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PROGNOSIS IN SCIATICA

A clinical follow-up of surgical and non-surgical treatment

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B: INTRODUCTION

There are different forms of sciatica, i.e., radiating pain in one or both legs corresponding to the innervation from one or more nerve roots. Among these forms there is one main type which has characteristic, clinically demonstrable neurological signs. Many feel that the pathogenesis may be ascribed to disc prolapse. Some authors claim that 80—90 % of all cases of sciatica covered by the above definition have this pathology. For the others no definite explanation can be found, but many theories have been discussed—most of which seek the causes in other kinds of mechanical root pressure or in inflammatory reactions.

The clinical course of sciatica varies. In some patients, the symptoms decline after a week or two, with or without treatment; in others, the pain persists, despite intensive therapeutic efforts, for many months or years.

Sciatica is regarded as an acute and generally transient episode triggered in a slowly progressive condition, disc degeneration, which often covers a period of decades.

Against this background two factors must be considered in the management of sciatica: firstly the effect of therapy on the acute condition and secondly, equally important, the effect which therapy may have on the changes which the intervertebral disc will undergo.

Up to 1934, when the connection between sciatica and disc prolapse was first established, non-surgical management was almost always the therapy of choice, and it has been pointed out that many thousands of patients must have recovered without surgical excision of their disc prolapses. The surgical alternative, established in the middle of the 1930's by the work of *Mixter & Barr* and others, has been the subject of great interest ever since, with the result that we are now quite familiar with its advantages and limitations. Corresponding analyses have not, however, been made concerning the behaviour of the sciatica syndrome during and after conservative management. As a result, even though few authors nowadays are prepared to recommend immediate surgery without first trying conservative management, there are still differences

of opinion about how long one should persist with conservative treatment before resorting to surgery. The current situation was described by *Mercer & Duthie* in *Orthopaedic Surgery* (1964) as follows: "The problem of conservative versus surgical treatment of persistent disc syndrome is settled in favour of the latter according to surgeons engaged in disc surgery but to the majority of others is unsolved."

Despite an abundant literature on the subject, further clinical studies therefore appear desirable and it was decided to present the experience gained at the Department of Orthopaedic Surgery at Karolinska Institutet in the treatment of acute sciatica.

The first surgery for disc herniation was performed at the Department in the spring of 1939, when a prolapse was excised in a patient with severe sciatica. There are now about three thousand operated patients and more than ten thousand have received conservative management. The principles for the management of acute sciatica have on the whole been uniform and characterised by a cautious attitude towards surgery. As a rule, there has been hesitation in choosing surgical intervention unless proper, conservative therapy had been attempted first, or if pre-operative myelography was negative. The most essential aspect of conservative management during the acute stages of sciatica has been to achieve relative immobilisation of the lumbar spine with the use of corset braces or bed-rest. The goal of surgery has been to remove the cause of root compression and, if possible, to prevent the development of new compression (careful evacuation of the ruptured disc), always with a minimum of exploration. Fusion in conjunction with excision of the disc prolapse ("combined operation") was performed to a limited extent in the 1940's but this method was subsequently abandoned.

The results of the operative therapy have been analysed in several works (*Friberg* 1941, *Friberg & Hirsch* 1946, *Hirsch* 1947, *Unander-Scharin* 1950, *Friberg & Hult* 1951). However, experience from recent years of either conservative or surgical treatment has not been presented, from this Department.

The present study has been restricted to the years 1955—1961 in order to gain an impression of the results attained with the current indications for the treatment of acute sciatica. The study includes all the patients with unilateral sciatica who were treated at the Department during this period. None of these patients had previously suffered from sciatica and none had symptoms lasting more than six months. Only those patients displaying neurological anomalies suggestive of a lesion of the 1st sacral and/or 5th lumbar nerve roots were included. All patients were treated

according to the principles currently applicable at the Department. The present series comprises 583 patients.

A difficulty inherent in any study of the results of treatment for sciatica arises from the fact that evaluations must be based almost entirely on the patients' subjective discomfort and ability to remember the clinical course of his complaint. These possible sources of error tend to increase in importance with the length of the interval between the debut of symptoms and the follow-up examination. A unique opportunity of objectivising and checking on patient information is provided, however, by the system of national health insurance, which came into force in Sweden on 1st January 1955. From that time on, every patient who consults a doctor and is officially registered as ill is represented on an index card (insurance card) filed with the social insurance authorities. Every reported illness, duration of same and diagnosis of its cause are reported on the card. I had access to these cards, which supplemented the clinical information from patients and the clinical data arising from follow-up examinations.

The purpose of this work was to study the acute course of sciatica and to survey the long-term prognosis. The following questions were especially considered:

1. How do surgical and conservative treatment during the acute course of the disorder affect the patient's subjective symptoms and the period of disablement?
2. Can any clinical or other factor or factors, be said, on the basis of the observations under 1. above, to affect, either favourably or unfavourably the acute attack, and should these factors then occasion a change in the management?
3. Is there any difference between the operated and non-operated groups with respect to the recurrence—during the period of observation—of sciatica or back pain or to residual discomfort in the form of sensory disturbances and pareses?
4. If such a difference exists, is it of such a magnitude that it also makes the operated and non-operated groups differ in the possibility of the patients leading a normal life?

C: HISTORICAL REVIEW

Prior to 1934 sciatica was a diffuse concept of unknown pathogenesis, although it had long been subject to lively discussion. An exhaustive account has been presented by *Friberg* (1941). Only a small proportion of cases, with distinct pathological changes such as tumours and infections, could be segregated and designated "symptomatic sciatica". The others were usually grouped together under the heading "idiopathic sciatica", and there was disagreement about which part of the sciatic nerve (nerve roots, main trunk or branches) gave rise to the pain. However, a proportion of the cases in this group presented neurological loss symptoms and in 1904 *Lortat—Jacob & Sabareanu* found that these loss symptoms occasionally displayed a segmental distribution; consequently they introduced the concept "sciatique radriculaire". *Dejerine & Regnard* (1912) emphasized that certain cases of sciatica were triggered from nerve roots. Treatment of idiopathic sciatica was, in principle, nonsurgical, even though certain theories led to surgery in the form of muscle divisions (*Ober* 1935, *Freiberg* 1937).

However, an increasing number of reports in the literature contained descriptions of disc material extruding into the vertebral canal. These observations had been made during anatomical dissections (*Luschka* 1858, *Andrae* 1929), autopsies (*Kocher*, 1896, *Middleton & Teacher* 1911) and surgery (*Dandy* 1929, *Alajouanine & Petit-Dutaillis* 1930). In 1931 *Antoni* reported the first case of operated disc prolapse in Sweden, the operation having been performed by *Olivecrona* in 1929. However, no connection was made between these findings and idiopathic sciatica. They were regarded either as being without clinical significance, or as the after-effects of severe trauma, or as rarities. From the 1920's and early 1930's there were also reports from a number of authors who, on exploration of the vertebral canal, found what they considered to be tumours originating in intervertebral discs (*Elsberg* 1931 et al.). These were called enchondroma, chondroma, fibroma etc. In view of existing knowledge, it is not unreasonable to assume that many of these were in fact cases of disc prolapse.

Credit for putting disc prolapses in their proper clinical context belongs

to *Mixter & Barr*. In 1934 they reported 19 cases of surgical treatment of disc herniation, 11 in the lumbar area. They suggested that the condition was common, that it often was the cause of idiopathic sciatica, that the neurological symptoms were not conspicuous as a rule and might even be absent, that disc herniation could be diagnosed pre-operatively with myelography, and that the surgical removal of protruding disc tissue gave very good results. The work of *Mixter & Barr* also provided a logical explanation for the long-observed connection between lumbar back pain and sciatica.

An important question arose: How often is idiopathic sciatica caused by disc prolapse? Various answers have been put forward, depending on how sciatica was defined. *Love* (1939) and *Craig & Walsh* (1939) reported the frequency to be 2—3 percent but included all cases with sciatica and/or back pain. *Mixter* (1937) maintained "that an unknown, but possibly small percentage of cases of intractable sciatic pain are caused by rupture into the spinal canal of a lumbar intervertebral disc". *Kuhns* (1941) felt that disc herniation was an uncommon cause of sciatica but other authors have arrived at much higher figures. *Sahlgren* (1946) estimated that approximately 54% of his patients, admitted to hospital for sciatica, had disc prolapse; *Sjöqvist* (1946) reported that 75—80% of patients operated for severe sciatica displayed this pathogenetic background. These series contained patients both with and without neurological signs. The frequency of disc herniation in patients with neurological signs and sciatica severe enough to indicate surgery, i.e. pure sciatica syndrome, was reported by *Friberg & Hult* (1951) to be 89 % and by *Hirsch & Nachemson* (1963) to be 83 %. The latter also found disc prolapse in 60 % of their patients with such severe sciatica that surgery was indicated, even though neurological signs were absent.

The greatest likelihood of finding a disc herniation is therefore apparently in patients who, in addition to severe sciatica, also display neurological signs. But even in this category 10—20% are negative on exploration. By combining subjective data and objective clinical findings with the results of myelography, it has been possible to reduce the number of "unnecessary" operations but not eliminate them completely. However, with the water-soluble iodine contrast (*Arnell* 1944, 1948, *Lindblom* 1946; *Knutsson* 1950/1951) used in Sweden, *Hirsch, Rosencrantz & Wickbom* (1969) have shown that a stricter interpretation of the myelographic changes results in closer agreement between the myelographic and surgical findings.

Many explanations have been sought, mainly mechanical in nature.

for negative explorations. One suggested by *Lindblom* (1943) is lateral disc herniation in the intervertebral foramen; this cannot be diagnosed in an exploration of the spinal canal and is accordingly overlooked in ordinary exploratory surgery. Using facetectomies, *Hirsch* (1945) and *Briggs & Krause* (1945) demonstrated the occurrence of such prolapses.

With anatomical dissection, *Friberg* (1941) established that root pressure can arise from even a slight ventrodorsal constriction of the intervertebral foramina between L4 and L5 or between L5 and S1. Such conditions could be created by posterior protrusion of the disc or by retro-position of a lumbar vertebra as a result of disc degeneration.

A thickening of the ligamentum flavum has also been considered a cause of root pressure (*Puusepp* 1932, *Brown* 1938). This finding was reported with rather high frequency in operated series from the early 1940's (*Friberg* 1941, *Malmros* 1942) but its clinical significance was subsequently questioned (e.g. by *Falconer et al.* 1948 and *Grill* 1954). In the series of *Gurdjian et al.* from 1961, such thickening was noted in only one of 1,176 operated cases.

The "concealed disc" concept introduced by *Dandy* (1941) was another attempt to explain negative explorations. *Dandy's* observations received considerable support initially but were subsequently criticised, e.g. by *Bradford & Spurling* (1947) and *Hirsch* (1965).

It has been maintained that many negative explorations arise from the surgeon's failure to localize the prolapse, often on account of migrating sequestra (*Armstrong* 1951, *Ross & Jelsma* 1952).

The fact that disc surgery for severe sciatica gave disappointing results in many cases, led to the proposal and increased acceptance of other theories which do not assume mechanical root pressure. As early as 1947, *Lindahl* proposed that sciatica is triggered by a combination of mechanical pressure and hyperalgesia of a nerve root as a result of previous changes in the root. After histological studies of nerve root specimens together with *Rexed* (1951) and experimental studies undertaken during surgery (1966), *Lindahl* felt that this theory could be confirmed. *Kelly* (1956) pointed out that the theory of an exclusively mechanical root pressure is incompatible with a number of known clinical, experimental and physiological facts. The nerve root hyperalgesia has generally been attributed to an inflammatory process but the underlying mechanism has never been explained. It is considered by many to be secondary to mechanical irritation or to extrusion of disc material into the vertebral canal; *Bobechko & Hirsch* (1965) proposed an auto-immunological origin. *Hirsch* (1959), *Hirsch, Ingelmark & Miller* (1963) and others sug-

gested leakage of acid metabolites from the interior of the degenerated disc as a possible cause. In intradiscal pH measurements, *Nachemson* (1969) found lower pH values when exploration was negative.

During the early years of disc surgery, there was a strong tendency to emphasize the significance of trauma in the development of disc herniation (*Love & Camp* 1937, *Love & Walsh* 1940). However, *Saunders & Inman* (1940) and *Friberg* (1941) regarded the prolapse as an expression of disc degeneration and the trauma as merely a possible, contributory factor of relatively subordinate importance. *Friberg* also found that herniation could not be elicited with a healthy intervertebral disc under experimental conditions. Disc degeneration was already well-known in the 1920's through the work of *Schmorl* and others. *Friberg & Hirsch* (1950) and *Hirsch & Schajowicz* (1952) described its pathological-anatomical development and noted a high frequency between the ages of 30 and 50, i.e. in the age groups in which disc herniation is most common. They also found that advanced disc degeneration can and often does occur without roentgenological signs. *Friberg & Hirsch* maintained that disc prolapse is only one detail in a slow pathomorphological course.

There is a wealth of evidence to show that the results of surgical treatment for severe sciatica are dependent upon whether or not mechanical root pressure is discovered and can be eliminated (*Friberg & Hirsch* 1946, *Aitken & Bradford* 1947, *Senning & Sjöqvist* 1947, *Waris* 1948, *Young* 1951, *Knutsson & Wiberg* 1958, *Hirsch & Nachemson* 1963). The importance of good pre-operative diagnosis is therefore obvious. In 1944 *Norlén* described the compression syndrome for the 4th and 5th lumbar and 1st sacral nerve roots, thereby improving the clinical diagnosis of level. There are, however, a great many cases in which several nerve roots are involved, so that myelography appears more dependable for determining the exact level. Despite this, many prefer to operate on the basis of clinical findings and to explore perhaps two or more levels rather than resort to myelography (e.g. *Bradford & Spurling* 1947, *Young* 1951, *Semmes* 1964). Other authors maintain the importance of myelography as a pre-operative diagnostic procedure (*Friberg & Hult* 1951, *Hirsch & Nachemson* 1963, *Hirsch, Rosencrantz & Wickbom* 1969).

The discography introduced by *Lindblom* and *Hirsch* (1948) initially gave rise to a certain optimism. However, the method does not appear to be superior to myelography in the diagnosis of disc prolapse (*Nordlander, Salén & Unander-Scharin* 1958) and it is nowadays seldom used in the routine diagnosis of disc herniation in Sweden.

The potential of electromyography in the diagnosis of lumbar nerve

root compression has been treated exhaustively by *Knutsson* (1961), who summarized his experience as follows: "It is clear from the present investigation that electromyography is not superior to the other two methods" (i.e. the clinical-neurological and myelographic) "but that it is a good supplementary method".

The surgical treatment of sciatica has dominated ever since *Mixter & Barr* established the clinical significance of disc herniation. Many operated series have been published but only a few which are relevant to the present study will be cited here. From the Mayo Clinic, *Love* and a number of co-workers (*Craig, Camp, Walsh and Young*) have reported on a rapidly growing material which in 1947 already comprised more than 1,200 operated cases. *Mixter, Barr, White* and others have analysed results achieved at the Massachusetts General Hospital. Other authors include *Dandy* (1941, 1944, 1947), *Bradford & Spurling* (1947), *Aitken & Bradford* (1947), *Lenhard* (1947), *Falconer et al.* (1948), *Echols* (1949), *Young* (1951), *Burns & Young* (1951), *O'Connel* (1951), *Armstrong* (1951), *Pouyanne* (1951), *Ross & Jelsma* (1952), *Grantham & Spurling* (1953), *Raaf* (1959), *Reynolds et al.* (1959), *Semmes* (1964).

In Scandinavia, interest in disc surgery has been strong. Large series have been published in Sweden e.g. by *Friberg* (1941), *Friberg & Hirsch* (1946), *Senning & Sjöqvist* (1947), *Lindgren* (1949), *Knutsson & Wiberg* (1958), *Söderberg & Sjöberg* (1961) and *Hirsch & Nachemson* (1963), in Denmark e.g. by *Malmros* (1942) and *Busch et al.* (1949), in Finland e.g. by *Waris* (1948) and *Kallio & Törmä* (1965), and in Norway e.g. by *Rövig* (1949) and *Kristiansen* (1962).

The results reported vary and are difficult to compare directly because of the composition of the series, different surgical indications and methods, varying periods of observation and differences in the criteria for evaluating final results. However, *Söderberg* (1956) has reviewed 3,928 operated cases from different series and found that 2,097, i.e. 53% of these, were free from symptoms. But the incidence of pain-free results ranged between the various studies from 13% to 80% and the periods of observation from one to twelve years.

