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The Significance of Preoperative Radiological Examinations in Patients Treated with Cloward's Operation*

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Summary

During a fifteen-year period 1,106 patients with symptoms and signs of cervical disc disease underwent Cloward's operation. Plain x-rays were performed in 94%, but the severity and extension of degenerative changes had no prognostic value. In 91% of the patients myelography was performed and in recent years mainly metrizamide was used as it was found to be more accurate. The findings on the myelograms were correlated according to age, severity and number of affected disc levels, but were independent of the duration of symptoms. Patients with medullary symptoms were found more often than not to have an anterior indentation into the spinal canal whereas most patients with radicular symptoms had wide cervical root sleeves or lateral compression. The best outcome was found among patients with monosegmental symptoms and signs and one affected disc level on the myelogram underlining that the indication for surgery in cervical disc disease should be based on both clinical and radiological findings.

Keywords: Cervical disc disease; myelography; Cloward's operation; outcome; cervical spondylosis.

In other studies we have described the clinical symptoms and signs which are significant for the long term result in cervical disc disease[8, 9, 10, 22]. Though the assumption—that relieving the pressure on the cervical roots or the spinal cord caused by the disease will be of benefit to the patient—is not always correct, it is still considered of major importance[4, 9].

It has been advocated that Cloward's operation could be performed on clinical symptoms and signs alone[18].

However, a recent prospective study[11] reveals that only 60% of patients with myelographic, surgically verified, disc herniation and pain syndromes corresponding to the dermatome of the level affected. Thus it seems rational to plan the level and extension of anterior disc surgery on radiological examination as advocated by several authors[2, 14, 17].

The purpose of this study is to disclose the significance of the preoperative radiological findings for the outcome in patients with cervical disc disease.

Material and Method

During a fifteen-year period 1106 patients underwent Cloward's operation solely for cervical disc disease[5]. The precise criteria for the selection of patients and the clinical description are given in a previous study[8, 9, 22]. From the patients' notes the clinical and radiological findings are registered retrospectively and the data calculated and stored in a computer.

The preoperative radiological examinations comprise plain x-rays of the cervical spine including oblique projections with assessment of severity and extension of spondylosis—performed in 94% of the patients—and meylography with assessment of severity and disc levels of all pathological changes—performed in 91% of the patients. The procedure of myelography has been standardized for all types during the whole period, but as from 1977 a change from oil to water soluble contrast media has taken place. The x-ray projections in the iodphendylate (Pantopaque^R) and metrizamide (Amipaque^R) myelograms were identical and performed with the patient in the prone position including, using horizontal beams, lateral and lateral/oblique projections, and p-a and p-a/oblique projections. Myelograms using positive contrast media were made by the lumbar route. Air myelograms were performed tomographically with hypocycloid movement in the lateral projection. All examinations were interpreted by experienced neuroradiologists. Diagnostic criteria are found in Fig. 1.

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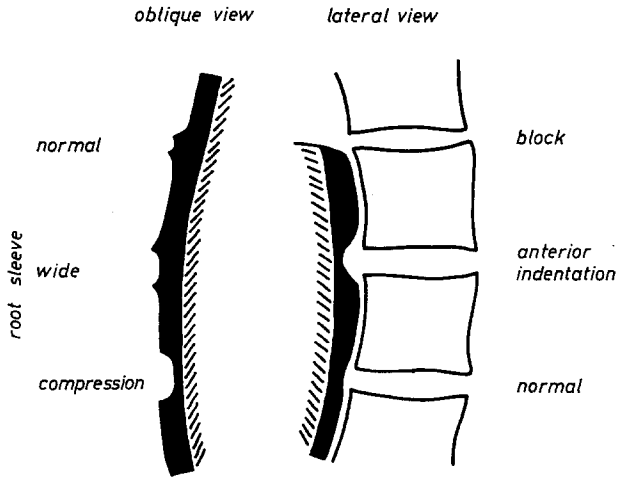

Fig. 1. Diagnostic criteria in myelography diagrammatic

Table 1. *Selected Groups of Patients in the Study*

Patient group	Number of patients	Criteria of selection
I	315	one myelographic abnormal disc level—operated on at that level
II	272	two myelographic abnormal disc levels—operated on at both levels
III	92	two myelographic abnormal disc levels—operated on at one level
IV	29	normal myelography—operation performed on clinical findings
V	100	no myelography—operation performed on clinical findings

In the computer the abnormalities described were registered with reference to each disc level, (and the findings of all disc levels in the single patient were registered, too). On the basis of the myelographic findings and surgical strategy five different groups of patients were selected for special purposes. The criteria for this selection are shown in Table 1. The age and sex distribution in the groups are very similar when they are compared with each other and with the rest of the material ($p > 0.40$).

The questionnaire filled in by patients 1–15 years postoperatively are the basis on which the results are assessed. The terms good or poor functional result as well as the patients' answers to the question: "Are you better than before the 1st operation" have previously been explained[8, 9].

Results

Radiological Findings

Spondylotic changes of the cervical spine were found in 79.5% of the 94% of patients in whom a plain x-ray of the cervical spine was performed preoperatively. In 44.7% of the patients more than one level was affected.

