

From the Orthopaedic Hospital, Copenhagen, Dept. 1 and 2 (Heads: A. Bertelsen and Hj. Larsen) and Dept. of Radiology (Head: M. Schalimtzek).

COMPARATIVE STUDY  
OF MYELOGRAPHIC FILLING DEFECTS  
IN ROOT SHEATHS AND OPERATIVE FINDINGS IN  
CASES OF SUSPECTED LUMBAR  
INTERVERTEBRAL DISC HERNIATION

By

K. SKOU ANDERSEN & OTTO SNEPPEN

Received 8.iii.67

In 1931 *Arnell & Lidström* introduced the water soluble contrast medium Abrodil in myelography. However, the new method did not acquire practical significance until about 15 years later, when *Arnell* (1944, 1948) and *Lindblom* (1946) had worked out a technique by which they demonstrated the numerous advantages of the method and reduced its untoward side effects to an acceptable minimum.

In Scandinavia, and later in several European centres, myelography using water-soluble contrast medium thereafter became the routine method for visualizing the lower part of the dural sac and the cauda equina. Therefore, this form of myelography may now be assessed on the basis of a fairly comprehensive material (*Levison* 1947, *Johanson* 1950 *Knutsson* 1951, *Andresen* 1953, *del Buono* 1957, *Schalimtzek* 1958, *Kolstad & Solem* 1959, *Amundsen et al.* 1963).

One of the main advantages of water-soluble contrast medium above the previously used iodized oils is that it clearly visualizes the root sheaths, thus facilitating a myelographic diagnosis of lateral disc herniations.

*Arnell* (1948) and *Lindblom* (1948) have studied the anatomical background of the myelographic picture of the root sheaths. They found the subarachnoid space of the root sheaths to vary widely in shape and extent from patient to patient, and in each individual case there might be a certain asymmetry without amounting to morbid changes. Accordingly, the normal myelographic appearances of the root sheaths may

vary within wide limits, and deficient of a root sheath need not necessarily mean a morbid condition in or around the nerve root concerned.

Where a filling defect in the root sheath represents not only a congenital variation in development, but a morbid condition, there are various aetiological possibilities, *viz.* disc herniation, spondylosis, spondylolisthesis, scar changes following previous operations, sequelae of arachnoiditis, tumours, or sequelae left by fractures of the spine (*Knutsson 1947, Arnell 1948, del Buono 1957, Walk 1958, Kolstad & Solem 1959, Cronqvist 1959*).

In many cases a straight X-ray film of the spine, supplemented by myelographic examination, will afford sufficient differential diagnostic certainty, so that the nature and site of the disease may be deduced from a comparison of the radiological and clinical findings. But often a filling defect in a root sheath is the main, or at times the only radiographic finding.

In the, by now comprehensive, literature on myelography using water-soluble contrast medium, there does not seem to have been any analysis of the diagnostic significance of the deficient root sheath filling on the basis of a clinical material. Accordingly, we felt that it would be of interest to investigate, by comparing the myelographic root sheath appearances with the findings at operation in a group of patients with presumed disc herniations, why the filling of the root sheath was deficient.

#### MATERIAL

During the period January 1959 to April 1966 748 myelographies were done in the Orthopaedic Hospital, Copenhagen, on patients whose clinical symptoms and signs indicated disc herniations of one or more of the 3 caudal lumbar discs.

The myelographies were carried out by the technique of *Levison (1947)*. The contrast medium used was 20 per cent Conturex (*syn. Myelotrast, Skiodan*) (methiodole sodium).

The classification of the cases was based upon the reports of the radiologist and the surgeon in the case sheets.

As far as the myelographic appearances of the root sheath are concerned, a distinction will be made between 2 forms of filling defect, *viz.* faint filling and shortening. The assessment of the intensity of the contrast as well as of the length of the root sheath was based upon comparison with the symmetrical root sheath. Where a faintly filled root sheath was also shortened, the case was assigned to the shortened group.