The fact that a progressive disc degeneration may spoil initially promising surgical results soon led to attempts to take primary action against this as well. It seemed logical to suppose—irrespective of how the symptoms are triggered—that the desired effect might be achieved by surgical fusion of the affected vertebral segment. This "combined operation" has been the subject of considerable discussion. Some surgeons reject the method or recommend it only as a secondary measure

if considerable pain develops in the postoperative course (*Friberg & Hirsch 1946, Bradford & Spurling 1947, O'Connel 1951, Young 1951*); others support it warmly. Thus, the frequency of "combined operations" at the Mayo Clinic and Massachusetts General Hospital has been about 50%. Analyses of the results from both these centres have been reported in recent years. According to *White (1966)* from Boston, it is obvious "that individuals, who have had the complementary vertebral fusion have on the whole fared little if at all better than those with a simple excision of protruded fibrocartilage". This view has been emphasized by *Hirsch* on many occasions in recent years. *Uhlein et al.* from the Mayo Clinic were also unable to find any significant difference between patients with and without the "combined operation". Experimental studies by *Rolander (1966)* strongly support this view.

Non-surgical treatment, which used to prevail almost exclusively, has attracted much less interest since 1934. The various methods of treatment have been numerous and the results difficult to evaluate. Authors who have reported on conservative management include *Kuhns (1941)*, *Brahme (1942)*, *Boysen (1947)*, *Ytrehus (1947)* and *Östberg (1950)*, whose series included patients with and without neurological symptoms, and *Dunning (1946)*, *Durbin (1948)*, *Henderson (1952)*, *Giuliani (1954)*, *Hardt (1954)*, *Mensor (1955)* and *Söderberg (1956)*, whose series included only patients with neurological symptoms. *Söderberg (1956)* also reviewed 3,551 conservatively managed patients from different studies and found that 1,388 of them i.e. 39%, were free of symptoms at the time of the follow-up examination. The period of observation ranged from one to eleven years and once again the frequency of symptom-free patients varied considerably between the studies (12.5% to 79%).

Of special interest are reports in which surgically and conservatively treated patients are studied side by side. I have found such work in the literature by *Kirstein (1945)*, *Young (1947)*, *Shinners & Hamby (1949)*, *Colonna & Friedenberga (1949)*, *Kehrer & Krischek (1950)*, *Bergsman, v. Reis & Sahlgren (1952)*, *Kohronen & Nummi (1952)*, *Millikan (1954)*, *Östergaard Jensen & Lund (1955)* and *Sparup (1960)*. As a rule, these authors maintain that even conservatively treated patients were diagnosed as cases of disc herniation, but the criteria for this diagnosis and the accounted results vary among the studies. In *Young's* series, for example, 80% of the 310 operated cases are symptom-free while the corresponding incidence for the conservatively managed patients is 21%. He feels that the overwhelming majority of all sciatic conditions are caused by a disc prolapse and that only surgery can provide the patient

with lasting relief. *Kehrer & Krischek* arrived at completely different results. Of 51 operated and 72 conservatively treated patients, 17.6% and 50% respectively were symptom-free. These authors maintain that disc herniation is only one, and perhaps not even the most common, cause of sciatica, and that genuine radiculitis, possibly with a rheumatic-allergic genesis, is just as common. However, *Kehrer & Krischek* are alone in this group in achieving better results with conservative treatment. *Kirstein, Shinnors & Hamby* and *Colonna & Friedenberg* found, as did *Young*, surgical therapy to be superior while the others report minor or no differences between the two methods.

The more recent theories on the cause of sciatica, which do not presume mechanical compression, have led to a more cautious attitude towards surgical treatment of these conditions and even towards new forms of therapy. Postulating an inflammatory genesis, triggered from the interior of the disc, as the cause of lumbar rhizopathies, *Feffer* (1963) treated a series of patients with intradiscal injections of hydrocortisone. The results were reported to be good. As early as 1959, *Hirsch* discussed the possibility of using chondrolytic enzymes in order to accelerate the degenerative process in the disc to the point at which it no longer gives rise to symptoms. *Smith & Brown* (1967) and *Hirsch* (1969) have reported good results with intradiscal injection of chymopapain, an enzyme which breaks down the mucopolysaccharide/protein complex in the disc.

However, it must be pointed out that comparisons of sciatic patients cannot be made simply with reference to the results of conservative management versus disc surgery. The reason, of course, is that in the conservatively managed cases, it is impossible to know to what extent the symptoms have been elicited by disc prolapse. Moreover, little is to be gained by taking a stand for or against the respective methods of treatment, as it has been established beyond doubt that each has its rightful place in the therapeutic arsenal for severe sciatic conditions. Interest should be devoted instead to studying the validity of the various indications for a particular therapy. Do the results of surgical treatment justify extending the indications for surgical intervention and briefer conservative management or does the reverse apply? Is it possible from the clinical picture to identify patients who will benefit from surgical treatment and, if so, what are the criteria for such a selection? *Hirsch* (1958) and others have discussed similar questions with small series. Further study would be of value, particularly in view of the current tendency, even among those undertaking disc surgery, to question the predominant importance of mechanical root compression in severe sciatica.

This work is an attempt, on the basis of the above questions, to analyse the results with a large material from the Department of Orthopaedic Surgery at Karolinska Institutet.

D: MATERIAL

The study comprises all patients examined in the period 1955—61 at the Department of Orthopaedic Surgery at Karolinska Institutet for unilateral sciatica and displaying characteristic neurological symptoms in the affected limb indicative of a lesion of the 5th lumbar and/or 1st sacral nerve roots. The characteristic symptoms for the 5th lumbar nerve root were taken to be paresis of the dorsal extensors of the foot and toes, paresis of the great toe extensor in particular, and for the 1st sacral nerve root a diminished or absent Achilles reflex. Patients with impaired perception of pain and touch as the only neurological finding were not included.

It is generally recognised (see e.g. *Friberg & Hirsch* 1946, *O'Connel* 1951 and *Knutsson* 1962) that the neurological signs frequently persist after subjective discomfort has disappeared. In order to reduce the possibility that the root lesion had arisen on an earlier occasion, all patients with recurrent sciatica were excluded from the study.

The symptomatology for an L4 syndrome is very similar to that seen in coxarthrosis, with pain and tenderness in the adductor muscles and the front of the thigh and impairment of the patellar reflex due to atrophy of the quadriceps. Furthermore, some patients who initially appeared to present a definite L4 syndrome, developed hip arthrosis (demonstrable clinically and with X-rays) in the course of a few years. Rather than make an uncertain selection amongst such cases, the entire group was excluded.

Patients with a history of neurological disease (e.g. polio), with surgical after-effects or with prior injuries which made the validity of neurological loss symptoms questionable, have also been excluded from this study.

As the purpose of this work was to study acute sciatica, all patients who had a history of sciatica longer than six months at the time of their first examination at the Department were also excluded.

Patients with sciatica are registered at the Department under the diagnostic headings "Herniation of Intervertebral Disc". "Suspected

Herniation of Intervertebral Disc" and "Lumbago-sciatica". These diagnoses were applied to 1,852 patients in the period 1955—61. 583 of these were new cases with pain in only one limb for a maximum of six months and with the indicated neurological signs in the affected limb. As already pointed out, relatively few of these patients came to the Department directly. The majority were referred by other hospitals or by doctors in private practice because symptoms had been alarming or resistant to conservative management. From this point of view, the series is over-representative of patients whose sciatica was so severe or of such long duration that an operation had to be seriously considered.

1. Distribution by Sex and Age

The series comprises 387 men and 196 women, a distribution of 66% and 34% respectively. This preponderance of males is apparent in all large studies of both conservatively and surgically treated sciatica, e.g. *Love & Walsh* (1940) 71%, *Barr & Mixter* (1941) 78%, *Friberg & Hirsch* (1946) 64%, *Waris* (1948) 72%, *O'Connel* (1951) 66%, *Ross & Jelsma* (1952) 62%, *Söderberg & Sjöberg* (1961) 65%, *Gurdjian et al.* (1961) 65.5%, and *Söderberg* (1956) 66%.

The distribution by age (*Fig. 1*) shows a maximum frequency for both men and women in the age group 30—39 years. Age group 30—49 years accounts for 71% of the entire series (males 71% and females 72%). This age distribution also agrees with previous studies. *Love* (1947), for

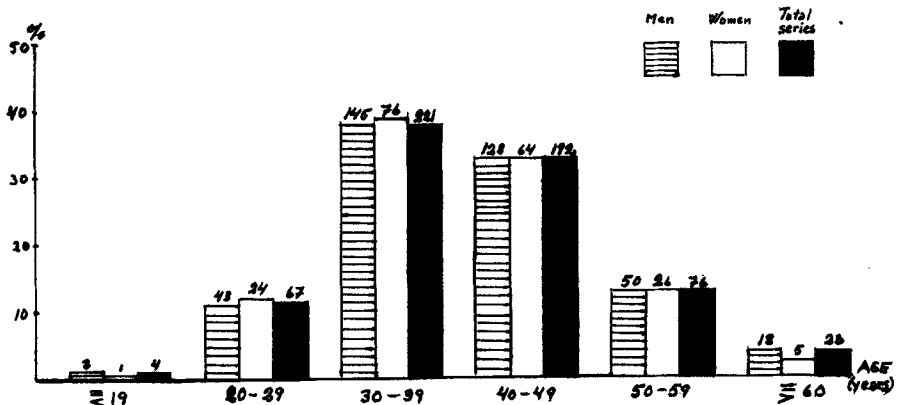


Fig. 1. Age distribution (per cent). The number of patients in each category is shown on top of the bars.

instance, reported the corresponding frequency in his series to be 66%; among other authors, *Waris* (1948) reported 72%, *Aitken* (1952) 70%, *Henderson* (1952) 75%, *Söderberg* (1956) 70%, *Knutsson & Wiberg* (1958) 65%, *Gurdjian et al.* (1961) 65% and *Hirsch & Nachemson* (1963) 72%. The oldest patient was 67 and the youngest 9 years, both males. As may be seen from *Fig. 1*, the age distribution in the various age groups is very similar for males and females.

2. Type of work (Table 1.)

70% of the men were manual workers, a frequency which is in agreement with *Friberg & Hirsch* (1946) 74% and *Sparup* (1960) 68%. *Söderberg* (1956) had 88% but his material was taken from an agricultural area. Only 23% were engaged in what could be called heavy manual labour, a figure which is much lower than in earlier series (*Friberg* 1941 63%, *Söderberg* 1956 60%). Women are more difficult to classify in this respect. The size of the group "manual labour" reflects the circumstance that all housewives who report that they manage their homes without help are placed by definition in this category.

Table 1.
Type of work at onset of sciatica.

	Heavy manual work	Manual work	Non-manual work
Men	23% (90/387)	47% (181/387)	30% (116/387)
Women	2% (4/196)	87% (170/196)	11% (22/196)
Total	16% (289/583)	60% (351/583)	24% (138/583)

3. Previous Back Pain

Information about lumbar back pain prior to the debut of sciatica was received from 549 patients. 420, i.e. 76% (77% of the males and 76% of the females) had had such pain with varying duration, intensity and character. Less than one-quarter of the material, i.e. 129 patients, could not recall having had symptoms from the lumbar region. *Hult* (1954) reported the frequency of lumbar pain among 1,193 manual labourers aged 25—59 years, chosen at random, to be 52.7% for those with lighter work and 64.4% for those with heavy work. *Hirsch, Jonsson & Lewin*

(1968) found lumbar disorders in 49% of a group of women statistically representative of the Swedish female population. *Horal* (1969) reported the frequency of lumbar disorders as 66.5% (66.4% for males and 66.7% for females) in a random control sample of 212 patients between 20 and 71 years none of whom had been registered officially as being ill in the decade before the study.

All but 33 of the present patients had undergone a radiological examination of the spine, either in conjunction with the onset of sciatica or subsequently during the course of the illness. In many cases, this was not done at the Department and the results were often impossible to trace. Information was available on 434 patients, 294 of whom (68%) displayed signs of lumbar disc degeneration in the form of reduction of disc-space, sclerosis and/or osteophytes. Such changes appeared in women somewhat more often (75%) than in men (65%). Using X-rays *Friberg & Hirsch* found disc degeneration in 39% of all patients who had applied to the Department in the period 1936—1946, though the frequency in the last two years was 50%. In *Hult's* (1954) series, the ratio of disc degeneration is 57.6% (46.7% of those with light manual occupations and 65.4% of those with heavy manual occupations) and 31.8% in *Horal's* (1969) control group. Among operated patients *Love* (1939) observed reduction of disc-space in 40%, *Norlén* (1944) in 35%, *Waris* (1948) and *Gurdjian et al.* (1961) in 30%. In conservatively managed patients, *Boysen* (1947) found disc changes in 56.6% and *Yttrhus* (1947) in 44.3%. In *Sparup's* (1960) series, comprising operated as well as non-operated patients, radiological indications of disc degeneration were found in 50%, with a higher incidence for women than for men.

As shown in *Table 2*, objective signs of disc degeneration increase, as might be expected, with increasing age. This agrees with the finding of

Table 2.

Age-group frequency of radiological changes indicating lumbar disc degeneration at the time of the first attack of sciatica (information was available for 434 out of 583 patients).

	29 years or less	30—39 years	40—49 years	50 years or more
Men	41% (17/42)	52% (60/115)	75% (65/87)	93% (50/54)
Women	50% (9/18)	74% (37/50)	85% (35/41)	78% (21/27)
Total series	43% (26/60)	59% (97/165)	78% (100/128)	88% (71/81)

Hirsch & Schajowicz (1952) and of *Hirsch* in a number of subsequent studies, and the tendency is also clear in *Horal's* (1969) study. It is striking that roentgenological changes were found in almost half the cases under 30 years. Subjective back pain does not follow this trend (*Table 3*). The incidence of patients with back pain is much the same in all but the youngest age group. The trend in females even tends to decline from the age of 40 onwards.

Table 3.

Age-group frequency of subjective lumbar pain prior to the first attack of sciatica (information was available for 549 out of 583 patients).

	29 years or less	30—39 years	40—49 years	50 years or more
Men	55% (23/42)	76% (107/140)	83% (100/120)	82% (50/61)
Women	65% (15/23)	84% (61/74)	75% (44/59)	67% (20/30)
Total series	59% (38/65)	78% (168/214)	81% (144/179)	77% (70/91)

Information about back pain as well as the results of radiological examination of the lumbar spine was available for 412 patients. 28% of those who had back pain showed radiologically normal lumbar spines, while 55% of those who had no symptoms from the low back displayed signs of disc degeneration. Agreement between objective radiological findings and subjective discomfort was found in 66% (271/412). These figures confirm the assertion of *Friberg & Hirsch* that ordinary X-rays of the spine do not provide satisfactory information about the condition of the intervertebral discs in the presence of lumbar pain.

4. Subjective Symptoms During the Primary Attack of Sciatica:

Onset: As a rule, the attack began gradually with increasing sciatica over a period of days and weeks. However, 139 patients (24% of the entire material) described the onset of symptoms as a sudden attack of pain, often in conjunction with a minor trauma or strain on the back. However, trauma features infrequently in this series: only 12 cases reported some accident in conjunction with the onset of symptoms. *Love & Walsh* (1940) reported trauma as the cause of pain in 58% of their cases. *Friberg* (1941) questioned this causal mechanism and found that only 18% of his operated patients could conceivably have such an aetiological background. Subsequently, *Waris* (1948) reported this frequency as

22%, O'Connel (1951) as 59%, Grantham & Spurling (1953) as 25% and Söderberg in results from a conservatively managed series as 21%.

Localisation of sciatica pain: This series, which is limited to unilateral sciatica, displays a minor preponderance for left-side sciatica: 335 patients (57%) reported radiating pain in the left leg. This tendency was equally applicable to women and men (59% and 54% respectively), to the L5 syndrome and the S1 syndrome (64% and 52% respectively) and to all age groups (Table 4). A similar finding has been reported among others by Malmros (1942) 62%, and Knutsson (1961) 54% though Rövig (1949) found a slight preponderance for right-sided sciatica.

Table 4.
Age-group frequency of left-sided sciatica.

20—29 years	30—39 years	40—49 years	50—59 years
55% (37/67)	58.5% (129/221)	58% (111/192)	56.5% (43/76)

Characteristic pain radiation: Characteristic radiation of pain has been defined according to Norlén (1944) and Friberg & Hult (1951), i.e. typical L5 pain shall be projected to the great toe and typical S1 pain to the heel. 143 patients (24.5% of the entire series) reported such radiation, the pain having L5 character in 53 cases and S1 character in 90 cases. In the other patients, the extent of the sciatica, as defined above, was atypical. The corresponding frequency for Waris (1948) was 30% and for Knutsson (1961) 38%. In both studies, S1 pain was the more common, as was the case with Söderberg (1956) who, however, reported a frequency as high as 74%.

