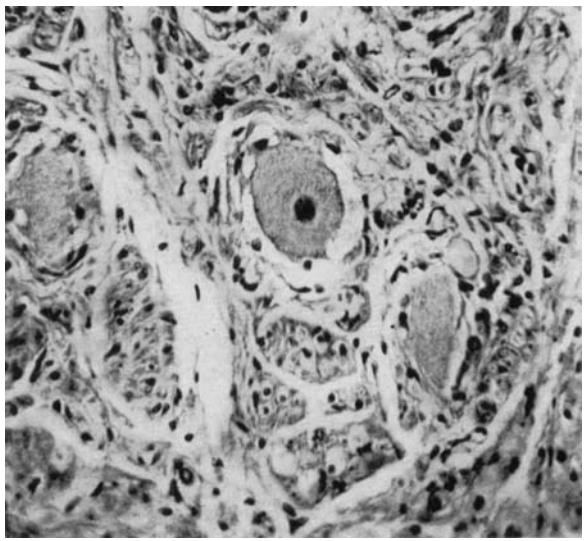

*Fig. 5.*

Normal spinal ganglion post-mortem material. The nuclei belong to mantle-cells surrounding ganglion cells, and Schwann and connective tissue cells in the nerve bundles. Hematoxylineosin.

to the point of obliteration. Some of these cases disclosed clinical signs of nerve irritation.

Our own material is composed of 10 cases and the operations for sciatica included biopsy from the dorsal part of the nerve root. As these biopsies were made as small as possible so as not to injure the function of the nerve roots, the specimens, in many cases, cannot be looked upon as representative of the entire nerve root. The possibility of the presence of pathologic changes apart from those revealed by the removed tissue cannot be excluded. The material was fixed in a formalin-acetic acid solution and stained with hematoxylin-eosin, Weigert-Hansen's connective tissue stain, azocarmin or silver impregnation of paraffin sections. Histologic examination showed that the specimens consisted of nerve fascicles from the dural pockets of the

roots, of fascicles distally to the pockets with occasional pure dural tissue, of parts of the spinal ganglion or solely of thickened perineural or peridural connective tissue.

*Case 1.* Jnr K.O. 475/48. Born 1912. Pain in back and right leg during 4 months. In the last month, severe pain in the whole leg. Cough pain. Status: Lasègue right 60°. Right heel reflex weaker. Non-paresis of great toe. Sensory impairment in right gluteal region. Operation: Partial laminectomy L4-L5 and L5-S1 + biopsy from the right S1 root. S1 root distinctly thickened. Neither hernia nor disc protrusion observable. Histologic investigation of removed tissue: Nerve fascicles + dura. A few degenerated nerve fibres. No cell infiltration. No thickening of the dura.

*Case 2.* Jnr K.O. 489/47. Born 1910. Recurrent lumbago during the last 7 years. For a year, weakness of the right leg with shooting pains. Myelography showed suspicion of disc-hernia L5-S1. Status: Lasègue right, 85°. Right heel reflex weaker. Non-paresis of the great toe. No sensory disturbance. Operation: Partial laminectomy L5-S1 + biopsy from the right S1 root. Osteophytes removed by chiselling. No hernia or disc protrusion observable. Histologic examination of removed tissue: Nerve fascicles. No pathologic changes observable.

*Case 3.* Jnr K.O. 264/47. Born 1928. Recurrent left-sided sciatica with pain sometimes in the heel, during 1 year. Status: Lasègue left 40°. Left knee and heel reflex negative. Paresis of the dorsal extensors in the left great toe. Impaired sensibility of left lower-leg laterally. Operation: Partial laminectomy L5-S1 + extirpation of disc-hernia + biopsy from S1 root. Histologic examination of removed tissue. Nerve fascicles + dura. Pronounced hyperplasia of the dural sheath, partly with homogenization of the collagen bundles. Nerve fascicles normal. No cell infiltration.

*Case 4.* Jnr K.O. 380/49. Born 1907. Continuous trouble in the back during 3 years. The last half year, increased trouble with pain in left leg and foot. Status: Lasègue left 30°, right 45° crossed. Heel reflexes normal. Paresis of dorsal extensors in left great toe. Operation: Partial laminectomy S1-S2 (lumbalisation of S1) + extirpation of disc prolapse + biopsy from S2 root + osteosynthesis S1-S2. Histologic examination of removed tissue: nerve fascicles. No pathologic changes observable.

*Case 5.* Jnr K.O. 187/48. Born 1918. Recurrent back trouble during 4 years. For 2 months pain in left leg down into the heel. No cough pain. Status: Lasègue left 40°, right 60°. Left heel reflex a trifle weaker than the right. Indication of paresis of dorsal extensors in left great toe. Impaired sensibility on the lateral side of left lower-leg. Myelography negative. Operation: Partial laminectomy L4-L5 and L5-S1 + biopsy from S1 root + osteosynthesis L4-L5-S1. Neither hernia nor disc protrusion observable. Histologic examination of removed tissue: Piece of spinal ganglion, nerve fascicles and connective tissue sheaths. The spinal ganglion cells are of normal appearance. Some fascicles show moderate degenerative changes. Connective tissue sheaths normal. No cell infiltrations.