Analysis of the 748 myelographies disclosed 229 cases in which a filling defect in a root sheath had been described and in which the nerve root concerned had been inspected at subsequent operation. These 229 cases make up the present material.

Cases in which the filling defect was doubtful or in which it might have been due to technical reasons were excluded.

All the patients had undergone operation because of a suspicion of disc herniation, and in all the myelogram and the clinical findings were in agreement, in so far as the surgeons found in all cases indication for laminectomy or hemilaminectomy in order to inspect the root corresponding to the deficiently filled root sheath. In other words, the clinical symptoms in all the cases might be imagined to be due, wholly or partially, to an affection of the root in question.

## RESULTS

In Table 1 the myelographic and operative findings in 229 cases of filling defects are compared.

Groups A and B represent cases in which a filling defect of the root sheath was the only abnormal myelographic finding in relation to the disc concerned.

*Table 1. Operative findings in 229 cases with defective root sheaths on the myelogram.*

Myelography	Operative findings corresponding to the abnormal root sheath on the myelogram			Total
	Posterior herniation of the intervertebral disc	No posterior disc herniation but other abnormalities	No posterior disc herniation Nerve root free and normal	
Group A	32 (51.6%)	16 (25.8%)	14 (22.6%)	62 (100%)
Group B	25 (71.4%)	4 (11.4%)	6 (17.2%)	35 (100%)
Group C	54 (85.7%)	4 (6.4%)	5 (7.9%)	63 (100%)
Group D	59 (85.5%)	9 (13.0%)	1 (1.5%)	69 (100%)
Total	170 (74.2%)	33 (14.4%)	26 (11.4%)	229 (100%)

On the basis of the myelograms the cases are classified into the following 4 groups:

- A. Faint contrast filling of the root sheath. Normal contrast column.
- B. Shortened root sheath. Normal contrast column.
- C. Faint contrast filling of the root sheath. Impression into the contrast column.
- D. Shortened root sheath. Impression into the contrast column.

It is apparent from the table that where the only myelographic finding was a fairly faint filling of a root sheath (group A) only 51.6 per cent proved to have a disc herniation in relation to this root, while 25.8 per cent showed other abnormalities in explanation of the myelographic findings. In the remaining 22.6 per cent the operations revealed a normal and free root.

Thus, in the present material a faint filling of a root sheath was a fairly uncertain sign of disc herniation.

Where the myelographic showed only a shortened root sheath (group B) 71.4 per cent of the operations revealed disc herniation in the site, while 11.4 per cent of the cases exhibited other morbid conditions as a cause of the myelographic abnormality. In the remaining 17.2 per cent operation showed a normal-looking and free root.

Thus, a shortened root sheath was a fairly certain sign of herniation of a disc in relation to the nerve root.

Groups C and D represent cases in which the myelography showed not only deficient filling of the root sheath, but also an abnormal shape of the contrast column. The operative findings, therefore, bore little relation to the deficient filling and are thus in this context of minor interest. However, the groups are of some value as a basis for comparison with groups A and B.

Where the myelographic finding was not merely a deficient filling of the root sheath, but also thinning of or impression into the contrast column (groups C and D), about 86 per cent of the cases showed disc herniation in relation to the root concerned, while about 10 per cent exhibited other abnormalities to explain the myelographic findings. In the remaining 4 per cent the operation revealed a normal and free root.

As might be expected, the more pronounced myelographic changes in groups C and D were relatively often signs of disc herniation, and in these groups the anatomical findings around the root were seldom normal.

As is apparent from Table 1, 170 cases (74 per cent) showed a disc herniation in relation to the deficiently filled root sheath. In 50 (29 per cent of these cases the root was, according to the operative report, "extended over the herniation" and in 47 cases (28 per cent) "squeezed". In 26 cases (15 per cent) the root was adherent, while in 17 (10 per cent) it was flattened or narrowed and in 7 (4 per cent) showed diffuse or spindle-shaped thickening. In 46 cases (27 per cent) the report gave no details concerning the root.