Pain on coughing and sneezing (Déjérine's sign): A positive indication of this symptom requires an aggravation of radicular pain by sneezing, coughing, straining at stool and in other Valsalva manoeuvres. Using this definition, Déjérine's sign was positive in 282 patients (48%). Friberg (1941) reported that 37 patients out of 44 in his operated series had positive cough and sneeze pain, i.e. 84%, but ascribed this high frequency to the fact that so much attention had been paid to this symptom that there had been no inclination to prescribe myelography—and hence to operate—in patients in whom it was absent. Waris (1948) pointed out that the same causes may account for the high frequency (89%) in his material. It is also apparent that he regarded Déjérine's sign as positive

when there was only an increase in lumbosacral pain. In subsequent studies, *Knutsson* (1961) had 46.6% and *Gurdjian et al.* (1961) had 48% positive cough and sneeze pain.

Impaired perception and pareses: Pain was the dominant symptom in almost all patients in this series, but a relatively large percentage, 30% or 175/583, displayed impaired perception in the form of paresthesia and numbness in the affected limb. Subjective signs of motor impairment in the form of weakness in the leg or foot were uncommon, being noted in only 5.5% of the cases.

Lumbosacral pain: Low back pain of varying intensity appearing concomitantly with the sciatica was a constant symptom and was found in 577 patients, i.e. 99% of the material. Other authors have reported similar frequencies, e.g. *Friberg* (1941) 91%, *O'Connel* (1951) 87%, *Gurdjian et al.* (1961) 98.5% and *Kristiansen* (1962) 99%.

Duration of symptoms: The duration of symptoms at the time of the examination at the Department is given in *Table 5*. Almost two-thirds of the cases had a history of sciatica for 3 months or less. As all patients with a history longer than six months were excluded from the material, these figures are not comparable with those published by other authors.

Table 5.
Duration of sciatica at the time of the first examination at the Department.

< 1 month	1 month	2 months	3 months	4 months	5 months	6 months
6% (33/583)	17% (100/583)	24% (142/583)	19% (113/583)	12% (69/583)	11% (62/583)	11% (64/583)

5. Objective Symptoms During the Primary Attack of Sciatica

Lasègue's sign: *Lasègue* described "the straight leg raising test" in 1864. Positive *Lasègue* in severe sciatica is nowadays regarded as a strong indication of root compression. According to some authors, e.g. *Waris* (1948), the symptom was considered so significant that there were no surgical indications if *Lasègue's* sign was negative during the course of the disorder. Even greater diagnostic significance was ascribed to crossed *Lasègue* (*Bechterew's* test).

A positive *Lasègue* has been reported with high frequency in both operated and non-operated sciatica series, e.g. *Friberg* (1941) 93%, *Love*

& Walsh (1943) 81%, O'Connel (1951) 99%, Söderberg (1956) 92%, Gurdjian *et al*, (1961) 80%, Knutsson (1961) 94.7% and Hirsch & Nachemson (1963) 85%. A positive Bechterew test was found in 20.9% of Knutsson's cases.

In the present series, Lasègue's sign was positive in 89% and crossed Lasègue in 15%.

Impaired sensibility: Impaired sensibility in conjunction with sciatica was described as early as the beginning of the 1800's. The circumstance, pointed out by Lortat-Jacob & Sabaréanu (1904), that these disturbances occasionally display a segmental distribution took on greater diagnostic significance when disc prolapse was shown to be a common cause of severe sciatica. The extent of sensory disturbances in lumbar root compression has been studied e.g. by Keegan (1943) and Norlén (1944). Keegan found that sensory losses infrequently occur over the entire dermatome corresponding to a nerve root but are occasionally more pronounced peripherally on the extremity. He felt this was because overlapping between dermatomes is least distinctive peripherally. On the basis of clinical and experimental studies, Norlén maintained that L5 lesions in particular display a characteristic sensory loss localised to the great toe and adjacent areas of the dorsum of the foot. S1 lesions, although not of the same diagnostic significance, displayed a high incidence of sensory impairment on the lateral aspect of the foot and little toe.

From the diagnostic point of view, however, sensory losses have been evaluated in different ways. Bradford & Spurling (1947) regarded them as particularly valuable while Malmros (1942) and Burns & Young (1951), for instance, felt they were of little value. In Raaf's (1959) operated series, cases of disc herniation displayed an even lower incidence of sensory losses than cases in which surgical exploration was unable to disclose any root compression.

Various frequencies have been reported for sensory disturbances in cases where the sciatica was caused by disc herniation, e.g. Love & Walsh (1940) 21%, Barr & Mixter (1941) 35%, Friberg (1941) 64%, Malmros (1942) 58%, Norlen (1944) 41%, Bradford & Spurling (1947) 77%, Knutsson (1961) 29%, Gurdjian *et al*. (1961) 40%. In Söderberg's (1956) conservatively treated material, the incidence of sensory losses was 37.8%.

In the present study, sensory examinations were performed, according to case reports, in 515 cases. Disturbances were noted in 272 patients (56% of those examined), of which, using Norléns definition, L5 losses

in 61 (12%) and S1 losses in 141 (27%); the sensory disturbance could not be associated with any particular dermatome in 86 patients (17%).

Impaired Achilles reflex: Disturbances of the Achilles reflex in sciatic conditions have been known since 1893, when *Sternberg* described such a case (*Norlén*). On the basis of surgical experience of disc prolapse, the symptom has become associated to an increasing extent with lesions of the 1st sacral root. *Norlén* (1944) found disturbances of the Achilles reflex in 89% of L5—S1 disc herniation, *Waris* (1948) in 94% and *Knutsson* (1961) in 80%. However, the symptom does not always provide a clear diagnosis of level. Changes in the Achilles reflex also occur relatively frequently in prolapses between L4 and L5: *Norlén* (1944) 41%, *Waris* (1948) 50%, *Knutsson* (1961) 37.8%.

In this study, an absent or impaired Achilles reflex was found in 343 patients, i.e. in 59% of the entire series.

Pareses: According to *Knutsson* (1961), cases with motor disturbances in the form of pareses and atrophies were described by *Guinon & Parmentier* in 1890. *Armstrong* (1965) maintains that mild paresis of affected muscle groups is usually present in sciatica caused by root compression but may be difficult to detect clinically. However, motor symptoms do not appear to have been accorded much significance in the diagnosis of level, even after the connection between sciatica and disc prolapse had been established, until *Norlén* (1944) pointed out the significance of great toe extensor paresis in L4—L5 disc herniations. He found such paresis in 14% of his series, and in all cases operative exploration disclosed compression of the 5th lumbar root. *Friberg & Hult* (1951) also emphasized the importance of isolated great toe extensor paresis but maintained that even paresis of the foot's dorsal extensors and pronators is usually indicative of an L5 lesion. *Knutsson* (1961) found weakness of the great toe extensor in 75% of L4—L5 and 46.7% of L5—S1 disc herniations. According to *Armstrong* (1965), the L5 root principally innervates the dorsal extensors of the foot and toes and the S1 root principally the plantar flexors, which is why a careful examination of ankle and toe movements is of great clinical importance. *Friberg & Hult* (1951) found extension and pronation pareses in 41% of 302 patients and *Ståhl* (1949) in 53% of 306 operated on for suspected disc herniation.

The present series contains 289 patients with pareses of the great toe and/or foot extensors and/or pronators, giving a frequency of 50% in the entire series. 173 of the patients displayed an isolated paresis of the great toe and 116 more extensive extension and pronation pareses, though

usually designated by the examiner as "tentative" or "mild". Routine examinations of the strength of the foot's plantar flexion were not performed and only a few pareses of the leg triceps were recorded.

Distribution of the compression syndrome: In accordance with the previously indicated definitions for various compression syndromes, 221 out of 583 patients displayed neurological symptoms from the L5 root only, and 289 displayed symptoms from the S1 root only; the other 73 showed signs of lesions of both roots. Comparisons with other reports are complicated by the fact that other series usually contain patients without neurological loss symptoms and the data are not suitable for classification into compression syndromes. Such comparisons are feasible, however, in the case of *Ståhl* (1949), *Friberg & Hult* (1951) and *Knutsson* (1961), and the figures arrived at are presented in *Table 6* together with the present findings.

Table 6.
Distribution of compression syndromes.

	Symptoms from 1st sac- ral root only	Symptoms from 5th lumbar root only	Symptoms from 1st sac- ral and 5th lumbar root
Ståhl	46%	31%	23%
(1949)	(136/299)	(93/299)	(70/299)
Friberg & Hult	50%	30%	20%
(1951)	(121/245)	(76/245)	(48/245)
Knutsson	31%	39%	30%
(1961)	(50/163)	(65/163)	(48/163)
Present series	49%	38%	13%
(1970)	(289/583)	(221/583)	(73/583)

As the table shows, the proportion of mixed syndromes, i.e. patients with objective loss symptoms from both the L5 and the S1 root, is much lower in the present series. It should be noted, however, that the series of *Ståhl*, *Friberg & Hult* and *Knutsson* are confined to operated patients. The explanation for this discrepancy may therefore be that objective polyradicular symptoms in themselves warranted more liberal surgical indications or that these "mixed syndromes" elicited more severe subjective symptoms, consequently leading more frequently to surgery.

Preliminary diagnosis: It may be of some interest to see how patients were evaluated after the first examination at the Department. This in-

formation was gathered from the preliminary diagnosis and from the more detailed written reports compiled by the specialist at the Department. It was found that 457 patients (78⁰/o) had been regarded as cases of suspected disc herniation, 65 patients (12⁰/o) had received the more conservative diagnosis "root syndrome" and 61 patients (10⁰/o) were recorded as cases of sciatica or lumbago-sciatica.

The analysis of data has consistently involved pair comparisons between groups. The statistical analysis has been performed throughout with the X²-test.

E: TREATMENT DURING THE ACUTE ATTACK OF SCIATICA

According to most authors, the fundamental principle in conservative management of sciatica is to achieve relative immobilisation of the lumbar spine (i.e. *Söderberg* 1956 and *Armstrong* 1965). After studying the most common methods of conservative management, *Söderberg* wrote: "It appears to me that of the above mentioned various types of treatment only the immobilisation secured by bed-rest and treatment with a plaster jacket can be regarded as a treatment of really therapeutic value." *Armstrong* points out that relative immobilisation can be achieved in many ways by various restrictions in the patient's normal activities—from strict bed-rest, in which the patient is even forbidden to sit up, to instructions on the avoidance of certain movements which impose a strain on the back. However, he feels that these measures must be supplemented, as a rule, by some kind of external fixation (e.g. plaster jacket, plaster or cloth brace). According to *Armstrong*, the degree of immobilisation should be dictated by the extent of the patient's discomfort.

Among other forms of conservative treatment, manipulation has attracted considerable interest. Different kinds of manipulation have been proposed, e.g. flexion treatment (*Abt & Keegan* 1944), extension treatment (*Francillon* 1950, *Giuliani* 1951), rotation treatment (*Mensor* 1955) and continuous or rhythmic traction (*Stoddard* 1951). Many authors are extremely critical of this kind of therapy (e.g. *Barr* 1947, *Armstrong* 1965). Critics of the method usually point to the danger of acute aggravation of the pain and, above all, of an increase in the neurological signs if a disc prolapse is pushed into the spinal canal instead of being reset.

Massage, physical therapy, injection and heat therapy are other conservative measures.

1. *Conservative Management in the Present Series*

By conservative management is meant that the patient has been subjected to relative immobilisation of the lumbar spine in a manner adapt-

ed to his subjective symptoms. As the purpose of this work was to study the behaviour of acute sciatica during conservative and surgical treatment, the non-operated patients were analysed as a group without regard to the forms of therapy used.

As already mentioned, most of the patients were referred to the Department from other hospitals or from doctors in private practice. This means that most patients had already been subjected to a course of conservative treatment at the time of their first examination at the Department. According to the case reports, relative inactivity had been prescribed for 452 of the 583 patients; 103 of these had received care in hospital, 108 had received no treatment, and information on prior therapy was lacking for 23 cases.

Table 7.
Result of the conservative therapy given prior to the first examination at the Department.

	No. of patients	Mean duration of symptoms (months)	Successful result of treatment No. of patients %
Treated	452	2.98	244 54%
Untreated	108	2.58	29 27%

The degree of sciatica in the patients upon their first visit to the Department is reported in *Table 7*. Among those already treated, 54% (244/452) reported that the sciatic symptoms had disappeared or diminished. In the group without prior therapy, freedom from symptoms or improvement was found in 27% (29/108). This difference between treated and untreated, in terms of the course of the sciatica, is highly significant, ($P < 0.001$). However, it should be noted that the average period with symptoms in the treated group was somewhat lower, which suggests that the difference would be smaller between strictly comparable series.

The therapy given at the Department is shown in *Table 8*. Conservative therapy for most patients consisted of rest in the form of official sick registration and a lumbar plaster or cloth brace. Many patients were prescribed an initial period of bed-rest in the home. Only a few patients with severe symptoms were admitted to the Department and treated with strict bed-rest. A small group with relatively mild symptoms and not very physically demanding occupations were permitted to continue

Table 8.
Treatment after the first examination at the Department.

	No treatment	Conservative treatment	Conservative treatment and operation	Operation
No previous treatment (108)	17	58	21	12
Conservative treatment previously (452)	40	285	69	58
No information about previous treatment (23)	6	11	3	3
Total series (583)	63	354	93	73

their normal activities wearing a corset brace. As a rule, physical therapy was initiated only after the sciatica had subsided.

Table 8 shows that the condition of 63 patients upon their first examination at the Department was such that no further treatment was indicated. Conservative therapy was begun or continued for 447 patients. However, this therapy was unsuccessful in 93 cases, which were sent for surgery. Surgery was considered indicated without further conservative measures in 73 patients. *Table 8* shows that 545 patients in all received conservative treatment during the attack of sciatica, i.e. 93% of the entire series. Seventeen patients recovered spontaneously and 12 were operated on acutely. There was no information on whether or not 9 patients had received conservative treatment.

2. Myelographic Examination

Myelography is regarded at the Department as a very important diagnostic aid, and surgery is performed only exceptionally without prior contrast examination. A negative myelography results in the already restrictive surgical indications being narrowed still further.

All myelographies in this series were performed with watersoluble iodine contrast medium with the patient under spinal anaesthesia. Because of its low viscosity, this contrast provides better filling of root pocket than oil-based iodine compounds. In addition, it is resorbed spontaneously within a few hours (*Arnell* 1944, 1948, *Lindblom* 1946, *Knutsson* 1950/51). Several reports have demonstrated agreement be-

tween surgical results and myelographic findings with this kind of contrast (Friberg & Hult 1951, Hirsch & Nachemson 1963, Hirsch, Rosencrantz & Wickbom 1969).

Myelographic examinations had been performed on a total of 203 patients, 53 of them at other hospitals before the patients were referred to the Department, but all the myelograms were evaluated by the Department's radiologist. No serious complications were recorded. A myelogram was regarded as positive if any of the following conditions were satisfied: (a) deformation of the dural sac on angular projection, (b) dislocation of a nerve root, (c) incomplete visualization of a root sheath if the contralateral sheath is filled. These are the criteria indicated by Hirsch & Nachemson (1963). However, in 1969, Hirsch, Rosencrantz & Wickbom showed that changes in a single root pocket were caused by disc prolapse in only two-thirds of cases while no or inadequate filling of a root pocket plus pronounced deformity of the dura on the same level was definitely indicative of herniation (in 264 of 265 cases).

The results of the myelographies are shown in Table 9. The number of positive myelograms was 183; 16 were negative. 38 patients were not operated, despite positive myelography. The reason for this in most cases was that the patient's symptoms had declined in the interval between the X-ray examination and evaluation at the Department. A number of patients refused surgery. Five patients received surgery despite negative X-ray, and 13 without prior myelography.

Table 9.
Myelographic findings.

	Operated	Unoperated	Total
Positive meyelography	145	38	183
Negative myelography	5	11	16
Result not known	3	1	4
Total	153	50	203

3. Surgical treatment

Indications: The surgical indications were very restrictive. In principle, surgical intervention was not considered justified without prior conservative therapy. 93% of the present series in fact received conservative therapy for various periods. No definite time limit was set for conservative measures, but a guiding principle was that if there had been no acceptable decline in symptoms after 2 months of official sick registra-

tion with a corset brace, surgery was generally suggested to the patient. Other surgical indications were: severe pain ruling out further conservative treatment (humanitarian indication) and severe pareses (absolute indication).