*Case 6.* Jnr K.O. 197/48. Born 1907. Recurrent lumbago during 4 years. For half a year increasing right-sided sciatica with pain down to the heel. Cough pain. Status: Lasègue right 45°. Right heel reflex negative. Non-paresis of great toe. No sensory disturbance. Operation: Partial laminectomy L5-S1 + extirpation of disc hernia + biopsy from S1 root. Histologic investigation of removed tissue: No nerve fascicles, connective tissue sheath. Excessive thickening of sheath and, in places, homogenization of the collagen bundles. Cell infiltrations here and there.

*Case 7.* Jnr K.O. 497/47. Born 1911. Six years ago attack of left-sided sciatica. Half a year ago, pain in the back which lasted 2 months and from a month ago increasing pain in the back and left leg down to the heel. Cough pain. Status: Lasègue left 15°, right 80°, crossed. Left heel reflex negative. Slight paresis of dorsal extensors in left great toe. Impaired sensibility of the sole of the foot. Operation: Partial laminectomy L5-S1 + extirpation of disc hernia + biopsy from S1 root. Histologic examination of removed tissue: Nerve fascicles. Clear degeneration within some of the fascicles. No cell infiltration.

*Case 8.* Jnr 2537/47 (Värnamo hospital). Born 1907. For 10 years recurrent back trouble, the last year with increasing pain in right leg. The last 2 months prolonged right-sided sciatica. Status: Lasègue right 80°. Right heel reflex considerably feebler than the left. No great toe paresis. No sensibility disturbance. Operation: Partial laminectomy L5-S1 + extirpation of disc prolapse + biopsy from S1 root. Histologic investigation of the tissue: Nerve fascicles + dura sheath. No pathologic changes observable.

*Case 9.* Jnr K.O. 359/49. Born 1902. Right-sided sciatica during one month. Status: Lasègue right 80°. Right heel reflex negative. No great toe paresis. No sensory disturbance. Operation: Partial laminectomy L5-S1 + extirpation of disc protrusion + biopsy from S1 root. Flat protrusion of disc behind root. Incision and removal of disc fragments. Removed tissue examined histologically. Piece of spinal ganglion, nerve fascicles and connective tissue sheath. Ganglion cells and nerve fibres are of normal appearance. The connective tissue sheath shows moderate hypertrophy with a certain homogenization of the collagen bundles.

*Case 10.* Jnr 281/47. Born 1905. Lumbago 15 years ago. 12 and 3 years ago right-sided sciatica. Recurrence of right-sided sciatica 4 months ago. Status: Lasègue right 30°, left 80°. Normal heel reflexes. Paresis of dorsal extensors in right great toe. Operation: Partial laminectomy L4-L5 and L5-S1 + extirpation of disc hernia L4-L5 + biopsy from S1 root. Between L5 and S1 no disc hernia or protrusion. Histologic examination of the removed tissue: Piece of spinal ganglion + nerve fascicles. Excessive cell infiltration between the ganglion cells and between the bundles of nerve filaments, with a preponderance of the mononuclear type. In a few places degenerated, decomposed ganglion cells.

Accordingly, all 10 cases have a long history, generally with recurrent sciatica and signs of root compression. At operation, a clear picture of disc hernia or prolapse was found in 5 cases. Of these, 2 showed normal nerve roots histologically. In 2, there was hyperplasia of the perineurium, while 1 case manifested severe hyperplasia of the perineurium with slight inflammatory reaction. Five cases revealed no compression of the examined nerve roots by disc hernia (facetectomy with inspection of the foramina intervertebralia was not performed). One of the 5 had a normal histologic picture, 2, degeneration of nerve fibres, 1, severe hyperplasia of the perineurium, and 1, in which ganglion tissue was removed, decided inflammatory changes with lymphocyte infiltration. Altogether, of the 10 cases, pathologic changes were found in 7.

From this investigation it can thus be deduced that pathologic

changes in the spinal nerves and nerve roots are very common phenomena in sciatica. As far as one can judge from the literature, they occur among 78 % of the patients and, relevant to our material of 10 cases, among 70 %. It may be asked whether these pathologic changes in the nerves can have developed secondarily through pressure on the nerves,—or are they an expression of an independent nervous disease?

