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INDICATIONS FOR SPINAL FUSION IMMEDIATELY FOLLOWING REMOVAL OF PROTRUDED NUCLEUS PULPOSUS

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When in the late thirties–after the fundamental publication of *Mixter & Barr* in 1934–the surgical treatment of disc protrusion became general, the majority of surgeons and patients were unanimous in the opinion that the removal of the protruded piece of disc gave satisfactory results.

However, the clinical entity of lumbago-sciatica is not 100 per cent equal to the pathological entity of disc protrusion, and a discussion on principal questions concerning the surgical treatment of disc lesions is still going on.

In this paper I shall give an account of my studies of one point only, viz, the question of primary fusion of the diseased part of the spine immediately following the removal of the protrusion.

The discussion on this problem was started in 1941 by *Barr & Mixter* who maintain, that there is a place for spine fusion at the time of laminectomy in perhaps 20 to 30 per cent of the cases of disc protrusion. These authors presume, that the pathological changes in the disc continue after removal of the protrusion, and that the stabilizing effect of immediate fusion will reduce the risk of recurrence and of persistent disabling back-ache. This view has found many supporters.

Later, comparison of groups of cases with and without primary fusion was published by *Ghormly, Love & Young* in 1942, and by *Smith, Deery & Hagman* in 1944. These investigations indicate a greater percentage of good results by the combined method than by simple excision.

The research of *Rövig* goes in the same direction. *Rövig* has performed simple excision in 53 cases out of a series of 100 patients and the combined operation in 47 cases. Comparison of the two series

shows that the late results are better in the group of combined operation than in the group of simple excision.

At the International Congress of Orthopedic and Traumatic Surgery held in Stockholm in the spring of 1951 the problem of disc protrusion was one of the main subjects. *Barr* opened the symposium. In a great number of operations he has performed fusion in 33 per cent and simple excision in 67 per cent. The late results as far as the sciatic pain was concerned were about the same, and very satisfactory in both groups, while back symptoms were relieved in 64 per cent of patients subjected to simple excision and in 80 per cent of patients subjected to the combined operation.

The second speaker *Young* (Cambridge) only exceptionally performs fusion; in only 24 of 717 followed-up cases was primary fusion performed (besides 28 for spondylolisthesis), Young records 56 per cent good results, 16 per cent satisfactory, 20 per cent improved and 7 per cent failures.

The third speaker *Pouyanne* (Bordeaux) performs fusion on about 10 per cent of his patients; the great majority of French surgeons only exceptionally carry out the combined operation.

The primary fusion had few advocates at this congress.

The opinion of the American surgeons is divided. *Grant, Spurling & Grantham* and *Lenhard* consider fusion unnecessary, *Caldwell & Sheppard* concluded in 1948: "There are no criteria for spine fusion following removal of a protruded nucleus pulposus".

In the Mayo clinic the combined operation is now performed in about one-third of the cases, (*Young & Walsh*).

I should like to say a few words on the outlook of patients with disc protrusion, who have been subjected to medico-physical treatment only. I have only found two such publications–one by *Kirstein* in 1945 and one by *Colonna & Friedenberg* in 1948. In both publications the clinical diagnosis of protruded disc is supported by myelography with positive findings–in Kirstein's series–it is true only with oxygen in 42 of 49 cases. Half the number of Kirstein's patients were operated upon, and both groups were followed-up for half a year to three years. Of the 24 patients not operated on, 37 per cent had been relieved of their radicular pain, against 72 per cent of the operative cases.

Colonna & Friedenberg have followed-up 28 patients with lumbago sciatica and a radiologically visible defect in the oil contrast medium due to disc protrusion. After medico-physical treatment the patients were followed-up from 1 to 8 years. 29 per cent of these patients had no pain for more than one year, 39 per cent had some pain, whereas 32 per cent were more or less disabled due to continuous or recurrent

pain. If a protrusion reaches a size sufficient for it to be visible in the myelogram, *Colonna* has the impression that the outlook for the patient is poor, unless he is operated on.

These investigations, however, give no answer to a question of some importance: Is it possible that nuclear tissue, protruded through the annulus fibrosus to the spinal canal, can return to its home in the disc? Is the protrusion in this respect similar to a hernia, so that it can protrude and return? And to what extent can medico-physical treatment contribute to such a retraction? Some authors give this possibility serious consideration. *Burns & Young* believe, that the protrusion may be reduced as a result of anesthesia and suitable positioning. Sometimes it will reappear if the patients cough.

Pouyanne considers the reduction of the nuclear hernia a probability, and gives this as the explanation of the possible absence of the hernia at an operative exploration.