As shown in *Table 8*, 166 patients were operated on during their first attack of sciatica, i.e. 28.5% of the entire series. Information was lacking on one patient who underwent surgery at his local hospital after a preliminary examination at the Department, as the case report could not be found. Surgical indications for the remaining patients were as follows (information taken from the respective case reports):

Pain of long duration	
(Conservative treatment completed)	123
Severe pain	
(Conservative treatment not completed) . . .	35
Severe pareses	7

Surgical technique: The purpose of the surgical technique was to seek out, with a minimum of exploration, a diagnosed or presumed disc prolapse, to remove the same and to evacuate the disc from which it had herniated. In the event of a negative exploration, the exposed disc was generally incised only if it displayed distinct degenerative changes with protrusion.

With few exceptions, the operation was performed under spinal anaesthesia. The musculature was disturbed only on the side to be explored. Surgery on the skeleton was restricted to a minimum and the vertebral canal was exposed by:

Partial hemilaminectomy	150
Hemilaminectomy	8
Transligamentary approach	4
Partial hemilaminectomy + hemifacetectomy	2
Unknown	1

As a rule, hemilaminectomy was only used in cases in which the initial intent was to explore two levels. Ever since *Hirsch* (1945) published a study from this Department covering 23 patients upon whom facetectomies were performed with results described as “very disappointing”, this type of surgery has been used only when there are strong reasons in favour of extended exploration; there were two such cases in this series.

As a result of the exactness afforded by myelography in level diagnosis, it was often only necessary to expose one space. When positive findings

were made here, surgery was terminated unless there were special reasons for exposing a second suspected space. In the event of a negative finding, however, both levels were exposed. The explorations were performed as follows:

	<i>No. of patients</i>
One level (positive findings)	137
One level (negative findings)	5
Two levels (one negative and one positive finding)	12
Two levels (both negative)	11

The basic principles stated above were not observed in 17 cases, 5 with only one level exposed, despite a failure to find any prolapse, and 12 in which two levels were exposed despite positive findings in the first. An analysis of surgical reports shows that in 4 of the 5 cases in the first group, the surgeon, although no definite root pressure is described, still felt he had found an acceptable explanation for the pain (disc degeneration with diffuse protrusion). In the other group, exceptions from customary surgical routine were made in 5 cases because patients had displayed such pronounced symptoms from two nerve roots that the surgeon, despite negative myelography, felt it proper to undertake exploration of both the L4—L5 and the L5—S1 levels; in two other cases the exceptions were due to misleading myelograms and in a further case to an error in localizing the correct interspace. In 5 cases, 1 from the first group and 4 from the second, the reasons for the surgeon's actions could not be ascertained.

Surgical findings: Definition: Positive finding=a diffuse or restricted protrusion from the disc or a free sequestrum pressing on a nerve root. Negative finding=all the others! The classifications were made on the basis of the information found in surgical reports. According to these definitions, surgical findings were as follows:

	<i>No. of patients</i>
Disc prolapse with sequestra	57
Disc prolapse because of local disc protrusion	93
Positive findings (total)	150
Disc degeneration with protrusion	11
Osteophytes	2
No disc pathology	2
Negative findings (total)	15

Among the positive findings there is one case in which exploration of the last two lumbar spaces failed to provide any explanation for the patient's condition. However, the pain persisted unchanged, and upon

re-operation a month later a distinct disc prolapse was removed which must have been overlooked in the first operation.

No surgical report indicated fibrosis or adhesences around the nerve root as the only surgical finding. *Hirsch & Nachemson* (1963) and *Hirsch, Rosencrantz & Wickbom* (1969) reported 7% (of 232 cases) and 8% (of 489 cases) respectively in which no other explanation for the patients' symptoms could be found.

All surgery was undertaken extradurally. Positive findings were made in 91% of the operated cases. Prolapses were located in the L5—S1 interspace in 86 cases (57%) and in the L4—L5 interspace in 64 cases (43%).

Most authors agree that 95% or more of all disc herniations are located in the last two interspaces of the lumbar spine. On the other hand, there is disagreement about which of these interspaces displays the highest incidence of prolapse. *Barr & Mixter* (1941) found that the frequency was higher for L4—L5, 81/57, as did *Busch et al.* (1949) 508/413, *Gurdjian et al.* (1961) 466/455, *de Palma & Gillespie* (1962) 42/37, and *Hakelius & Hindmarsh* (1969) 696/672. *Grantham & Spurling* (1953) regarded both sites as equally common, while a higher incidence for L5—S1 is reported by *Love & Walsh* (1943) 390/360, *Friberg & Hirsch* (1946) 21/15, *Lindgren* (1949) 184/116, *O'Connel* (1951) 248/188, *Ross & Jelsma* (1952) 227/104, *Ståhl* (1949) 167/117, and *Knutsson & Wiberg* (1958) 134/82.

Fifteen negative explorations were found in this series, i.e. in 9% of the cases. The incidence of negative explorations also varies between operative series, depending upon a number of factors such as the composition of the series, the definition of negative exploration and of surgical indications etc. Using the same definition for negative findings as in this series, *Hakelius & Hindmarsh* (1969) found that the incidence of negative explorations amongst all the Department's cases operated on in the period 1939—64 was 28% (511/1886). Using a comparable definition, *Aitken & Bradford* (1947) had 37% negative explorations (67/170), *Lindgren* (1949) 16% (96/596), *Burns & Young* (1951) 18% (163/913), *Knutsson & Wiberg* (1958) 12.7% (32/251), *Raaf* (1959) 23.8% (195/819) and *Hirsch & Nachemson* (1963) 23% (53/323).

Authors who define "negative findings" as those cases in which no disc pathology of any kind is found have, of course, much lower figures, e.g. *O'Connel* (1951) 3.4% (18/518), *Ross & Jelsma* (1952) 0.5% (2/366), *Gurdjian et al.* (1961) 2% (25/1176) and *Semmes* (1964) 2% (31/1500). By way of comparison, there were 2 completely negative explorations in the present series, i.e. 1.5% (2/165).

Evacuation of exposed discs: In conjunction with the removal of the disc prolapse, it has been customary to undertake a careful curettage of the disc's interior. Even in cases in which intervertebral discs displayed degenerative changes that could not be associated with any root pressure, the discs were incised and evacuated. Healthy discs were not touched as a rule.

Surgical complications: The following serious complications, directly ascribable to the surgery, were recorded:

	<i>No. of patients</i>
Surgical root lesions	5
Deep wound infection	3
Discitis, spondylitis	2
Pulmonary embolism	2
Meningism	2
Post-operative haemorrhage	1

There was no mortality in conjunction with surgery. Two of the 5 root lesions were total and three partial.

Duration of post-operative hospitalisation: The duration of hospital care is shown in Fig. 2. The longest period was 64 days and the shortest 4 days. The median value was 12.7 days and the mean period 13.7 days.

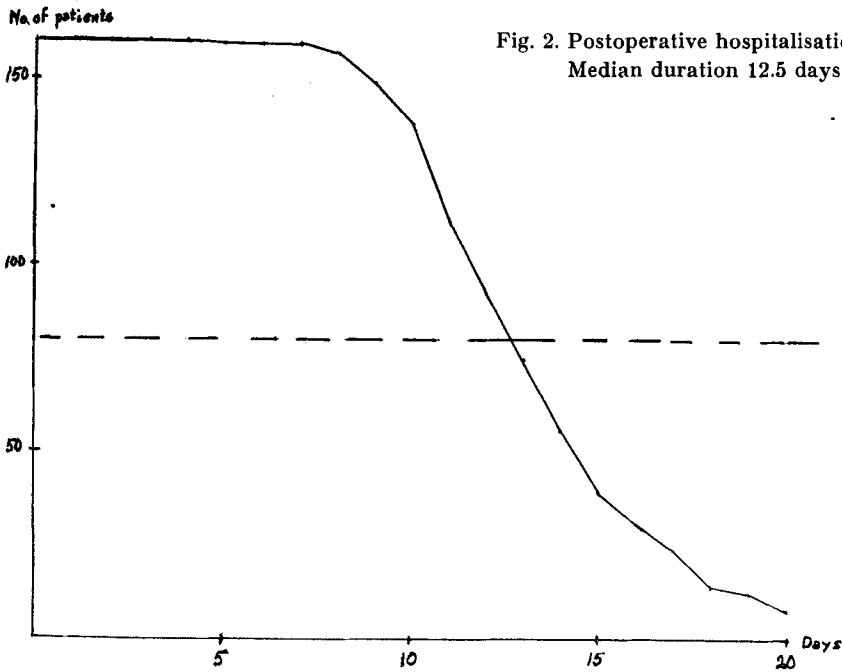


Fig. 2. Postoperative hospitalisation.
Median duration 12.5 days.

F: RELIABILITY OF PRE-OPERATIVE LEVEL DIAGNOSIS

(Table 10)

Many authors emphasize the importance of exact pre-operative localisation of the disc herniation and scarcely anyone disputes that myelography is the best aid in this respect. *Barr* (1947) achieved exact level diagnoses in 90% of his operated cases with the help of contrast examination, *Friberg & Hult* (1951) in 83%, *Aitken* (1952) in 68%, *Raaf* (1959) in 82%, *Lansche & Ford* (1960) in 80.9%, *Gurdjian et al.* (1961) in approx. 75%, *Söderberg & Sjöberg* (1961) in 89%, *Hardy* (1965) in 80% and *Hakelius & Hindmarsh* (1969) in 83%. However, myelographic examination has certain weaknesses. *Hirsch & Nachemson* (1963), for instance, reported exact agreement between myelography and surgical findings in 90% of the cases in which the myelogram was positive but found disc herniation in 50% of the cases with neurological signs but negative myelography. As subsequently shown by *Hirsch, Rosencrantz & Wickbom* (1969), the reliability of myelography depends very largely

Table 10.
Reliability of the preoperative diagnosis of level.

	I	II	III	IV	V
	Myelographic diagnosis (all cases)	Myelographic diagnosis (monoradi- cular cases)	Neurological diagnosis (all cases)	Neurological diagnosis (allowing for loss of sensitivity)	Neurological diagnosis (monoradi- cular cases)
No. of patients	150	115	165	165	129
No. with correct diagnosis of level	130	101	97	104	104
Percentage with correct diagnosis of level	86%	89%	59%	63%	81%

upon how the results are interpreted, in particular the importance accorded to isolated changes in a nerve root.

In the present series, in which 150 of 165 operated patients had pre-operative myelography, exact agreement was found in 130 cases, i.e. 86%, and discrepancies in 20 cases. The myelograms which did not agree with surgical findings consisted of 12 "false" positives, 2 "false" negatives, 4 in which the myelography displayed double disc herniation but in which only one prolapse could be found in surgery and 2 in which the myelogram was positive in the wrong interspace.

The results of clinical-neurological level diagnosis for most authors were much inferior to the results achieved with myelography. The reasons for this appear to be that neurological signs from two nerve roots are very common and that the large group of disc herniations which are not accompanied by demonstrable neurological signs cannot be detected with this form of diagnosis. Even so, *Barr* (1947), using a clinical-neurological examination, was able to make exact site determinations in 50% of the prolapses in his operated cases, *Bradford & Spurling* (1947) in 70%, *Friberg & Hult* (1951) in 65% (only the cases with objective neurological symptoms), *Lansche & Ford* (1966) in 39.2% and *Hakelius & Hindmarsch* (1969) in 46%.

In the present series, there is exact agreement between neurological symptoms and surgical findings in 97 cases, i.e. 59% of the operated group. The 68 cases in which the diagnosis was misleading are made up of 46 patients with symptoms from two nerve roots, 11 with positive neurology despite negative surgical findings, and 11 in whom neurological symptoms suggested root pressure at one level but in whom surgery disclosed the prolapse at another.

In calculating the above figures, consideration was paid to the occurrence of characteristic pain irradiation, sensory losses, pareses and reflex disturbances. When only the neurological signs, upon which selection for this series was based, are considered, the pre-operative level diagnosis agrees with surgical findings in 63% of the cases (104/165).

Stdhl (1949) reported that cases with neurological signs from one root displayed good agreement between clinical and surgical findings in 80% of his series. In the present series there were mono-radicular symptoms in 129 cases. Surgery confirmed the clinical symptomatology in 104 of these, i.e. in 81%.

Of the 129 patients displaying monoradicular symptoms, 115 underwent myelography. Surgical findings agreed with the myelography in 101 cases, i.e. 89%.

In this series, myelography gave more accurate pre-operative level diagnosis than the clinical-neurological method. This is true even if no consideration is paid to less exact neurological signs. On the other hand, there is no great difference between myelography and neurological diagnosis in cases with a purely monoradicular syndrome.

G: COMPARISON BETWEEN SURGICALLY AND CONSERVATIVELY TREATED CASES

In *Table 11*, the series is divided into operated (166 patients) and non-operated (417 patients) cases in order to compare the frequency of clinical findings at the first examination at this Department.

Distribution by age shows a higher ratio of younger patients in the operated group than in those managed conservatively. The difference between patients under 40 years is almost significant ($P < 0.05$). However, the maximum is at 30—39 years for both groups. The average age of the operated patients was 39.5 years and the non-operated 41.1 years.

Distribution by sex and occupation shows only minor differences between the two groups. These are not significant ($P > 0.05$).

Only minor differences can be found in the clinical data regarding the occurrence of *subjective back pain before the sciatica attack, roentgenological changes in the lumbar spine, acute onset, typical radiating pain, sensory disturbances and the length of clinical history prior to examination at the Department*. The average history was 2.99 months for operated patients and 2.87 months for non-operated patients.

The table shows a comparatively higher frequency of "suspected disc herniation" as the primary diagnosis in the operated group. However, with the Department's terminology, the diagnosis "root syndrome" and the diagnosis "suspected disc herniation" are, in practice, identical concepts and may reasonably be grouped together under a heading covering all patients in whom root pressure was presumed to be the precipitating factor. These patients appear almost as frequently in the non-operated as in the operated group and there was no significant difference ($P > 0.05$) between them.

Positive cough and sneeze pain appears more frequently in the operated group, i.e. 57% as opposed to 45% in the conservatively managed group. The difference is significant ($P < 0.01$).

Lasègue's test was, as a rule, more positive in the operated group than amongst conservatively managed patients. The difference is highly sig-

nificant ($P<0.001$). This is also true of the occurrence of crossed Lasègue where the difference is significant ($P<0.01$).

The table also includes dorsal extension and pronation pareses, which were designated as total, pronounced or manifest by the examiner. The frequency of *distinct motor disturbances* is greater in the operated group. The difference between the two groups is significant ($P<0.01$).

Table 11 shows that cases with objectively demonstrable symptoms from two nerve roots are overrepresented in the operated as compared to the non-operated group. The difference is highly significant ($P<0.001$).

Table 11.
Comparison between the operated patients and those treated conservatively.

	Under 40 years of age	Men	Manual work	Back pain before first sciatic attack	Radiological lumbar chan- ges at first sciatic attack	Acute onset
Operated cases	56% (94/166)	68% (113/166)	75% (124/166)	79% (127/161)	68% (100/147)	51% (48/94)
Non-operated cases	48% (198/417)	66% (274/417)	77% (321/417)	76% (293/388)	67% (194/287)	48% (91/189)

	Typical radiating pain	Cough and sneeze pain	Lasègue positive under 60°	Crossed Lasègue	Loss of sensibility	"Mixed" syndrome
Operated cases	28% (46/166)	57% (95/166)	74% (122/166)	26% (43/165)	52% (77/149)	22% (36/165)
Non-operated cases	23% (97/417)	45% (187/417)	44% (182/412)	11% (45/412)	58% (211/366)	9% (37/417)

	Distinct paresis	Initial diag- nosis: suspect- ed disc her- niation or root syndrome	Duration of sciatica → 2 months	Duration of sciatica 2—4 months	Duration of sciatica 4—6 months
Operated cases	23% (39/166)	92% (153/166)	47% (78/166)	29% (48/166)	24% (40/166)
Non-operated cases	15% (61/417)	89% (369/417)	47% (197/417)	32% (134/417)	21% (86/417)

H: COURSE OF THE ACUTE SCIATICA SYNDROME WITH CONSERVATIVE MANAGMENT AND AFTER SURGERY

The dominant symptom in an acute sciatica syndrome is almost always pain and the decisive factor in successful or unsuccessful management is the effect of therapy on this symptom. In only a minority of patients are objectively demonstrable neurological signs significant from the functional point of view. When sciatic pain and the back pain generally associated with it have disappeared, the patient is generally able to return to work, even if neurological findings remain unchanged. It is therefore obvious that any appraisal of treatment must be based mainly on the patient's subjective assessment of his symptoms, there being no possibility of establishing an objective yardstick for the intensity of sciatica.

According to the principles employed in the selection of this series, all patients had severe unilateral sciatica, combined with objectively demonstrable signs (mainly pareses), occasionally affecting the ability to work. Therefore, the results of treatment have been studied exclusively in terms of the effect on the pain. The course in conservative management and with surgical treatment will be considered with regard to the following factors.