Another thing which appears from Table 1 is that in 33 cases (14.4 per cent) operative revealed no disc herniation, but other abnormalities in explanation of the deficient root-sheath filling. The operative findings in these 33 cases are listed in Table 2.

Table 2 shows that apart from disc herniations the most common cause of deficient root-sheath filling was periradicular scar tissue left

by previous operations for disc herniation. In this connection, it must be mentioned that local epidural haematomas arising after herniation surgery are apt to be localized where the dura is relatively loosely attached, *i.e.* between the nerve roots. Subsequent fibrosis of the haematoma will therefore be apt to affect the roots concerned and accordingly manifest itself on the myelogram as a filling defect in the root sheath (*Cronquist 1959, del Buono 1957, 1959*).

*Table 2. Operative findings in 31 cases without posterior disc herniation, but with other abnormalities corresponding to the defective root sheath on the myelogram.*

Operative findings corresponding to the defective root sheath on the myelogram	No. of pts.
Scar tissue (following operation for herniated disc)	9
Degeneration of the disc with adherent nerve root	9
Spondylolisthesis	5
Osteophytes with nerve-root compression	4
Hypertrophy of the ligamentum flavum with nerve-root compression	2
Adherent nerve root, but otherwise normal structures	2
Cyst of the nerve root	1
Nerve root thickened, but otherwise normal structures	1
<b>Total</b>	<b>33</b>

It may be seen also from Table 2 that in 9 cases the myelographically abnormal root was adherent in relation to a narrowed disc with degenerative changes. As the history of low-back pain and sciatica in these cases was on the whole rather long (> 2 years), the adhesions may be imagined to have been caused by previous herniations. In another 2 cases there were periradicular adhesions for which no explanation could be found.

Five patients exhibited arcolysis and spondylolisthesis at the site of the deficiently filled root sheath. The nerve roots in question were of a normal appearance, and in fact there were no signs of actual pressure. In all cases the loose arch was excised. This resulted in 3 cases in marked subjective improvement with complete relief of root pain, while in 1 there was moderate improvement and in 1 none. Accordingly, it is reasonable to assume that the nerve roots have been affected by the spondylolisthesis and that this was the explanation of the deficient root-sheath filling.

In 4 cases, where osteophytes were found in relation to the nerve root,

and in 2 cases, where the ligamentum flavum was greatly thickened, an extremely cramped space in the root canal afforded an adequate explanation of the myelographic findings.

Lastly, it will be seen from Table 2 that in one case operation revealed a root cyst and in another case diffuse thickening of the root. In the latter case the root sheath was divided; it showed considerable thickening and adhesions to the nerve fibres, but these changes are unexplained.

Among the total material of 299 cases 26 (11.4 per cent) showed an apparently normal and free nerve root (cf. Table 1). It cannot be decided whether the myelographic appearances represented a non-morbid asymmetry in the development of the root sheath or whether there was a question of a morbid phenomenon. But it may be mentioned that in 12 of the 26 cases there was herniation of a disc proximally to the deficiently filled root sheath. When considering the oblique course of the nerve roots, it may be imagined that in some of these 12 cases the myelographic appearances were due to an influence by the named herniation upon the root in its proximal course.

#### DISCUSSION AND CONCLUSION

The present study did not include any assessment of the diagnostic accuracy obtained by the myelographic investigation as a whole. It aimed exclusively at elucidating the cause of a single component in the myelographic picture, viz. the deficiently filled root sheath.

Now, a deficient filling of a root sheath is not infrequently the only myelographic evidence of disc herniation, so that assessment of this very finding may decide whether or not surgery is carried out.

As might be expected on the basis of the studies of *Arnell* (1948) and *Lindblom* (1948), we found in the present material too that with a view to disc herniation the deficient filling of a root sheath was not a particularly specific sign.