However, as far as I have been able to observe, there is until now no record of a safely and myelographically diagnosed disc protrusion having disappeared in the myelogram as a result of medico-physical treatment. Thus, until further evidence is produced, we are hardly entitled to count on this possibility. The cure of the clinical symptoms by medico-physical procedures is established by other mechanisms.

At the Surgical Department B of the University Hospital of Oslo, we–I and my assistants–of whom I will mention *Lange* and *Homb,* for a period of eight years (from 1942 to 1950) have operated on 100 patients with back-ache and sciatica by removal of a disc protrusion or an arthrotic lip,–of the latter there have been 11 cases. The indications for operation have been rather severe. There is unanimity on the point that protracted, repeated medico-physical treatment is necessary in all patients with lumbago sciatica. The results of *Colonna,* who obtained cures in about 30 per cent of medically treated patients, cured for more than one year, probably corresponds to the average clinical experience.

The great majority of our patients have an invalidity of long duration in their history, the longest is 20 years. 37 patients have had symptoms for more than 4 years, 59 patients for more than 2 years, 78 patients for more than 1 year.

The great majority of patients had been subjected to protracted medico-physical treatment, many to X-ray irradiation,–only one patient had not received such treatment. He was a considerably disabled youth, who had a myelographically visible protrusion.

I have the impression that medico-physical treatment has a better

and safer effect in elderly patients than in young. *Time* also works differently and more efficiently in elderly patients than in young adults.

For the past 3–4 years we have used *myelography* (with abrodil) as a routine method and have been satisfied with this means of localizing the lesion. Abrodil reveals details of the spinal roots which cannot be brought to light by lipiodol, and in my opinion there is no doubt that the Swedish resorbable abrodil is preferable to any oil contrast medium.

A report of our results was given in The Norwegian Surgical Society one year ago by *Lange*.

Even a successful myelography, however, does not reveal every protrusion; the lateral protrusions may escape discovery, and in a few cases we have removed a protrusion supported by the clinical diagnosis alone.

In this series of 100 patients we have no deaths, but some complications: 3 patients had a hematoma in the wound and 3 others a temporary wound infection. 3 patients, subjected to combined operation, developed ureteral calculus. Thrombosis and possibly an embolus occurred in two cases out of 21 fused patients and in 3 cases out of 79 without fusion. One patient had parotitis, one had to be operated on for intestinal obstruction. One patient had postoperative paraparesis, probably due to postoperative hemorrhage. She was completely cured after a few months. Another patient has a persistent paresis of the 5th lumbar root. The other complications have left no sequels.

The age of the patients has varied between 17 years (one case) and 64 years (two cases), the majority being between 30 and 50 years of age.

We have precise data concerning the *occupation of every patient*, viz.: 36 heavy workers (labourers, farmers, sailors), 24 housewives, and 40 who had various occupations, such as office workers, chauffeurs, salesmen, factory workers, nurses, and so forth.

In the case histories there is evidence of definite traumatism as origin of the symptoms in 30 cases.

Operations have been performed under general anesthesia after removal of the yellow ligament through a small arcotomy. From each of the 2nd and 3rd lumbar discs a protrusion was removed once, at the level of the 5th lumbar disc the root was decompressed in 55 cases, and in the remainder at the 4th lumbar disc.

A *primary fusion* was performed in 21 cases by means of a tibial transplant, or–for the past two-three years–mostly by means of a piece of the iliac crest on either side of the spinous processes.

The *indications* for this fusion have been formulated with some hesitation–at least in the beginning. But I have tried an individual selection, and have arrived at the following indications, mainly based on the radiograms in each separate case[1]:

1. Predominating back pain and manifest spondylarthrosis.
2. Narrowing of more than one disc space.
3. Retroposition of a vertebra.
4. Cases where the inferior articular process had to be partially resected (in some lateral protrusions).

I believe I have found a *fifth indication* by the study of this material, and I shall return to this in the following.

In the spring of 1951 all 100 patients were followed-up and received a questionnaire, to which every one of them responded. They were asked about relief or presence of pain in the leg and in the back, about their ability to work, whether they resumed the work they had before the onset of the illness, and about their income.

The answers to the questionnaire were satisfactory as a means of judging the results of the surgical treatment.

Moreover, I have personally examined 79 of the 100 patients, and if not all of them have been subjected to such a personal examination, it is due to the wide distances from the hospital to the homes of these patients, many of them living several days' journey from Oslo.