1. The patient's subjective assessment of the sciatica's development, taken from case reports prepared at the time.
2. The period of official sick registration during the sciatica syndrome, as registered with the local social insurance authorities.

1. The Patient's Subjective Assessment of the Sciatica's Development

The first comprehensive notes on the patients' conditions occur in the case reports as a rule 10—30 days after the commencement of conservative management or completion of surgery. Further checkups were then made at monthly intervals—more frequently if the patient's condition warranted—until acceptable results had been achieved. I have chosen to report on the state of the sciatica, as assessed by the patients, 10—30

days (*Table 12*), approx. 2 months (*Table 13*), approx. 3 months (*Table 14*) and approx. 6 months (*Table 15*) after the start of conservative management or completion of surgery. The 63 patients, whose symptoms had subsided to such an extent by their first examination that no further treatment was given, have been excluded.

The cases are divided up in the tables into operated and non-operated, and each of these groups into symptom-free, improved, unchanged and worse, all according to what the patient reported to the examiner or controller. With increasing length of observation, an increasing number of patients were no longer checked up for two main reason: (*a*) the treatment administered had not affected the sciatica and the patient underwent surgery; this group is shown in column 5 in *Tables 13—15*. (*b*) The treatment administered had the intended effect so that no further check-ups were considered necessary; these patients will be found in column 6 in *Tables 12—15*.

Tables 12—15.

The patients' subjective assessment of the effect of treatment during the acute attack of sciatica.

Table 12.
10—30 days after the start of treatment.

	1.	2.	3.	4.	5.	6.
	Free of symptoms	Improved	Unchanged	Worse	Operated or reoperated	Not examined
Operated	64% (107/166)	24% (40/166)	3% (5/166)	0% (0/166)	0% (0/166)	9% (14/166)
Non-operated	8% (34/447)	38% (168/447)	17% (77/447)	7% (31/447)	0% (0/447)	30% (137/447)

Table 13.
2 months after the start of treatment.

	1.	2.	3.	4.	5.	6.
	Free of symptoms	Improved	Unchanged	Worse	Operated or reoperated	Not examined
Operated	34% (57/166)	16% (27/166)	1% (1/166)	2% (4/166)	0% (0/166)	47% (77/166)
Non-operated	8% (35/447)	28% (124/447)	5% (24/447)	4% (19/447)	10% (46/447)	45% (199/447)

Table 14.
3 months after the start of treatment.

	1.	2.	3.	4.	5.	6.
	Free of symptoms	Improved	Unchanged	Worse	Operated or reoperated	Not examined
Operated	22% (36/166)	7% (11/166)	2% (3/166)	2% (4/166)	1% (1/166)	66% (110/166)
Non-operated	6% (22/401)	15% (60/401)	3% (12/401)	3% (13/401)	6% (22/401)	67% (272/401)

Table 15.
6 months after the start of treatment.

	1.	2.	3.	4.	5.	6.
	Free of symptoms	Improved	Unchanged	Worse	Operated or reoperated	Not examined
Operated	7% (12/166)	3% (5/166)	1% (1/166)	0% (0/166)	0% (0/166)	89% (148/166)
Non-operated	2% (7/379)	4% (13/379)	2% (8/379)	1% (4/379)	4% (16/379)	87% (331/379)

However, the case reports did not always state why patients failed to turn up. Other factors than those mentioned, e.g. dissatisfaction with the results of treatment, may have played a part in some cases. In *Table 16* the 148 operated and the 331 conservatively managed patients who did not attend the 6 months check-up are reported with respect to their subjective opinion of their condition at their last examination at the Department. It will be seen that 92% of the operated and 82% of the conservatively treated patients reported a favourable effect of the treatment. In the remainder of the report, this group has been included among those who were symptom-free, which means that the results may appear more favourable than they really were. However, the figures in *Table 16* suggest that this is probably the case to a greater extent in the conservatively treated than in the surgically treated group.

The detailed results, with respect to the course of the sciatica during conservative and surgical treatment respectively, based on the patients' subjective assessments, are shown in *Tables 12—15*. The two groups are not strictly comparable in that a selection was made prior to sur-

Table 16.

Effect of treatment subjectively assessed at the last check-up by the patients who did not attend the final check-up after 6 months.

	Free of symptoms	Improved	Unchanged	Worse
Operated	80% (119/148)	12% (18/148)	7% (10/148)	1% (1/148)
Non-operated	22% (73/331)	60% (198/331)	16% (52/331)	2% (8/331)

gery. However, it is reasonable to assume that the operated patients were generally regarded as having more severe subjective symptoms and, according to *Table 11*, had more pronounced signs of root involvement than the conservatively managed patients. Despite this, there appears to be a general tendency for the course to be more favourable for surgically treated patients, a difference which is pronounced in the early check-ups but which evens out in the period up to 6 months, at which time the results for the two forms of therapy are practically identical.

Table 17 summarizes results for the patients who felt they had *benefitted* from the treatment or who stopped coming to check-ups (patients in columns 1, 2 and 6 in *Tables 12—15*). The higher frequencies found among operated patients are almost significant for the check-up after 3 months ($P < 0.05$) but not at 6 months, ($P > 0.05$).

Table 18 covers the patients who considered themselves *free of symptoms* or for whom check-ups were discontinued (columns 1 and 6 in *Tables 12—15*). In all probability, this group is better limited than the one in *Table 17*. The differences between the two groups are significant for the 6 months check-up ($P < 0.01$). However, the differences diminish sharply with increasing length of observation.

Table 17.

Comparison between operative and conservative management: favourable effect at various intervals after the start of treatment.

	10—30 days	2 months	3 months	6 months
Operated	97% (161/166)	97% (161/166)	95% (157/166)	99% (165/166)
Non-operated	76% (339/447)	81% (358/447)	88% (354/401)	93% (351/379)

Table 18.

Comparison between operative and conservative management: free of symptoms at various intervals after the start of treatment.

	10—30 days	2 months	3 months	6 months
Operated	73% (121/166)	81% (134/166)	88% (146/166)	96% (160/166)
Non-operated	38% (171/447)	52% (234/447)	73% (294/401)	89% (338/379)

These results prompt the following conclusions:

1. A significantly larger number of patients in the operated group broke-off the check-ups or reported that the sciatica had *diminished* 10—30 days, 2 months and 3 months after the initiation of treatment. There was no difference between the groups at 6 months.
2. The check-ups had terminated or the patients reported *disappearance of sciatica* symptoms in a significantly larger number of operated cases at the check-ups 10—30 days, 2 months, 3 months and 6 months after the initiation of treatment.

Tables 19 and 20 have the same lay-out as *Tables 17 and 18*, but the cases have been divided into four groups: 1. operated cases with positive finding (151 patients), 2. operated cases with negative finding (15 patients), 3. conservatively managed cases with positive myelography (38 patients), and 4. conservatively managed cases without myelography or with negative myelography (408 patients).

Table 19 shows that patients with negative surgical findings were improved by surgery as quickly and to the same extent as those in whom a prolapse had been excised in surgery, and that conservatively managed patients with positive myelographies displayed better results, if anything, from therapy than other conservatively treated patients.

Table 20 gives a somewhat different picture of the results of treatment. Absence of sciatica symptoms was achieved most rapidly and with the highest frequency in group 1, while the other three groups, particularly during the first three months after the initiation of therapy, show much poorer and approximately equivalent results.

There are many conceivable explanations for the encouraging results in groups 2 and 3 in *Table 19*. Both groups cover a relatively small number of patients, so that minor displacements make for major differences

Table 19.
Development of the sciatic syndrome in different categories of patients: favourable effect of treatment.

	10—30 days	2 months	3 months	6 months
Operated, positive finding	97% (147/151)	97% (146/151)	94% (142/151)	99% (150/151)
Operated, negative finding	93% (14/15)	100% (15/15)	100% (15/15)	100% (15/15)
Non-operated, positive myelography	84% (32/38)	89% (34/38)	93% (35/38)	97% (37/38)
Non-operated, others	75% (307/409)	79% (324/409)	88% (319/363)	89% (304/341)

Table 20.
Development of the sciatic syndrome in different categories of patients:
free of symptoms.

	10—30 days	2 months	3 months	6 months
Operated, positive finding	77% (116/151)	85% (128/151)	90% (136/151)	97% (146/151)
Operated, negative finding	33% (5/15)	40% (6/15)	67% (10/15)	93% (14/15)
Non-operated, positive myelography	58% (22/38)	60% (23/38)	76% (29/38)	93% (35/38)
Non-operated, others	37% (149/409)	52% (211/409)	73% (265/363)	88% (303/341)

in percentage results. In group 2, a certain placebo effect could possibly be ascribed to the surgery undertaken, while group 3 is clearly a selected group where, notwithstanding positive myelography, symptoms had already begun to subside at the time of the first examination at the Department.

2. Duration of Official Sick Registration During the Primary Sciatica Syndrome

Information on the duration of official sick registration was obtained from the files of the social insurance authorities. Data were not available for 68 cases for one of the following reasons: 1. the patient had died (19 cases), 2. the patient was no longer resident in Sweden (13), 3. the patient could not be traced (25), 4. the patient, at the time of the illness, was not

entitled to compensation for sick registration (3), and 5. the patient's file card could not be located at the local social insurance office (8).

No official sick registration was undertaken in conjunction with the primary sciatica syndrome in 58 cases. The majority, belong to the category with the mildest symptoms, for whom operative therapy was not considered. The rest were a few patients who, despite severe symptoms, did not feel they could stop working and who were therefore only treated with a lumbar brace.

The duration of official sick registration can therefore be recorded for 461 patients, 320 treated conservatively and 141 with surgery.

Conservative therapy was considered to have started from the beginning of the official sick registration. The duration of disablement during conservative management was taken from the first day of sick registration to the day of re-certification as "fit for work" and for surgical treatment from the day of the operation to the day of "fit for work" re-certification.

The results are presented in *Table 21* and graphically reproduced in *Fig. 3*. Obviously, few "fit for work" re-certifications take place in the operated group during the first 30 days, and there is a higher incidence of conservatively treated patients who regain full ability to work during this period and up to 60 days. From about the 70th day this ratio is reversed and proportionally more operated patients are re-certified as "fit for work", the difference between the two groups being significant ($P < 0.01$) 90 days after the beginning of the treatment. After 6 months of conservative treatment, 17% (55/320) of the patients were still officially registered as ill, compared with 9% (12/141 patients) in the surgery group. This difference is almost significant ($P < 0.05$).

The medium duration of sick registration was 80 days for operated cases and 94 days for non-operated.

Dividing the material into four groups, 1. operated cases with positive finding (129 patients), 2. operated cases with negative finding (12 patients), 3. conservatively managed cases with positive myelography (30 patients) and 4. conservatively managed cases without myelography or with negative myelography (290 patients), we find (*Table 22* and *Fig. 4*) that the periods of official sick registration are longer on the average for groups 2 and 3. Six months after the start of therapy, 25% of the negative explorations and 37% of patients who did not receive surgical therapy despite positive myelography were still officially regis-

Table 21.
Duration of sickness registration during the acute attack of sciatica.

Days after start of treatment	0	10	20	30	40	50	60	70	80	90
Operated patients still registered as sick	100% 141	100% 141	99% 140	98% 139	89% 128	84% 119	76% 107	64% 90	50% 70	38% 53
Unoperated patients still registered as sick	100% 320	96% 308	91% 291	87% 277	81% 260	77% 245	72% 229	66% 212	61% 195	53% 171

Days after start of treatment	100	110	120	130	140	150	160	170	180
Operated patients still registered as sick	31% 44	28% 39	21% 30	18% 26	14% 20	13% 19	10% 14	9% 12	9% 12
Unoperated patients still registered as sick	46% 147	41% 132	36% 114	31% 98	29% 91	24% 75	20% 62	18% 57	17% 55

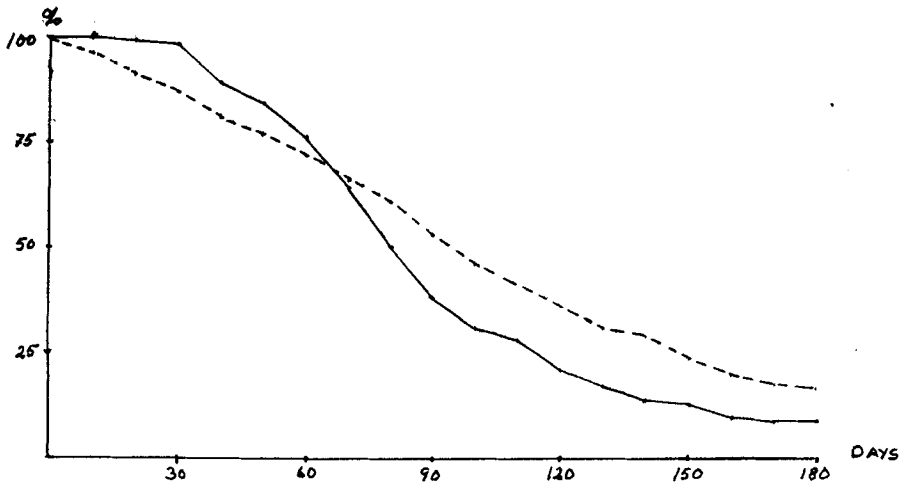


Fig. 3. Graphic representation of Table 21.

———— = Operated - - - - = Unoperated

Table 22.
Duration of sickness registration during the acute attack of sciatica.

Days after start of treatment	0	10	20	30	40	50	60	70	80	90
Operated cases, positive finding, still registered as sick	100% 129	100% 129	99% 128	98% 127	90% 116	83% 107	74% 96	61% 79	47% 60	34% 44
Operated cases, negative finding, still registered as sick	100% 12	100% 12	100% 12	100% 12	100% 12	100% 12	91% 11	91% 11	84% 10	75% 9
Non-operated cases, positive myelography, still registered as sick	100% 30	100% 30	100% 30	100% 30	100% 30	93% 28	87% 26	83% 25	83% 25	70% 21
Non-operated cases, others, still registered as sick	100% 290	96% 278	90% 261	86% 247	79% 230	74% 213	70% 203	64% 187	59% 170	52% 150

Days after start of treatment	100	110	120	130	140	150	160	170	180
Operated cases, positive finding, still registered as sick	29% 37	25% 32	18% 23	16% 20	11% 14	11% 14	8% 10	7% 9	7% 9
Operated cases, negative finding, still registered as sick	58% 7	58% 7	58% 7	50% 6	50% 6	42% 5	33% 4	25% 3	25% 3
Non-operated cases, positive myelography, still registered as sick	67% 20	60% 18	53% 16	53% 16	50% 15	47% 14	47% 14	40% 12	37% 11
Non-operated cases, others, still registered as sick	44% 127	39% 114	34% 98	28% 82	26% 76	25% 71	16% 48	15% 45	15% 45

tered as ill. The corresponding frequency for group 1 is 7%, while for group 4 it is 15%. The difference between groups 1 and 3 is significant ($P < 0.01$).

The median duration of sick registration was 78 days for group 1, 130 days for group 2, 140 days for group 3 and 93 days for group 4.

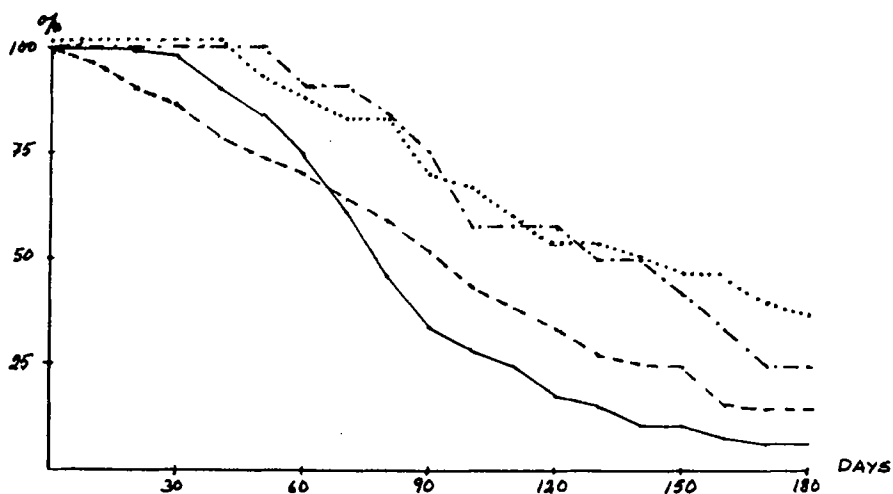


Fig. 4. Graphic representation of Table 22.