The diagnostic uncertainty manifests itself especially in cases where faint filling, without shortening of the root sheath, was the only myelographic finding. In this connection it is remarkable that disc herniation was found in only 52 per cent of the cases while 26 per cent exhibited other periradicular abnormalities.

In assessing these findings, however, it must be taken into consideration that in all cases the clinical symptoms might be imagined to be due, wholly or partially, to an affection of the root concerned. On this background the frequency of disc herniation is hardly above that which

would be expected, if the operation had been done on the basis of clinical findings alone. Accordingly, the relatively faintly filled root sheath is a fairly certain sign of disc herniation, which does little to support the clinical diagnosis.

Where a shortened root sheath was the only myelographic finding, operation showed in 71 per cent herniation in relation to the root and in only 11 per cent other abnormalities.

The shortened root sheath, then, is a relatively specific sign which gives good support to the clinical diagnosis of herniation.

In respect to the aetiology of root lesions not due to disc herniations, the findings in the present material were in keeping with those of previous clinical studies (Table 2). For instance, *Knutsson* (1947), *Cronqvist* (1959), and *del Buono & Fuchs* (1959) found that frequently sequelae of herniation surgery manifest themselves myelographically as deficient filling of the root sheath, while *Andresen* (1953) found periradicular adhesions as an explanation of this myelographic appearance. It is known also that spondylolisthesis, osteophytes, or a thickened ligamentum flavum may influence the filling of the root sheaths (*Arnell* 1948, *Johansen* 1950, *Cronqvist* 1959, *Fassbender & Stössel* 1960).

#### SUMMARY

In 229 cases showing deficient root-sheath filling in Conturex (methiodole sodium) myelography the myelographic and operative root findings were compared. In all cases the operation was done because of a suspicion of disc herniation.

When a faintly filled root sheath was the only myelographic abnormality 51. per cent of the patients showed herniation in relation to the root concerned (Table 1, group A).

When a shortened root sheath was the only myelographic abnormality 71.4 per cent of the patients showed herniation in relation to the root (Table 1, group B).

Where deficient filling of a root sheath occurred together with an abnormal contrast column, 86 per cent of the cases had disc herniation in relation to the root (Table 1, groups C and D).

The operative findings in 33 cases with root lesions unrelated to disc herniation are listed in Table 2.

It is concluded that a faint filling of a root sheath can only to some extent support a clinical diagnosis of disc herniation, while a shortened root sheath is a relatively specific sign of disc herniation.

## RESUME

Dans 299 cas examinés à la myélographie Conturex (méthiodole sodium) qui montraient un remplissage déficient d'une gaine de racine rachidienne, les trouvailles myélographiques et opératoires ont été comparées. Dans tous les cas l'opération a été pratiquée parce qu'on suspectait une hernie discale.

Lorsque la gaine d'une racine rachidienne était faiblement remplie 51,6 pour cent des malades présentant cette anomalie avaient une hernie en relation avec la racine impliquée (Tableau 1, groupe A).

Lorsque le raccourcissement de remplissage d'une gaine de racine rachidienne était la seule anomalie, 71,4 pour cent des malades avaient une hernie discale en relation avec cette racine (Tableau 1, groupe B).

Lorsqu'une gaine de racine défectueusement remplie a été observée en même temps qu'un contraste anormal dans la colonne, 86 pour cent des malades avaient une hernie discale en relation avec cette racine (Tableau 1, groupes C et D).

Les trouvailles opératoires dans 33 cas de lésion de racines rachidiennes n'ayant aucun rapport avec une hernie discale sont rapportées sur le Tableau 2.

Il est conclu qu'un faible remplissage d'une gaine de racine rachidienne ne peut appuyer qu'à un certain degré le diagnostic clinique d'une hernie discale, alors qu'un raccourcissement de la gaine d'une racine rachidienne est un signe spécifique de la hernie discale.

## ZUSAMMENFASSUNG

In 299 Fällen, die mangelhafte Wurzelscheidenfüllung bei der Conturex (Methiodole Natrium) Myelographie zeigten, wurden die myelographischen und operativen Wurzelbefunde verglichen. In allen Fällen wurde die Operation wegen des Verdachtes einer Diskushernie vorgenommen.