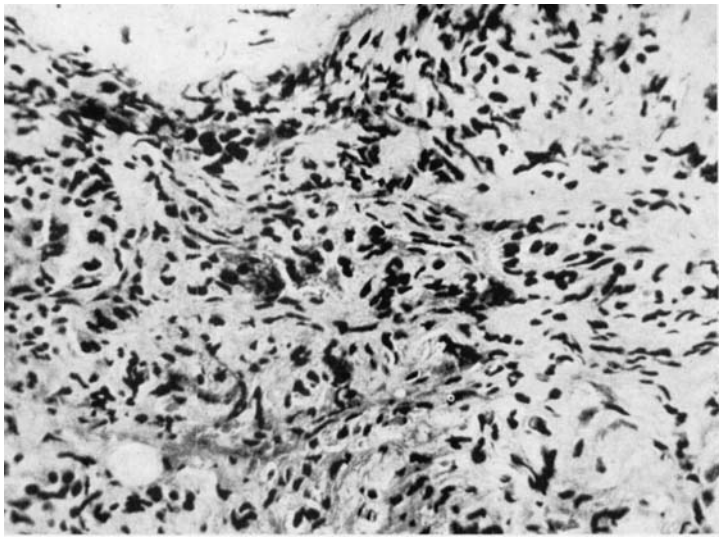

*Fig. 6.*

Spinal ganglion with great cell increase between the nerve fibres and their bundles. Centrally in the picture are remnants of ganglion cells, surrounded by collections of mononuclear cells. Hematoxylin-eosin. Case 10.

Such a question cannot be definitely answered yet, but when the answer comes it will undoubtedly be that both alternatives are possible. The majority of changes observed in this material, i.e., degeneration of nerve fibres and moderate hyperplasia of the perineurium may presumably be due to the effect of pressure. They histologically resemble those described by Lindblom and Rexed which were brought about in the nerve roots when compressed by lateral disc hernia. Hyperplasia of the connective tissue in the perineurium was more severe in this material, however, and of a somewhat different type. In the cases in which inflammatory changes with infiltration of lymphocytes and proliferation of connective tissue cells were involved, it is scarcely conceivable that these were the result of pressure. The histologic findings in our material, as well as the corresponding descriptions in the

literature, argue in favour of the assumption that at least in some cases of sciatica, neuropathologic changes occur which originate from another cause than pressure from a disc hernia. If, in such a case, a protrusion presses upon the nerve root, highly irritable through disease, this is obviously a further indication to extirpate the disc-hernia.

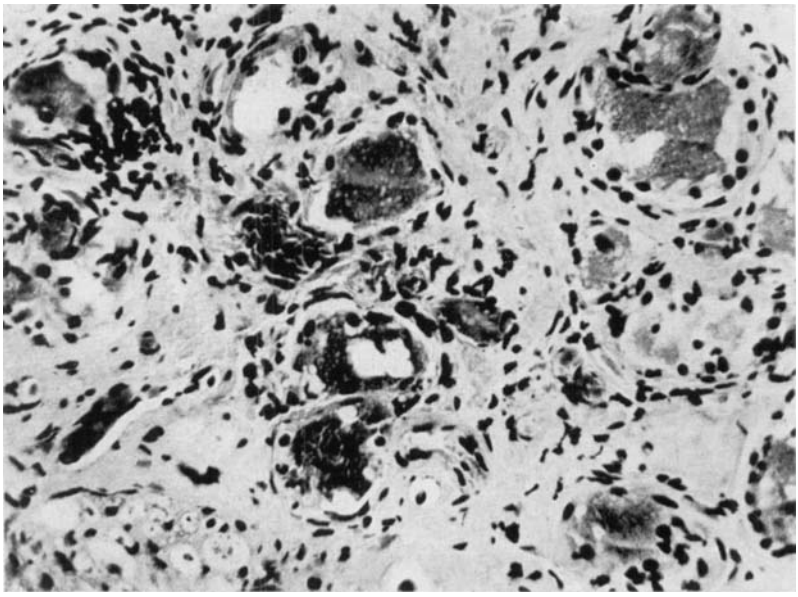

*Fig. 7.*

Another part of the spinal ganglion seen in Fig. 6. Decomposing spinal ganglion cells with surrounding accumulations of mononuclear cells. Hematoxylin-eosin. Case 10.


## SUMMARY

The literature on the subject is reviewed. An account is given of histologic examinations of tissue removed from the spinal nerve roots of 10 operated cases of sciatica. The authors come to the conclusion that pathologic changes in nerves and nerve roots in sciatica are common phenomena, and that in some cases at least, these changes should not be looked upon as caused by disc-hernia compression.



## ZUSAMMENFASSUNG

Die Litteratur über das Thema wird besprochen. Ein Bericht über die histologischen Untersuchungen von Gewebe, das von Nervenwurzeln des Rückenmarkes bei 10 wegen Ischias operierten Patienten entfernt

wurde, wird vorgelegt. Die Verfasser kommen zu dem Schluss, dass Pathologische Veränderungen von Nerven und Nervenwurzeln in Fällen von Ischias eine häufige Erscheinung sind, und dass in einigen dieser Fälle diese Veränderungen nicht als durch Scheibenvorfall hervorgerufen, angesehen werden können.

RESUME

La littérature publiée sur le sujet est passée en revue. Il est rendu compte de l'examen histologique de tissu de racines nerveuses provenant de 10 cas de sciatiques qui ont été opérés. Les auteurs arrivent à la conclusion que les modifications pathologiques dans les nerfs et les racines nerveuses sont des phénomènes communs aux cas de sciatique et que, dans une partie des cas tout au moins, ces modifications ne sauraient être causées par compression discale.

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