- = Operated, positive finding
- - - - - = Operated, negative finding
- = Unoperated, positive myelography
- . - . - = Unoperated, others

I: THE LONG-TERM PROGNOSIS

A follow-up study of the series was made in 1965—67; 19 patients had died during the period of observation, 13 had established residence abroad and 25 could not be traced. Thus, 526 patients were reached by a request for a follow-up examination; 410 of these attended in person while 58, who reported that they were unable to attend (most often because they lived too far away), filled in detailed questionnaires.

The course of the lumbago-sciatica complaint after the initial syndrome had subsided could therefore be followed in 468 patients, i.e. 89% of all those with whom contact had been established and 80% of the total series. There were 296 males (64%) in the follow-up examinations and 172 females (36%). (The corresponding frequencies for the original series were 66% and 34% respectively.) The follow-up comprised 138 patients (29.5%) who had received surgical treatment for the sciatica syndrome and 330 patients (70.5%) who had been managed conservatively. (In the original series, the distribution was 28.5% and 71.5% respectively.)

Although a follow-up examination with a questionnaire is obviously inferior to one conducted personally, there seemed to be two good reasons for including these patients in appropriate sections of the analysis. First of all, any appraisal of a patient's lumbago-sciatica complaint necessarily has to be based on subjective values, which can also be communicated in a questionnaire. Second, the information provided could be checked to a certain extent via the insurance cards.

58 patients chose not to participate in the follow-up examination, i.e. 43 men and 15 women (51 non-operated and 7 operated patients).

The average period of observation for those in the follow-up examination is 7 years 4 months (shortest period 3 years 1 month and longest 12 years 10 months); for the operated patients the figure was 7 years 2 months (shortest period 3 years 2 months and longest 12 years 9 months) and for the non-operated 7 years 4 months (shortest period 3 years 1 month and longest 12 years 10 months).

The distribution by age and sex of the patients in the follow-up exami-

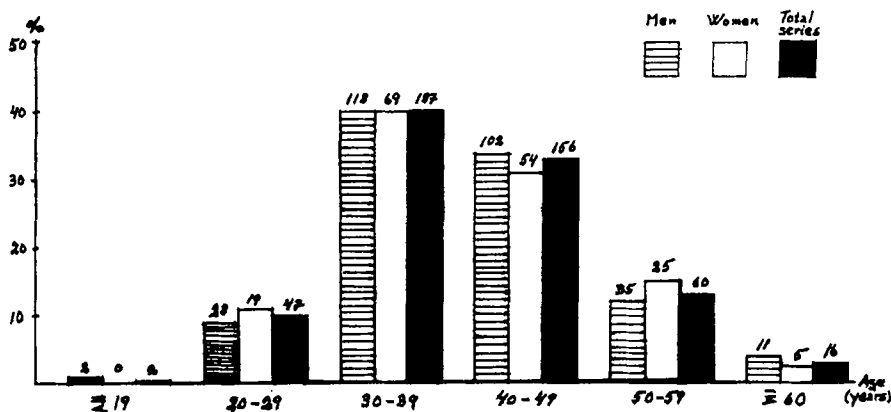


Fig. 5. Age distribution (per cent) of the follow-up series. The number of patients in each category is shown on top of the bars.

nation is shown in Fig. 5. There is close agreement with the distribution reported for the primary series in Fig. 1.

The clinical data to which particular attention was paid in the follow-up examination were: 1. low back pain, 2. symptoms remaining after the sciatica syndrome such as residual sciatica, motor and sensory disturbances, 3. recurrence of severe sciatica, 4. changes in the patient's normal activities caused by lumbago and/or sciatica symptoms. The history was supplemented by a clinical examination of the back and relevant neurology—Lasègue's test, tests of pain and touch perception on the lower leg and foot, strength of the great toe extensors, the foot's dorsal extensors, pronators and plantar flexors, and the patellar plus Achilles reflexes. Finally, a record was obtained of any sick registration for lumbago and/or sciatica from the patients' social insurance cards during the period of observation. The patients examined via a questionnaire were given questions concerning the same clinical factors. Both when recording the history and when formulating the questionnaire, a great deal of effort was devoted to inducing the patient to distinguish between pain from the back and pain from the leg.

1. Subjective Low Back Symptoms During the Period of Observation

It is well-known that lumbar symptoms present a clinical picture with many aspects, in respect to character, intensity, duration and periodicity. This applies not only to comparisons of different patients but also in one and the same patient. Nor is the classification of these symptoms facili-

tated by the lack of detailed knowledge as to the pathological and anatomical background of the various kinds of pain. However, it is customary to make a division, according to the character of the symptoms, into lumbar insufficiency and lumbago (*Hult 1954, Horal 1969*), though *Hult* points out that even the borderline between these two groups is very fluid.

No classification according to these guidelines has been attempted in this study. Instead, the intention has been to illuminate the manner in which lumbar disorders developed during the observation period as compared with the condition prior to the sciatica syndrome. As already shown (*Table 11*), 79% of the operated and 76% of the conservatively treated patients had some kind of lumbar complaint prior to the debut of the sciatica syndrome. These complaints, as well as lumbar symptoms arising during the period of observation, were discussed in detail during the follow-up examination, and patients were required to compare the condition of the back both before and after the syndrome. The patients were given four alternatives: 1. no symptoms, 2. improvement, 3. unchanged, and 4. worse.

Patients who had no back symptoms except in conjunction with the sciatica syndrome were placed in group 1. Only exceptionally and when there were special reasons was the classification, as reported by the patient, changed.

The results are reported in *Table 23*, from which 21 patients from the conservatively managed group have been excluded because they underwent surgery for recurrence during the observation period. 43 patients (31%) of the operated and 39 patients (13%) of the conservatively treated group reported having no lumbar symptoms since the decline of the sciatica syndrome. 34 (25%) of the operated and 131 (42%) of the non-operated patients felt that lumbar pain had increased after the scia-

Table 23.
Long-term prognosis: back status subjectively assessed during the observation period in relation to the status before the primary sciatic syndrome.

	Free of symptoms	Improved	Unchanged	Worse
Operated	31% (43/138)	21% (29/138)	23% (32/138)	25% (34/138)
Non-operated	13% (39/309)	16% (49/309)	29% (90/309)	42% (131/309)

tica syndrome. A statistical analysis of these results showed, in respect to *absence of symptoms*, that the difference was highly significant ($P < 0.001$) and in respect to a *deterioration* also highly significant.

Conclusion: The number of patients without lumbar symptoms during the observation period is larger in the operated group. The number of patients who became worse during the observation period is greater in the non-operated group.

2. *Objective Back Findings at the Follow-up Examination*

Most of the patients in this series were examined at the Department for the first time during their initial lumbago-sciatica episode. A direct comparison between back findings then and the findings at the follow-up examination would, therefore, be misleading.

Instead, only those patients were classified as good results who, in the follow-up examination, did not display serious objective findings in the form of incorrect postures, contractures and restricted mobility in the lumbar spine. In the conservatively managed group, 19 patients were excluded because they had undergone surgery during the period of observation. According to this classification 74% of those operated (88/119 patients) compared to 69% of the non-operated (189/272 patients) were regarded as having a satisfactory function of the back. The difference is not significant ($P > 0.05$).

Conclusion: No difference in objective back findings could be found between operated and conservatively managed groups.

3. *Corset Brace Wearers During the Observation Period*

Although the use of a lumbar brace is not an objective measure of the degree of back pain, this factor seems worth considering since there is some justification for assuming that patients who permanently or periodically use this aid really do have lumbar symptoms. 21 patients from the conservatively managed group, who underwent surgery during the observation period, have been excluded.

23% (32/138 patients) of the operated and 39% (121/309 patients) of the non-operated patients reported that they had used lumbar braces periodically or permanently. The difference between the groups is significant ($P < 0.01$). It should be noted that the number of permanent users is relatively small, i.e. 25 patients (7 operated and 18 non-operated). 50% of the brace wearers were women, whereas the proportion of women in the total series is 36%.

Conclusion: A larger number of patients in the non-operated group reported in the follow-up examination that they permanently or periodically used lumbar braces during the period of observation.

4. *Residual Sciatica During the Observation Period*

Only sciatic pain which could not be referred to a recurrent sciatica syndrome was included under this heading. The classification is based upon the patients' own assessment of symptoms. The patient's history was studied closely and a clinical examination was performed to exclude, as far as possible, other than radicular causes of the pain. It should be mentioned in this context that all patients had previously experienced sciatica and often emphatically maintained that the symptoms now described had the same character and localisation as the initial syndrome but were much less intense.

Having analysed the complaints, the patients were asked to grade the severity of the pain according to three alternatives. 1. No or negligible pain, 2. mild pain, or 3. considerable pain. This classification was rejected only in a few cases in which there was a clear discrepancy with known facts.

The results are reported in *Table 24*. In order to achieve a purely conservatively managed group, 21 patients from the non-operated group who underwent surgery during the observation period, were excluded. 56% of the operated (77/138) and 39% of the conservatively treated (119/309) cases reported freedom from symptoms or negligible pain. This difference is highly significant ($P < 0.001$). 12% of the operated (16/138) and 20% of the conservatively treated (61/309) reported that they had considerable pain. This difference is not significant ($P > 0.05$).

Conclusion: A larger number of operated than non-operated patients report having only negligible pain during the period of observation.

Table 24.
Long-term prognosis: residual sciatica during the observation period.

	Free of symptoms	Mild pain	Considerable pain
Operated	56% (77/138)	32% (45/138)	12% (16/138)
Non-operated	39% (119/309)	41% (129/309)	20% (61/309)

Table 25.
Long-term prognosis: motor symptoms during the observation period.

	Free of symptoms	Mild discomfort	Considerable discomfort
Operated	76% (104/138)	17% (24/138)	7% (10/138)
Non-operated	77% (238/309)	17% (54/309)	6% (19/309)

5. Subjective Motor Symptoms During the Period of Observation

The patient's subjective feelings of leg or foot weakness are summarized in *Table 25*.

Definition: 1. Symptom-free: No feeling of weakness or instability or wholly negligible symptoms. 2. Mild discomfort: feeling of weakness or instability not influencing patient's ability to work or leisure activities except upon unusual exertion. 3. Considerable discomfort: feeling of weakness or instability affecting patient's ability to work and engage in leisure activities.

As will be seen from the table, the difference between the groups is minor and without significance ($P > 0.05$). The number of patients with considerable symptoms was small.

Conclusion: In this series there is no difference between operated and conservatively managed patients in terms of subjective motor symptoms during the period of observation.

6. Objective Motor Loss Symptoms at the Follow-up Examination

The clinical follow-up examination included tests of the strength of the great toe's dorsal extensor, the foot's pronators, dorsal extensors and plantar flexors. The patients with a recurrence of the sciatica syndrome during the period of observation were excluded so as to facilitate comparisons with findings from the first examination. 66 operated and 119 non-operated patients remained, who had pareses at the first examination.

The results at the follow-up examination will be found in *Table 26*. 53% of the operated (35/66) and 45% (54/119) of the conservatively treated patients had no pareses at the follow-up examination. The difference is not significant ($P > 0.05$). Complete regression of pareses would appear to have occurred as frequently in operated as in non-operated patients in this series.

Table 26.

Long-term prognosis: persistent pareses in patients who had an objective loss of motor function during the primary sciatic syndrome.

	No pareses	Great-toe pareses only	More extensive pareses
Operated	53% (35/66)	27% (18/66)	20% (13/66)
Non-operated	45% (54/119)	39% (46/119)	16% (19/119)

7. Subjective Sensory Symptoms During Period of Observation

Symptoms during the period of observation in the form of numbness and paraesthesias caused only a few patients to consult a medical practitioner or to register as officially ill and are, therefore, difficult to manage from the point of view of classification. Table 27 is based solely on the patients' assessments. The difference between the operated and conservatively managed groups is minor and not significant ($P > 0.05$). Only a small number of patients designated their sensory disturbances as "considerable".

8. Objectively Demonstrable Sensory Loss at Follow-up Examination

The patients were examined with respect to impaired sensitivity to pain and touch on the lower leg and foot. Sensory losses were demonstrated in 34% of the operated patients (40/119) and in 33% (96/291) of those managed conservatively. The corresponding figures before the start of treatment for the primary sciatica syndrome were 52% and 58% (Table 11).

9. Recurrences

The designation of an episode of severe sciatica as recurrent sciatica was

Table 27.

Long-term prognosis: sensory symptoms during the observation period.

	Free of symptoms	Mild discomfort	Considerable discomfort
Operated	70% (97/138)	22% (30/138)	8% (11/138)
Non-operated	72% (225/309)	22% (67/309)	6% (17/309)

admitted only if such a designation had been used in the case report at the hospital treating the patient. If such reports were not available, the following conditions had to be satisfied:

1. Pain, in the patient's opinion, should have been at least similar to the initial sciatica syndrome.
2. The patient, according to the records of the social insurance authorities, should have been officially registered as ill for at least 14 days in conjunction with the complaint.

According to these criteria, 67 of 330 conservatively managed patients and 14 of 138 operated patients had recurrences, i.e. 20% and 10% respectively. This difference is significant ($P < 0.01$).

Among the 67 non-operated patients there were 55 recurrences in the same limb as in the initial syndrome; 19 of these patients had subsequently undergone surgery in which a disc prolapse was found in 17 cases, exploration being negative in the other two. The 14 operated patients all had recurrent sciatica in the same limb, 7 were re-operated, a disc prolapse being found in 4 cases, of which three on the same level as in the first operation. Adherences were found in two cases and one exploration was negative.

Table 28 shows that recurrences appear to be evenly distributed over the entire period of observation apart from a maximum during the first year.

Conclusion: Recurrence of severe sciatica during the period of observation occurred more often among conservatively treated patients.

Table 28.
Annual frequency of recurrence during the observation period.

	No. of patients observed	No. with recurrence	Percentage recurrence
→ 1 year	468	21	4.5%
1—2 years	468	8	1.7%
2—3 years	468	13	2.8%
3—4 years	428	8	1.9%
4—5 years	372	11	3.0%
5—6 years	311	8	2.6%
6—7 years	250	4	1.6%
7—8 years	189	3	1.6%
8—9 years	132	4	3.0%
9—10 years	72	1	1.4%

10 Occupation, Leisure Activities, Disturbed Sleep

At the follow-up examination, patients were asked if they had been forced to switch to lighter work because of lumbago and/or sciatica. 12% of the operated (16/138) and 15% (50/330) of the conservatively treated reported that this was the case. The difference is not significant ($P>0.05$). Six patients, 1 operated and 5 conservatively managed, received early disability pensions because of lumbago-sciatica. 15% of the operated (20/138) and 15% (49/330) of the conservatively treated patients reported that they had been forced to restrict their leisure activities during the period of observation because of lumbago and/or sciatica. 20% of the operated (28/138) and 13% of the conservatively treated (43/330) reported that they suffered sleep disturbances for the same reason. This difference, which is not significant ($P>0.05$), reflects the higher incidence of nocturnal leg cramps in operated patients.

11. Official Sick Registration for Lumbago-Sciatica During Period of Observation

The information was obtained from the files of the social insurance authorities. Such information was available for 454 follow-up patients. The results are reported with patients divided into four categories: 1. no sick registration, 2. 1—30 days total sick registration, 3. 31—90 days total sick registration, 4. more than 90 days total sick registration.

65% of the operated (87/135) and 48% of the non-operated (154/319) patients had not been officially registered as ill in the interval between their "fit for work" re-declaration after the primary sciatica syndrome and the follow-up examination (*Table 29*). The difference is significant ($P<0.01$). Most of the conservatively managed patients officially regis-

Table 29.
Long-term prognosis: sickness registration for lumbago-sciatica during the observation period.

	No sick registration	Registered as sick 1—30 days	Registered as sick 31—90 days	Registered as sick 91 days or more
Operated	65% (87/135)	9% (12/135)	13% (18/135)	13% (18/135)
Non-operated	48% (154/319)	23% (74/319)	15% (46/319)	14% (43/319)

Table 30.

Long-term prognosis: sickness registration for lumbago-sciatica during the observation period, excluding recurrences of severe sciatica.

	No sick registration	Registered as sick 1—30 days	Registered as sick 31—90 days	Registered as sick 91 days or more
Operated	70% (95/135)	10% (14/135)	12% (16/135)	8% (10/135)
Non-operated	59% (187/319)	26% (83/319)	10% (31/319)	5% (18/319)

tered as ill were, however, only disabled for periods under 30 days. Longer periods of sick registration occurred with equal frequency in both groups.

As indicated above, there was a higher incidence of recurrence in the conservatively managed than in the operated group. Excluding the sick registrations which are attributable to recurrences (*Table 30*) the difference between the groups is reduced but is still almost significant ($P < 0.05$).

Conclusion: A larger number of non-operated patients than operated were on the sick list for back and/or sciatica pain during the observation period. This applies even when one excludes sick registrations due to recurrences.