Comparing the results of the objective examination of 79 patients with the impression we obtain from the written replies of these 79 individuals, there is very good correspondence between them. This goes far to show, that the written responses are reliable on the whole.

The *observation time varies between* more than one year and more than eight years. All patients have been followed-up for more than one year, 77 for more than two years, 62 for more than three years, and 38 for more than four years.

98 of 100 patients have resumed work–at least temporarily–whereas two patients have not been able to work at all. I shall deal with them below.

We are now concerned with the *late results* in the two groups, one group of 21 patients who have been fused, and one group of 79 patients who have been subjected to simple excision; of the 21 fused patients I have personally re-examined 13, and of the non-fused 79 I have personally re-examined 66 patients.

[1] Cases of Spondylolisthesis are always fused–as a matter of course; in this series we have no such case.

The two patients who have been unable to resume work after the operation, belong to the group of fusion. One of them, a man aged 64 years, was operated on 8 years ago, and after the operation his sciatic pain in the right leg was relieved. However, for some time before the operation his right foot had been cold, and X-ray examination revealed arteriosclerotic deposits in the arteries of the foot. In 1948 he returned to the hospital for examination. He had no sciatic pain, no back-ache, but disabling pain in his cold right foot. Shortly afterwards he was the victim of a severe trauma to his back in an automobile accident, and one year ago one toe of his right foot was amputated for arteriosclerotic gangrene.

The second patient, a woman, improved owing to the combined operation, but after a severe trauma–fall on the seat–she got recurrent pain in the back and the leg. X-ray examination demonstrated serious structural changes of the body of the 5th lumbar vertebra of uncertain etiology, which were suspected by radiologists as being of inflammatory origin–a traumatic etiology not being excluded. However, she is at present in the hospital, having been reoperated on, and the root having been decompressed by removal of cicatricial tissue. She is now improving.

In the group of fusion we have also three patients who occasionally feel slight discomfort from their back, but they are very happy about the operation, and are able to carry out the work that they had before the onset of the illness. This also applies to the remaining 16 patients of the group, who are without any symptoms at all. (Table I).

TABLE I
With Spinal Fusion, 21 Patients.

Unable to work (complicated cases, traumata)	2
Able to work, slight discomfort from back	3
Completely free from symptoms	16
	21

The results in the group of 79 patients treated by *simple excision* may best be studied in the table. (Table II).

23 patients are completely free from symptoms. 18 may sometimes feel slight discomfort from back or leg, but they are fully able to work. That makes 41 patients out of 79 with excellent or satisfactory results.

Next we have 24 patients who are working well, but who have occasional back-ache or pain in the leg, temporarily disabling, for instance a housewife washing clothes feels tired in her back after a while, and must stop washing to rest for half an hour.

TABLE II

Without primary fusion, 79 patients.

66 out of 79 (83.5 %) Working in previous occupation	Well, no symptoms	23	41 of 79 (50 %)
	Occasional insignificant discomfort from back (and a few from leg)	18	
	Occasional back-ache or pain in leg, temporarily disabling	24	
	Sciatica, clinical recurrence of protrusion	1	
	Disabling pain in back and leg, presently out of work	1	
	Slight discomfort from back or leg, working in changed occupation	5	
	Recurrent back-ache, sec. fusion	4	
	Recurrence of protrusion removal, sec. fusion	3	
		79	

One patient has clinically a recurrent protrusion but is working in his office and has declined reoperation.

Among the 79 patients five are working, but have changed their occupation, and finally, in the group of 79 cases we have 7 who have been reoperated on and have had a *secondary fusion;* in three of them a recurrent protrusion was excised–two in the same disc as before and one in another disc; and in 4 patients the secondary fusion was necessitated by disabling back-ache.

By comparison of the results in these two groups, the one of which is four times the size of the other, we find a distinct difference in the ratio of symptom-free patients. This is better in the group of fusion than in the group of simple excision; the two failures in the group of fusion are such complicated cases, arteriosclerotic gangrene in one case and repeated severe traumata in the other, that they should probably be left out of consideration.

The seven cases of secondary fusion in this material–three after removal of recurrent protrusion and four due to persistent back-ache–are evidence that we have not fused primarily in an unduly great number of our patients; on the contrary–the primary fusion in my opinion ought to be applied in more than 21 per cent of patients who have been treated surgically.