Wenn eine schwach gefüllte Wurzelscheide die einzige myelographische Anomalie war, zeigten 51,6 Prozent der Patienten Hernienbildung im Verhältnis zu der betroffenen Wurzel (Tafel 1, Gruppe A).

Wenn eine verkürzte Wurzelscheide die einzige myelographische Anomalie war, zeigten 71,4 Prozent der Patienten Hernienbildung im Verhältnis zur Wurzel (Tafel 1, Gruppe B).

Wo magelhafte Füllung zusammen mit einer abnormalen Kontrastsäule auftraten, hatten 86 Prozent der Fälle eine Diskushernie im Beziehung zur Wurzel (Tafel 1, Gruppen C und D).

Die operativen Befunde in 33 Fällen mit Wurzelschädigungen ohne Beziehung zu einer Diskushernie sind in der Tafel 2 angeführt.

Man schliesst, dass eine schwache Füllung einer Wurzelscheide nur bis zu einem gewissen Grade die klinische Diagnose einer Diskushernie unterstützen kann, während eine verkürzte Wurzelscheide ein verhältnismässig spezifisches Zeichen einer Diskushernie ist.

#### REFERENCES

- Amundsen, P., Helsingen, P. & Kristiansen, K. (1963) Evaluation of lumbal radiculography ("myelography") with water-soluble contrastmedia. *Acta radiol.* **2**, 659.
- Andresen, I. (1953) Et materiale af abrodilmyelografier. *Nord. Med.* **50**, 1401.
- Arnell, S. & Lidström, F. (1931) Myelography with Skiodan (Abrodil). *Acta radiol.* **12**, 287.
- Arnell, S. (1944) Weitere Erfahrungen über myelographie mit Abrodil. *Acta radiol.* **25**, 408.
- Arnell, S. (1948) Myelography with water-soluble contrast, with special regard to the normal picture. *Acta radiol. Suppl.* 75.
- Cronqvist, S. (1959) The postoperative myelogram. *Acta radiol.* **52**, 45.
- Del Buono, M. S. (1957) Die lumbale Myelographie zur diagnose der Diskushernie. *Fortschr. Geb. Röntgenstr.* **87**, 334.
- Del Buono, M. S. & Fuchs, W. L. (1959) La myélographie lombaire post-opératoire. *Ann. Radiol.* **II**, 837.
- Fassbender, C. W. & Stössel, H. G. (1960) Die Bedeutung der Übersichtsaufnahme (Leeraufnahme) der Lendenwirbelsäule und der Abrodil-Myelographie beim lumbalen Bandscheibenvorfall. *Neurochir.* **3**, 72.
- Friberg, S. & Hult, L. (1951) Comparative study of abrodil myelogram and operative findings in low back pain and sciatica. *Acta orthop. scand.* **20**, 303.
- Johanson, C. E. (1950) Results of myelographies with water soluble media. *Acta chir. scand.* **99**, 560.
- Knutsson, F. (1947) The myelogram following operation for herniated disc. *Acta radiol.* **32**, 60.
- Knutsson, F. (1951) Lumbal myelography with water-soluble contrast in cases of disc. prolapse. *Acta orthop. scand.* **20**, 294.
- Kolstad, P. & Solem, G. H. (1959) Myelografi med vannopløselig kontrastmiddel. *Nord. Med.* **61**, 306.
- Levison, H. (1947) Abrodilmyelografi. *Ugeskr. Læg.* **38**, 545.
- Lindblom, K. (1946) Lumbal myelography by abrodil. *Acta radiol.* **27**, 1.
- Lindblom, K. (1948) The subarachnoid spaces of the root sheaths in the lumbar region *Acta radiol.* **30**, 419.
- Schalimtzek, M. (1958) Roentgenological examination of the function of the lumbar spine. Universitetsforlaget, Aarhus.