12. Long-Term Prognosis for Operated with Negative Surgical Findings and Conservatively Managed with Positive Myelography

Of the 15 patients who underwent surgery with negative surgical findings, 12 had follow-up examinations; of 38 conservatively managed patients with positive myelographies, 24 had follow-up examinations. In the account above, these patients were included in the operated and conservatively treated groups respectively.

Tables 31—34 report them separately and relate them to the two main groups with respect to back pain, residual sciatica, sick registration for lumbago-sciatica and recurrences during the period of observation. As both groups are small, it would be hazardous to draw any definite conclusions about the prognosis. However, in these patients on whom negative explorations were performed or who were not treated surgically despite positive myelographies, there is nothing to suggest, poorer long-term prognosis than in the other patients.

Table 31.

Long-term prognosis: back status subjectively assessed during observation period in relation to the status before the sciatic attack.

	Free of symptoms	Improved	Unchanged	Worse
Operated, positive finding	34% (43/126)	21% (26/126)	21% (27/126)	24% (30/126)
Operated, negative finding	0% (0/12)	25% (3/12)	42% (5/12)	33% (4/12)
Non-operated, positive myelography	0% (0/24)	29% (7/24)	17% (4/24)	54% (13/24)
Non-operated, others	14% (39/285)	15% (42/285)	30% (86/285)	41% (118/285)

Table 32.

Long-term prognosis: degree of residual sciatica during the observation period.

	None	Mild	Considerable
Operated, positive finding	59% (74/126)	31% (39/126)	10% (13/126)
Operated, negative finding	25% (3/12)	50% (6/12)	25% (3/12)
Non-operated, positive myelography	50% (12/24)	37% (9/24)	13% (3/24)
Non-operated, others	38% (107/285)	42% (120/285)	20% (58/285)

Table 33.

Long-term prognosis: sickness registration for lumbago-sciatica during the observation period.

	No sick registration	Registered as sick 1—30 days	Registered as sick 31—90 days	Registered as sick 91 days or more
Operated, positive finding	64% (79/123)	8% (10/123)	14% (17/123)	14% (17/123)
Operated, negative finding	67% (8/12)	17% (2/12)	8% (1/12)	8% (1/12)
Non-operated, positive myelography	53% (11/21)	33% (7/21)	10% (2/21)	4% (1/21)
Non-operated, others	48% (143/298)	23% (67/298)	15% (44/298)	14% (42/298)

Table 34.
Long-term prognosis: recurrence of severe sciatica during the observation period.

	Percentage of recurrence	No. of patients with recurrence	No. of patients
Operated, positive finding	10%	13	126
Operated, negative finding	8%	1	12
Non-operated, positive myelography	12%	3	24
Non-operated, others	21%	64	306

J: DURATION OF OFFICIAL SICK REGISTRATION DURING THE ACUTE ATTACK CORRELATED WITH CERTAIN CLINICAL AND NON-CLINICAL FACTORS

Are there any clinical or other factors which warrant more energetic attempts to diagnose root compression and eliminate this surgically? In order to investigate this question, certain factors were correlated with the duration of official sick registration during the acute attack. In the analysis, patients who had been registered as ill for a period equal to or less than the median for the operated group, i.e. 80 days, are designated good results; others are termed poor results. The analysis covers all the operated patients with positive surgical findings and all the conservatively treated patients who had been registered as ill, except those with positive myelographies, and for whom index cards were available from the social insurance authorities. The groups comprise 130 operated and 295 conservatively managed patients.

The factors tested in relation to the duration of sick registration were *age, sex, Lasègue test reaction, objective neurology during the acute attack and early vs late surgery.*

1. *Sex—Duration of Sick Registration (Table 35)*

In the operated group, there is no major difference between men and women. Among non-operated patients, women tend to display longer periods of sick registration than men, the difference being almost significant ($P < 0.05$). The operated males display a higher frequency of good results than conservatively treated males, but the difference is not significant ($P > 0.05$). In the female group, the corresponding difference is almost significant ($P < 0.05$). The results suggest, therefore, that active diagnosis amongst conservatively managed women might conceivably have led to better results during the acute attack.

2. *Age—Duration of Sick Registration (Table 36)*

The material was divided into two groups: 1. patients under 40 years, 2. patients 40 years of age or more. The best results are found among

younger operated patients. The number of patients in this group with an official sick registration time of 80 days or less was proportionally larger compared to older operated patients as well as compared to younger conservatively treated patients, the differences being highly significant ($P<0.001$) and significant ($P<0.01$) respectively. The results suggest that a greater diagnostic effort should have been made with conservatively managed patients under 40 years of age.

3. *Lasègue Test—Duration of Sick Registration (Table 37)*

The material was divided into: 1. patients with a 45° Lasègue and 2. patients with a Lasègue positive beyond 45° . With reference to good results, the table shows a numerical—though not significant ($P>0.05$)—difference in frequency of strongly positive Lasègue (45° or less) between operated and non-operated patients. The operated and conservatively treated cases with weakly positive Lasègue have similar sick registration periods. The results show that Lasègue's test alone does not provide any guidance in the selection of patients for surgery.

Tables 35—38.

Relation between a short period of sickness (registered for 80 days or less) for the acute attack of sciatica and various factors.

Table 35

	Sex	
	Male	Female
Operated	55% (47/86)	50% (22/44)
Non-operated	48% (90/186)	32% (35/109)

Table 36

	Age	
	Under 40	40 or more
Operated	67% (50/75)	35% (19/55)
Non-operated	46% (62/136)	40% (63/159)

Table 37

	Lasègue's test	
	→ 45°	Over 45°
Operated	58% (49/85)	44% (19/43)
Non-operated	44% (52/117)	41% (73/178)

Table 38

	Neurology		
	5th lumbar syndrome	1st sacral syndrome	5th lumbar and 1st sacral syndrome
Operated	55% (26/47)	52% (32/62)	53% (11/21)
Non-operated	43% (51/120)	41% (67/164)	54% (6/11)

4. Neurology—Duration of Sick Registration (Table 38)

The cases were divided into: 1. patients with symptoms from the S1 root only, 2. patients with symptoms from the L5 root only, and 3. patients with symptoms from both these roots. Table 38 shows that an operated monoradicular syndrome has shorter sick registration periods than a non-operated, though the difference is not significant ($P > 0.05$). There is nothing to suggest that either of the monoradicular syndromes has a poorer prognosis than the other. The polyradicular syndromes have about the same frequency of good results in both operated and conservatively treated groups.

Conclusion: As an isolated factor, the objective neurology does not provide any guidance in the choice of therapy with a view to reducing the duration of sick registration during the acute attack.

5. Early vs late surgery

Table 39 shows the results of an analysis of the problem of early or late surgery. "Early" surgery is defined as an operation after conservative therapy for 60 days or less. Exploration after more than 60 days

conservative management is defined as “late”. The table shows that the duration of official sick registration after “early” surgery is less than after “late” surgery. The difference is almost significant ($P < 0.05$).

Table 39
Early vs late operation.

	Good results
“Early” operation	64% (40/63)
“Late” operation	43% (29/67)

K: GENERAL CONCLUSIONS AND SUMMARY

This series covers 583 patients who were referred to or who applied to the Department of Orthopaedic Surgery at Karolinska Institutet because of unilateral first episodes of sciatica with a maximum history of 6 months and who displayed indications of a lesion of the 5th lumbar and/or 1st sacral nerve root. They constitute a consecutive series over a 7-year period (1955—61) and were chosen so as to represent a clinical picture of the type of sciatica usually regarded as being caused by root compression. Both the objective and subjective symptomatology and the distribution by age and sex display general agreement with most comparable, published series in which the cause of pain was shown on exploration to be root compression caused by a disc herniation.

Therapy was characterized by a cautious attitude towards surgery.

Conservative management, consisting of relative immobilisation of the lumbar spine, was administered to 545 patients, i.e. 93% of the entire series; only 12 of 166 operated patients had not received such therapy. For the remaining 26 cases information is lacking. The operation was generally preceded by myelography with water-soluble iodine contrast.

Surgery was undertaken in 166 or 28.5% of the 583 patients during the first sciatica attack. Compared with the non-operated group, the average age of the operated patients is somewhat lower. Positive cough and sneeze pain, strongly positive Lasègue, crossed Lasègue, pronounced pareses and polyradicular symptoms appear clinically more often in the operated group than in the conservatively managed patients. This suggests that the difference in symptomatology between the groups is probably one of degree rather than kind.

The following observations were made:

I. The course of the acute sciatic attack in surgical and conservative treatment respectively

1. A good surgical result depends entirely upon whether or not a disc prolapse is found and removed. If this is the case, the patient can be expected to experience speedier relief from the sciatica and the period of

official sick registration will be shorter than for conservatively managed cases.

2. Negative explorations can influence the acute course of the disorder and, if anything, tend to lengthen it, as compared to conservatively managed patients.

3. Positive myelography constitutes a strong indication for surgical intervention because conservative management may involve an extended period of illness during the acute attack.

4. From the remarks under 1—3, it is clear that the pre-operative diagnosis should be determined as exactly as possible. Myelography with water-soluble iodine contrast is superior to clinical-neurological level diagnosis. The method did not give rise to serious complications and made it possible to restrict explorations to one interspace in 85% of all operated cases.

5. The period of officially registered illness is likely to be shorter after surgery with prior conservative management lasting less than 60 days than after non-surgical treatment of longer duration.

6. The longest periods of official sick registration during the acute sciatic attack were found among conservatively managed females and among conservatively managed patients under 40 years. It is possible that the immediate results would have been better if the diagnosis, aimed at disclosing a root compression, had been pursued with greater energy in these groups.

7. However, the reported results also show that an acute sciatica with neurological symptoms is a transient condition which, with few exceptions, subsides after a relatively short period. It nearly always leads to acceptable final results, irrespective of whether treatment is surgical or not. In this series, the results of operative and conservative therapy are almost identical six months after the start of treatment. On the other hand, time may be gained with surgical intervention in certain cases, and this time factor is of significance in conditions of severe sciatic pain.

II. *Long-Term Prognosis*

The results of this study thus appear to confirm the view that acute sciatica episodes run a relatively brief course in most cases, regardless of the treatment administered. It is also generally acknowledged that the attacks are caused by lumbar disc degeneration. However, this disc degeneration is a pathomorphological process lasting several decades. It

is associated with a symptomatology which, although scarcely dramatic for most patients, is in the long run a greater threat to the patient's ability to work and lead a normal life. An immediate, favourable therapeutic effect is not enough. It must also be shown that the therapy does not have an unfavourable effect on the basic disorder. Therefore, the long-range prognosis was closely studied through personal follow-up examinations of 410 patients and through questionnaires from 58 patients, i.e. 80% of the entire series and 89% of those patients whom it had been possible to contact. The periods of observation varied from 3 years 1 month to 12 years 10 months (average 7 years 4 months). 138 of the patients contacted in this manner had undergone surgery and 330 had been treated conservatively during the acute sciatica episode. On the basis of this analysis, the following conclusions have been reached regarding the long-range prognosis.

1. No results suggest that operative therapy, on the indications applied, impairs the long-range prognosis.

2. Certain results point to a better prognosis for operated patients. This is particularly true with respect to the patients' subjective assessment of lumbar pain, residual sciatica and with respect to the frequency of recurrences, according to the criteria established for these. Furthermore, a larger percentage of the conservatively managed patients were forced to officially register as ill because of lumbago and/or sciatica during the period of observation.

3. However, most results show no substantial difference between the groups, as the following table indicates:

	% operation	% conservative
Reduced working capacity	12	15
Complete loss of ability to work	0.75	1.5
Restrictions in leisure activities	15	15
Regular sleep disturbances	20	13
Sick registration for lumbago-sciatica for more than 90 days	13	14
Pronounced residual sciatica	12	20
Residual, pronounced pareses	20	16
Pronounced subjective motor symptoms	7	6
Pronounced subjective sensory symptoms	8	5
Objective sensory loss	34	33
Surgery for recurrences	5	6

4. From the points raised under 1—3 above, it is clear that the treatment administered during the acute sciatica attack does not exert a *decisive* influence on the long-term prognosis. However, certain results suggest that the patients' subjective assessments tend to shift from "good" to "excellent" in the operated group as compared to the conservatively managed group but that "mediocre" or "poor" results are equally common in both groups.

REFERENCES

- Abt & Keegan: Quoted by Söderberg 1956.
- Aitken, A.: Rupture of the intervertebral disc in industry, further observations on the end results. *Am. J. Surg.* 84: 261, 1952.
- Aitken, A. P. & Bradford, C. H.: End results of ruptured intervertebral discs in industry. *Am. J. Surg.* 73: 365, 1947
- Alajouanine, T. & Petit-Dutailis, D.: Le nodule fibro-cartilagineux de la face postérieure des disques intervertébraux. *Presse med.* 38: 1657, 1930.
- Andrae, R.: Über Knorpelknötchen am hinteren Ende der Wirbelbandscheiben im Bereich des Spinalkanals. *Beitr. pat. Anat.* 82: 464, 1929.
- Antoni, N.: Ett fall av kronisk rotkompression med ovanlig orsak, hernia nuclei pulposi disci intervertebralis. *Svensk Läk.-tidn.*, 28: 436, 1931.
- Armstrong, J. R.: The causes of unsatisfactory results from the operative treatment of lumbar disc lesions. *J. Bone Jt. Surg.* 33-B: 31, 1951.
- Armstrong, J. R.: Lumbar disc lesions. 3:d edition. E. & S. Livingstone Ltd, Edinburgh and London 1965.
- Arnell, S.: Weitere Erfahrungen über Myelographie mit Abrodil. *Acta radiol.* 25: 408, 1944.
- Arnell, S.: Myelography with water-soluble contrast, with special regard to the normal roentgenpicture. *Acta radiol. Suppl.* 75, 1948.
- Barr, J. S.: Ruptured intervertebral disc and sciatic pain. *J. Bone Jt. Surg.* 29: 429, 1947.
- Barr, J. S.: Low back and sciatic pain. Results of treatment. *J. Bone Jt. Surg.* 33-A: 633, 1951.
- Barr, J. S. & Mixter, W. J.: Posterior protrusion of the lumbar intervertebral disc. *J. Bone Jt. Surg.* 23: 444, 1941.
- Bergsman, A., v. Reis, G. & Sahlgren E.: Diagnosis and treatment of sciatica based on a follow up study. *Acta med. Scand.* 144: 71, 1952.
- Bobechko, W. P. & Hirsch, C.: Auto-immune response to nucleus pulposus in the rabbit. *J. Bone Jt. Surg.* 47-B: 574, 1965.
- Boysen, G.: Sciatica, especially the prognosis by conservative treatment. *Acta med. Scand.* 128: 473, 1947.
- Bradford, F. K. & Spurling, R. G.: The intervertebral disc. With special reference to rupture of the anulus fibrosus with herniation of the nucleus pulposus. Springfield Ill., Charles C. Thomas, 1947.
- Brahme, L. A.: A contribution to the knowledge of the prognosis of ischias. *Acta med. Scand.* 110: 1, 1942.
- Briggs, H. & Krause, J.: The intervertebral foraminotomy for relief of sciatic pain. *J. Bone Jt. Surg.* 43: 475, 1945.