It is of interest to examine a little more closely the four patients who have had secondary fusion because of persistent, disabling back-ache–in order to determine whether they have any other characteristic in common. In fact, they have in common that the protrusion has

been removed from the 4th lumbar disc in all four cases. This is worth attention. In the 79 patients, who were not fused primarily, the 5th lumbar disc was the site of origin of the protrusion in a greater ratio than the 4th disc, 45 patients out of 79 having a protrusion from the 5th disc against 32 from the 4th disc. It is reasonable to assume, that the constant presence of an operated 4th disc among the disabled and secondarily fused backs, and the relatively stronger representation of anl operated 5th disc among the symptom-free patients, are not accidental, but probably mean that the outlook *for the back is poorer after removal of the protrusion from the 4th lumbar disc than from the 5th lumbar disc.*

In examining the other end of the group of non-fusion, that is, the 23 patients who are completely free from symptoms after the operation, we find that 7 of the 23 patients had a protrusion from the 4th disc and 16 from the 5th disc, and also that in this group the outlook is better for protrusion from the 5th, than from the 4th disc[1]. (Table III).

TABLE III

In 79 patients, simple excision.

From 4th lumbar disc protrusion removed in 32 cases
„ 5th „ „ „ „ „ 45 „

Of 79 patients, simple excision, 23 are free from symptoms
Of the 23 patients 7 had protrusion from 4th lumbar disc
„ „ „ „ 16 „ „ „ 5th „ „

Free from symptoms after operation on 4th disc 7: 32 ($< \frac{1}{4}$)
„ „ „ „ „ „ 5th „ 16: 45 ($> \frac{1}{3}$)

It is improbable that many surgeons today will utilize the primary fusion in every patient operated on for protrusion. The simple excision will relieve the sciatic pain in the great majority of cases, and the late results, taking into account the back as well, may be excellent or satisfactory in 40–50 per cent. If all patients were fused, the procedure would be an additional and unnecessary one for about half of them.

The selection of cases for primary fusion must be attempted, if we want to limit our intervention to the strictest necessary.

This follow-up examination has given us confidence in the four indications for primary fusion already stated. Our secondary fusions prove that we have not given to the primary fusion a sufficiently wide application. A protrusion removed from the 4th lumbar disc leaves the

[1] Poyanne, who has operated on 10 recurrences out of 480 observations, stresses the predominance of the 4th lumbar disc in the recurrences (8 out of 10).

back with more precarious stability than the operation on the 5th disc. It is therefore specially in patients with a diseased 4th lumbar disc that the primary fusion should be given further application.

SUMMARY AND CONCLUSIONS

In a follow-up study of 100 patients, subjected to operation for protruded disc in the lumbar region, all concerned have responded to a questionnaire. Moreover, 79 patients have been personally re-examined by the author.

Observation time varies between more than one year and more than eight years.

79 patients have been subjected to simple excision, 21 have also been treated with immediate fusion.

We have attempted an individual selection for primary fusion.

The follow-up examination gives better results in the group of fusion than in the group of simple excision. In this latter group there are three cases of recurrent protrusion (reoperated and subjected to secondary fusion). Further, four patients have had a secondary fusion, due to persistent, disabling back-ache. All these four had their protrusion removed from the 4th lumbar disc.

An operation for disc protrusion must be supposed to leave the back with a more precarious stability, if the origin of the protrusion has been the 4th lumbar disc, than if it has been removed from the 5th lumbar disc.

In giving the primary fusion further extension, we should specially keep in view cases of protrusion from the 4th lumbar disc.

RESUME

L'auteur rend compte de 100 observations de malades ayant subi une intervention chirurgicale pour hernie discale de la région lombaire. Tous les opérés ont répondu à un questionnaire.

79 de ces opérés ont été ensuite réexaminés par l'auteur.

La période d'observation varie entre un peu plus d'une année et 8 ans.

79 malades ont subi une simple excision de la hernie, tandis qu'une greffe fixatrice complémentaire a été posée chez 21 malades.

Dans les indications pour cette fixation primaire et préventive, nous avons essayé de procéder par selection individuelle.

Les résultats tardifs sont meilleurs pour le groupe des malades fixés, que pour ceux à simple excision.

Dans ce dernier groupe, il y a eu 3 cas de récidive, l'un pour le même disque, et deux pour un autre que celui opéré en premier lieu; ces trois cas de récidives ont été réopérés et ont subi alors une fixation secondaire.

Des lombalgies persistantes et rebelles ont exigé une fixation secondaire chez 4 malades du groupe des simples excisés, chez tous lesquels, la hernie avait été enlevé — lors de la première intervention — du 4ème disque lombaire.

Si nous désirons donner à la fixation primaire une application plus étendue — et l'auteur est d'avis, qu'il faut le faire, — c'est surtout aux malades, porteurs de hernie du 4ème disque lombaire qu'il faut l'appliquer.