- Brown, H. A.: Enlargement of the ligamentum flavum, a cause of low back pain with sciatic radiation. *J. Bone Jt. Surg.* 20: 325, 1938.
- Burns, B. H. & Young, R. H.: Results of surgery in sciatic and low back pain. *Lancet* 245, 1951.
- Busch, E., Andersen, A., Broager, B. et al.: Prolapse af lumbar disk. *Ugeskr. for laeger* 111: 165, 1949.
- Craig, W. M. & Walsh, M. N.: Diagnosis and treatment of low back and sciatic pain caused by protruded intervertebral disc and hypertrophied ligaments. *Minnesota med.* 22: 511, 1939.
- Colonna, P. C. & Friedenberg, Z. B.: The disc syndrome. Results of the conservative care of patients with positive myelograms. *J. Bone Jt. Surg.* 31-A: 614, 1949.
- Dandy, W. E.: Loose cartilage from intervertebral disc simulating tumor of the spinal cord. *Arch. Surg.* 19: 660, 1929.
- Dandy, W. E.: Concealed ruptured intervertebral discs. *J. A. M. A.* 117: 821, 1941.
- Dandy, W. E.: Newer aspects of ruptured intervertebral discs. *Ann. Surg.* 119: 481, 1944.
- Dandy, W. E.: Recent advances in diagnosis and treatment of ruptured intervertebral discs. *Am. J. Surg.* 115: 514, 1947.
- Déjérine, J. & Regnard, M.: Sciatique radriculaire avec paralysie dissociée des muscles antero-externes de la jambe droite. Intégrité des jambier antérieur. Anesthésie dans le territoire de S I. *Rev. neurol.* 23: 288, 1912.
- Dunning, H. S.: Prognosis in so-called sciatic neuritis. *Arch. Neurol. Psychiat.* 55: 573, 1946.
- Durbin, F. C.: The conservative treatment of sciatic pain by immobilisation in a plaster jacket. *J. Bone Jt. Surg.* 30-B: 487, 1948.
- Echols, D. H.: Surgical treatment of sciatica. Results three to eight years after operation. *Arch. Neurol. Psychiat.* 61: 672, 1949.
- Elsberg, C. A.: The extradural ventral chondromas (ecchondroses) their favorite sites, the spinal cord and root symptoms they produce and their surgical treatment. *Bull. Neurol. Inst. New York* 1: 350, 1931.
- Falconer, M. A., McGeorge, M. & Begg, A. C.: Surgery of lumbar intervertebral disc protrusion. A study of principles and results based upon 100 consecutive cases submitted to operation. *Brit. J. Surg.* 35: 225, 1948.
- Feffer, H. L.: A physiological approach to lumbar intervertebral disc derangement. In Adams J. P., editor: *Current practise in orthopedic surgery*. St. Louis the C. V. Moseby Co. 1: 111, 1963.
- Francillon, M. R.: Au sujet du traitement conservateur des hernies discales. *Helvet. chir. acta*, 17: 355, 1950.
- Freiberg, A. H.: Sciatic pain and its relief by operations on muscle and fascia. *Arch. Surg.* 34: 337, 1937.
- Freiberg, S.: Low back and sciatic pain caused by intervertebral disc herniation, anatomic and clinical investigation. *Acta. schir. scand. Suppl.* 64, 1941.
- Freiberg, S. & Hirsch, C.: On late results of operative treatment for intervertebral disc prolapses in the lumbar region. *Acta. chir. scand.* 93: 161, 1946.
- Freiberg, S. & Hirsch, C.: Anatomical and clinical studies on lumbar disc degeneration. *Acta orthop. scand.* 19: 222, 1950.
- Freiberg, S. & Hult, L.: Comparative study of Abrodil myelogram and operative findings in low back pain and sciatica. *Acta orthop. scand.* 20: 303, 1951.

- Giulliani, K.: Konservative Behandlung der Bandscheibenschäden. Arch. klin. chir. 267: 113, 1951.
- Grantham, E. G. & Spurling, R. G.: Ruptured lumbar intervertebral discs. Med. clin. North Am. 37: 479, 1953.
- Grill, W.: Die Pathologie des Ligamentum flavum in ihrer klinischen Bedeutung. Med. Monatsschr. 4: 914, 1950.
- Guinon, G. & Parmentier, E.: Quoted by Knutsson (1961).
- Gurdjian, E. S., Webster, J. E., Ostrowski, A. Z., Hardy, W. G., Lindner, D. W., Thomas, L. M.: Herniated lumbar discs an analysis of 1176 operated cases. J. trauma, 1: 158, 1961.
- Hakelius, A. & Hindmarsh, J.: The comparative reliability of preoperative diagnostic methods in lumbar disc surgery. In print.
- Hardt: Ergebnisse der konservativen Ischiasbehandlung. Beilageheft Ztschr. Orthop. 84: 118, 1954.
- Hardy, R. C.: Herniated intervertebral lumbar disc: Current concepts in diagnosis and management. Texas J. med. 61: 482, 1965.
- Henderson, R. S.: The treatment of lumbar intervertebral disc protrusion. An assessment of conservative measures. Brit. med. J. 2: 597, 1952.
- Hirsch, C.: On lumbar facetectomies. Acta orthop. scand. 17: 240, 1947.
- Hirsch, C.: An attempt to diagnose the level of a disc lesion clinically by disc puncture. Acta orthop. scand. 18: 132, 1948.
- Hirsch, C.: The clinical evaluation of sciatica. Acta orthop. scand. 27: 210, 1958.
- Hirsch, C.: Studies on the pathology of low back pain. J. Bone Jt. Surg. 41-B: 237, 1959.
- Hirsch, C.: Efficiency of surgery in low back disorders. Patoanatomical, experimental and clinical studies. J. Bone Jt. Surg. 47-A: 991, 1965.
- Hirsch, C.: Personal communication, 1969.
- Hirsch, C., Ingelmark, B.-E. & Miller, M.: The anatomical basis for low back pain. Acta orthop. scand. 33: 1, 1963.
- Hirsch, C., Jonsson, B., & Lewin, T.: Low back symptoms in a swedish female population. Clin. Orthop. 63: 171, 1969.
- Hirsch, C. & Nachemson, A.: The reliability of lumbar disc surgery. Clin. Orthop. 29: 189, 1963.
- Hirsch, C., Rosencrantz, M. & Wickbom, I.: Lumbar myelography with water-soluble contrast media, with special reference to the appearances of root pockets. Acta radiol. 8: 54, 1969.
- Hirsch, C. & Schajowicz, F.: Studies on structural changes in the lumbar anulus fibrosus. Acta orthop. scand. 22: 184, 1953.
- Horal, J.: The clinical appearance of low back disorders in the city of Gothenburg, Sweden. Acta orthop. scand. Suppl. 118, 1969.
- Hult, L.: Cervikal, dorsal and lumbar spinal syndromes. Acta orthop. scand. Suppl. 17, 1954.
- Hult, L.: The Munkfors investigation. Acta orthop. scand. Suppl. 16, 1954.
- Kallio, E. & Törmä, T.: Late follow up of lumbar disc surgery without fusion. J. Int. Coll. Surg. 44: 191, 1965.
- Keegan, J. J.: Dermatome hypalgesia associated with herniation of intervertebral disc. Arch. Neurol. Psychiat. 50: 67, 1943.

- Kehrer, H. & Kirschek, J.: Vergleichende Betrachtung der Erfolge bei konservativer und operativer Behandlung des Ischias. *Neue med. Welt*, 1: 1010, 1950.
- Kelly, M.: Is pain due to pressure on nerves? *Neurology* 6: 32, 1956.
- Kirstein, L.: An after-examination of operated and non-operated cases with clinical symptoms of herniated disc. *Acta. med. scand.* 120: 93, 1945.
- Knutsson, B.: Comparative value of electromyographic, myelographic and clinical—neurological examination in diagnosis of lumbar root compression syndrome. *Acta orthop. scand. Suppl.* 49, 1961.
- Knutsson, B.: How often do the neurological signs disappear after the operation of a herniated disc? *Acta orthop. scand.* 32: 352, 1962.
- Knutsson, B. & Wiberg, G.: On surgically treated herniated intervertebral discs. *Acta orthop. scand.* 28: 108, 1958.
- Knutsson, F.: Lumbar myelography with water-soluble contrast in cases of disc prolapse. *Acta orthop. scand.* 20: 294, 1950/51.
- Kocher, T.: Die Verletzungen der Wirbelsäule als Beitrag zur Physiologie des menschlichen Rückenmarks. *Mitt. Grenzgeb. Med. Chir.* 1: 415, 1896.
- Korhonen, A. & Nummi, P.: Symptoms and late results in operated and unoperated cases of lumbar disc herniation. *Duodecim* 68: 328, 1952.
- Kristiansen, K.: Lumbale skiveprolaps: Symptomatologi og indikationer för kirurgisk behandling. *Nord. med.* 67: 73, 1962.
- Kuhns, J. G.: Conservative treatment of sciatic pain in low back disability. *J. Bone Jt. Surg.* 23: 435, 1941.
- Lansche, W. E. & Ford, L. T.: Correlation of the myelogram with clinical and operative findings in lumbar disc lesions. *J. Bone Jt. Surg.* 42-A: 193, 1960.
- Lasègue, C.: Considerations sur la sciaticque. *Arch. gén. méd.* 2: 558, 1864.
- Lenhard, R. E.: End-result study of the intervertebral disc. *J. Bone Jt. Surg.* 29: 425, 1947.
- Lindahl, O.: Om ischiassjukdomens patogenes. *Svensk Läk.-tidn.* 51: 2389, 1947.
- Lindahl, O.: Hyperalgesia of the lumbar nerve-roots in sciatica. *Acta orthop. scand.* 37: 367, 1966.
- Lindahl, O. & Rexed, B.: Histologic changes in spinal nerve-roots of operated cases of sciatica. *Acta orthop. scand.* 20: 215, 1951.
- Lindblom, K.: Lumbala diskprolaps vid foramina intervertebralia. *Nord. med.* 16: 3597, 1942.
- Lindblom, K.: Lumbar myelography by Abrodil. *Acta radiol.* 27: 1, 1946.
- Lindblom, K.: Diagnostic puncture of discs in sciatica. *Acta orthop. scand.* 17: 231, 1948.
- Lindgren, S.: Some problems concerning the herniated intervertebral disc from a clinical point of view. *Acta chir. scand.* 98: 295, 1949.
- Lortat-Jacob, L. & Sabarèanu, G.: Sciatique radiculaire unilatérale. *Presse. méd.* 2: 633, 1904.
- Love, J. G.: Low back and sciatic pain. *Surg. clin. North Am.* 19: 943, 1939.
- Love, J. G.: The low back pain with or without sciatica. *J. Bone Jt. Surg.* 29: 438, 1947.
- Love, J. G. & Camp, J. D.: Root pain resulting from intraspinal protrusion of intervertebral discs: Diagnosis and surgical treatment. *J. Bone Jt. Surg.* 19: 776, 1937.

- Love, L. G. & Walsh, M. M.: Intraspinous protrusion of intervertebral discs. *Arch. surg.* 40: 454, 1940.
- Love, J. G. & Walsh, M. M.: Protruded intervertebral discs. *Surg. Gyn. Obstet.* 77: 497, 1943.
- Luschka, H.: Die Halbgelenke des menschlichen Körpers. Georg Reimer, Berlin 1858.
- Malmros, R.: Den lumbale diskusprolaps og ligamentaere rodskompression. Munksgaard, København 1942.
- Mensor, M. C.: Non-operative treatment, including manipulation for lumbar intervertebral disc syndrome. *J. Bone Jt. Surg.* 37-A: 925, 1955.
- Mercer, W. & Duthie, R. B.: *Orthopaedic surgery*, 6th ed. Arnold, London, 1964.
- Middleton, G. S. & Teacher, J. H.: Injury of the spinal cord due to rupture of an intervertebral disc during muscular effort. *Glasgow med. J.* 76: 1, 1911.
- Millikan, C. H.: The problem of evaluating treatment of protruded lumbar intervertebral disc. Observations of results of conservative and surgical treatment in 429 cases. *J. A. M. A.* 155: 1141, 1954.
- Mixter, W. J.: Rupture of the lumbar intervertebral disc: an etiological factor for so-called "sciatic" pain. *Ann. Surg.* 106: 777, 1937.
- Mixter, W. J.: Rupture of the intervertebral disc. *J. A. M. A.* 140: 278, 1949.
- Mixter, W. J. & Barr, J. S.: Rupture of the intervertebral disc with involvement of the spinal canal. *New Engl. J. Med.* 211: 210, 1934.
- Nachemson, A.: Intradiscal measurements of pH in patients with lumbar rhizopathies. *Acta orthop. scand.* 40: 23, 1969.
- Nordlander, S., Salén, E. & Unander-Scharin, L.: Discography in low back pain and sciatica. *Acta orthop. scand.* 28: 90, 1958.
- Norlén, G.: On the value of the neurological symptoms in sciatica for the localization of a lumbar disc herniation. *Acta Chir. Scand. Suppl.* 95, 1944.
- Ober, F. R.: The role of the iliotibial band and fascia lata as a factor in the causation of low back disabilities and sciatica. *J. Bone Jt. Surg.* 18: 105, 1936.
- O'Connell, J. E. A.: Protrusions of the lumbar intervertebral discs. A clinical revision based on 500 cases treated by excisions of the protrusion. *J. Bone Jt. Surg.* 33-B: 8, 1951.
- de Palma, A. F. & Gillespie, T.: Long-term results of herniated nucleus pulposus treated by excision of the disc only. *Clin. Orthop.* 22: 139, 1962.
- Pouyanne, M. L.: Résultat du traitement chirurgical des lombo-sciatiques. 5:e Congrès Int. Chir. Orthop. Stockholm 1951: 148, 1951.
- Puusepp, L.: Kompression der Cauda equina durch das verdichtete Ligamentum flavum. Tumorsymptome. Operation. Heilung. *Fol. Neuropath. Eston.* 12: 38, 1932.
- Raaf, J.: Some observations regarding 905 patients operated upon for protruded lumbar intervertebral disc. *Am. J. Surg.* 97: 388, 1959.
- Reynolds, F. C., McGinnis, A. E., & Morgan, H. C.: Surgery in the treatment of low back pain and sciatica. *J. Bone Jt. Surg.* 41-A: 223, 1959.
- Rolander, S. D.: Motion of the lumbar spine with special reference to the stabilizing effect of posterior fusion. *Acta orthop. scand. Suppl.* 90, 1966.
- Ross, P. & Jelsma, F.: Post-operative analysis of herniated lumbar discs. *Am. J. Surg.* 84: 657, 1952.
- Rövig, G.: Rupture of lumbar discs with intraspinal protrusion of the nucleus pulposus. *Acta chir. scand. Suppl.* 144, 1949.

- Sahlgren, E.: Nyare synpunkter på lumbago-ischias problemet. Nord. med. 29: 505, 1946.
- Saunders, J. B. & Inman, V. T.: Pathology of the intervertebral disc. Arch. surg. 40: 389, 1940.
- Schmorl, G.: Über die an den Wirbelbandscheiben vorkommenden Ausdehnungs- und Zerreibungsvorgänge und die dadurch an ihnen und der Wirbelspongiosa hervorgerufenen Veränderungen. Verhandl. deutsch. path. Gesellsch. 22: 250, 1927.
- Semmes, R. E.: Ruptures of the lumbar intervertebral disc: Their mechanism, diagnosis and treatment. Springfield Ill. Charles C. Thomas, 1964.
- Senning, Å. & Sjöqvist, O.: Senresultaten vid diskbräck. En efterundersökning av 400 opererade fall. Nord. med. 34: 1128, 1947.
- Shinners, B. M. & Hamby, W. B.: Protruded lumbar intervertebral disc results following surgical and non-surgical therapy. J. neurosurg. 6: 450, 1949.
- Sjöqvist, O.: Contribution to discussion. Nord. med. 29: 509, 1946.
- Smith, L. & Brown, J. E.: Treatment of lumbar intervertebral disc lesions by direct injection of chymopapain. J. Bone Jt. Surg. 49-B: 502, 1967.
- Sparup, K. H.: Late prognosis in lumbar disc herniation. Acta rheum. scand. Suppl. 3, 1960.
- Sternberg: Quoted by Norlén.
- Stoddard, A.: Manipulative procedures in the treatment of intervertebral disc lesions Brit. J. Phys. Med. 14: 101, 1951.
- Ståhl, F.: Clinical diagnosis of lumbar disc herniations. Acta orthop. scand. 18: 141, 1949.
- Söderberg, L.: Prognosis in conservatively treated sciatica. Acta orthop. scand. Suppl. 21, 1956.
- Söderberg, L. & Sjöberg, S.: On operated herniated lumbar discs. Acta orthop. scand. 31: 146, 1961.
- Uihlein, A., Kenefich, T. P. & Holman, C. B.: Neurological changes, surgical treatment and postoperative evaluation. J. Bone Jt. Surg. 50-A: 182, 1968.
- Unander-Scharin, L.: On low back pain with special reference to the value of operative treatment with fusion. Acta orthop. scand. Suppl. 5, 1950.
- Waris, W.: Lumbar disc herniation. Clinical studies and late results of 374 cases of sciatica. Acta chir. scand. Suppl. 140, 1948.
- White, J. C.: Results in surgical treatment of herniated lumbar intervertebral discs. Investigation of late results in subjects with and without spinal fusion. Clin. neurosurg. 13: 42, 1966.
- Young, H. H. & Walsh, A. C.: Combined operation for low back and sciatic pain Follow-up study. Collect. papers Mayo clinic and Mayo Foundation (1947) 39: 475, 1948.
- Young, R. H.: Protrusion of intervertebral discs. Proc. Roy. Soc. Med. 40: 233, 1947.
- Young, R. H.: Observations on the results of operation for low back pain and sciatica. Soc. Int. Chir. Orthop., Stockholm, 1951.
- Ytrehus, Ö.: Prognosis in medically treated sciatica. Acta med. scand. 128: 452, 1947.
- Östberg, O.: Some aspects of the treatment of sciatica. Acta med. scand. Suppl. 246, 1950.
- Östergaard Jensen, O. & Lund, M.: Prognosen ved lumbago-ischias. Ugeskr. laeger, 117: 67, 1955.