ZUSAMMENFASSUNG

Der Verfasser berichtet über 100 Patienten, die wegen Nucleusprolaps operiert worden sind. Sie haben alle einem Fragebogen geantwortet.

Überaus sind 79 von diesen Patienten vom Verfasser persönlich untersucht worden.

Die Observationszeit variiert von einem Bischen mehr als 1 Jahr bis 8 Jahren.

In 79 Patienten bestand die Operation in einfacher Excision des Prolapses, in 21 Patienten ist überaus eine Fixation ausgeführt.

In unseren Indikationen haben wir für diese Fixation eine individualisierende Auswahl ersucht.

Die Spätresultate sind besser für die Gruppe der Fixierten als für die einfach Excidierte. In der letzernannten Gruppe finden sich 3 Recidivkranke — von denen 1 sein Recidiv aus derselben Scheibe und 2 mit Recidiv aus einer anderen Scheibe als die erst operierte. Diese 3 Recidivkranke sind reoperiert und jetzt auch sekundär fixiert worden.

In 4 Fällen aus der Gruppe der einfach Excidierten haben fortfahrende invalidierende Rückschmerzen eine sekundäre Fixation erfordert; und — was Aufmerksamkeit verdient — in allen diesen 4 Kranken war der Nucleusprolaps aus der 4ten Lumbalknorpelscheibe entfernt worden.

Die Stabilität des Rückgrats ist vermutlich mehr verstört durch einen Nucleusprolaps aus der 4ten als aus der 5ten Lumbalscheibe.

Wenn wir der primären Fixation eine weitere Applikation geben wollen, muss dabei den Kranken besondere Aufmerksamkeit gewidmet werden, in welchem der Nucleusprolaps zur 4ten Lumbalscheibe gehört.

REFERENCES

Mixter, W. J. & Barr, J. S.: Rupture of the intervertebral disc with involvement of the spinal canal. New Engl. J. Med. Vol. 211, 1934, P. 210.

Barr, J. S. & Mixter, W. J.: Posterior protrusion of the lumbar intervertebral discs. J. Bone & Joint Surg. Vol. 33, April 1941, P. 444.

Ghormly, R. K., Love, J. G. & Young, H. H.: The combined operation in low back and sciatic pain. J.A.M.A. Vol. 120, 1942, P. 1171.

Smith, A. Def., Deery, E. M. & Hagmann, G. L.: Herniation of the nucleus pulposus. J. Bone & Joint Surg. Vol. 26-A, 1944, P. 821.

Rövig, G.: Rupture of lumbar discs with intraspinal protrusion of the nucleus pulposus. Acta Chir. Scand. 1944, Supplem. 144.

Barr, J. S.: Low back and sciatic pain. Results of treatment. J. Bone & Joint Surg. Vol. 33-A, July 51, P. 633.

Burns, B. H. & Young, R. H.: Results of surgery in sciatic and low back pain. Lancet. Vol. 260, No. 6649, Febr. 1951, P. 245.

Grant, C. G. et al.: Association of neurologic, orthopedic & röntgenographic findings in displaced intervertebral discs. Surg. Gyn. & Obstetr. Vol. 87, No. 5, Novbr. 1948, P. 561.

Spurling, R. G. & Grantham, E. G.: Endresults of surgery for ruptured lumbar intervertebral discs. Journ. of Neurosurg. Vol. 6, No. I, P. 57.

Lenhard, R. E.: Endresult study of the intervertebral disc. J. Bone & Joint Surg. Vol. 29, 1947, P. 425.

Caldwell, G. A. & Sheppard, W. B.: Criteria for spinal fusion following removal of protruded nucleus pulposus. J. Bone & Joint Surg. 30-A, Oct. 1948, P. 911.

Young, H. H. & Walsh, A. C.: Combined operation for low back and sciatic pain. Collected Papers, Mayo Clinic 1948, Vol. 39, P. 475.

Kirstein, L.: An after examination of operated and non-operated cases with surgical symptoms of herniated discs. Acta Med. Scand. Vol. 120, 1945, P. 93.

Colonna, P. C. & Friedenberg, Z. B.: The disc syndrom. The results of the conservative care of patients with positive myelogram. J. Bone & Joint Surg. Vol. 31-A, July 1949, P. 614.

Poyanne, M. L.: Lumbo-sciatalgie. Résultats du traitement. International Congress of Orthopedic & Traumatic Surg. Stockholm, 1951.

Lange, J. & Ödegaard, H.: Abrodil myelography in herniated disc in the lumbar region. Radiology, Vol. 57, 1951, P. 186.