Table 2. *The Type of Myelography Related to the Most Severe Findings*

	Iod-phendylate	Metriz-amide	Air	Iodphendylate and air
Number of patients	757	75	91	75
No abnormality	2%	3%	9%	2%
Wide root sleeve	9%	28%	1%	7%
Lateral indentation	10%	7%	3%	3%
Anterior impression	30%	37%	72%	56%
Intentation + impression	44%	22%	1%	20%
Subtotal and total block	5%	3%	14%	12%

Eight cases with other combinations of myelography or unsuccessful attempts are excluded.

There is a connection between these findings and the age of the patients, but it is not prognostically significant. One or more preoperative myelograms were performed in 91% of patients as shown in Table 2 which gives the distribution of the most severe findings in the single patient.

The metrizamide myelograms showed wide root sleeves in 28% of the patients, whereas iodphendylate myelograms only showed this finding in 9% ($p > 0.001$).

The severity and extension of the myelographic findings vary much with age as will apear from Table 3 and 4. The percentage of patients in whom only one disc level was affected decreases significantly from young, through the middle/age to the elderly age group

Table 3. *The Number of Pathological Disc Levels Related to Age*

Number of pathological disc levels	Age groups (years)		
	0–40	41–59	> 60
0	7%	2%	2%
1	52%	32%	18%
2	33%	42%	41%
3	7%	19%	21%
4	1%	5%	15%
> 4	0%	0%	2%
Number of patients	150	679	173

Table 4. *The Most Severe Myelographic Findings Related to Age*

Most severe myelographic findings	Age groups (years)		
	0–40	41–59	⩾ 60
No abnormality	7%	2%	2%
Wide root sleeve	13%	10%	6%
Lateral compression	7%	9%	8%
Anterior indentation	39%	32%	31%
Indentation and impression	29%	36%	44%
Subtotal and total block	5%	6%	9%
Number of patients	150	679	173

Table 5. *Clinical Findings Related to Myelographic Sleeve Involvement in Patients with one Abnormal Disc Level on the Myelogram*

Clinical findings	Number of patients	Percentage of root sleeve involvement
Monosegmental Radicular symptoms	103	59%
Other radicular symptoms	106	48%
No radicular symptoms	66	47%
Monosegmental Radicular deficits	63	62%
Spinal cord symptoms and deficits	31	19%

Table 6. *Frequency and Types of Reoperations in Different Groups of Patients*

Patient group	Number of patients	No re-operation	Reoperations	
			Only former disc level	New + former disc level
All patients	1,106	87%	5%	8%
I	315	92%	4%	4%
II	272	87%	6%	7%
III	92	82%	6%	12%
IV	29	78%	4%	18%
V	100	87%	5%	8%

Table 7. *The Outcome in Different Groups of Patients*

Patient group	Number of patients	Good functional result
All patients	925	45%
I	274	46%
II	217	46%
III	86	43%
IV	26	46%
V	88	53%

($p > 0.001$). Similarly the severity of the findings worsens with age. No difference in the myelographic "landscape" was found when relating this to the duration of symptoms. Different symptoms and signs from the upper extremities offered no significant difference in the myelographic findings (Table 5). Patients with medullary symptoms and signs, however, had root affection in only 19% of cases.

The Results Related to Myelographic Findings

Table 6 shows the number of reoperations in different groups of patients. The frequency of revisions ranges between 3.5 and 5.4. The number of reoperations at a new disc level, however, ranges from 4% in the group of patients with primarily one abnormal disc level to 18% in the group of patients who had normal myelographies prior to operation. Most interesting is perhaps the different frequency of reoperations in the two groups with two abnormal discs. Twelve percent of the group operated on at one disc level had reoperations performed, whereas the comparable group of patients operated on at two disc levels had a frequency of 7% ($p = 0.08$).

The functional results in these patientgroups are quite similar, however, as will appear from Table 7.

Table 8 shows that there was no significant difference in the outcome in relation to different myelographic pictures in patients with one affected disc level. Table 9 shows the result in this particular group related to the clinical symptoms. It is demonstrated that a relevant clinical picture together with one myelographic abnormal disc level gives the best outcome. The result of the operation on a patient with uncertain radicular involvement or with cord (medullary) involvement is poorer.

Table 8. *The Outcome Related to the Myelographic Findings in Patients with One Affected Disc Level Subsequently Operated Upon*

Myelographic findings	Number of patients	Good functional result	"Better than before 1st operation"
Wide root sleeve	55	45%	71%
Lateral indentation	22	41%	73%
Anterior impression	114	43%	62%
Indentation and impression	66	52%	73%
Subtotal and total block	17	47%	65%
Total	274	45%	67%

Table 9. *The Outcome Related to Clinical Findings in Patients with One Abnormal Disc Level on Myelography Subsequently Operated Upon*

Clinical findings	Number of patients	Good functional result	"Better than before 1st operation"
Monoradicular symptoms	103	52%	71%
Other radicular symptoms	106	42%	68%
No radicular symptoms	66	38%	59%
Monoradicular deficits	63	53%	80%
Spinal cord symptoms and deficits	31	39%	61%

Table 10. *Radiological Findings in Patients with Excellent and Poor Functional Result*

Preoperative radiological findings	Outcome (functional result)	
	Excellent (n = 166) %	Poor (n = 138) %
Spondylosis, distribution		
None	19	16
One level	34	29
Two levels	26	34
Three levels	12	10
> three levels	3	7
Not described	6	4
Spondylosis, degree		
None	19	16
Slight	57	54
Severe	17	25
Not described	7	5
Myelography, number of pathological Disc levels		
None	4	7
One discs	32	35
Two discs	36	32
Three discs	15	15
Four discs	4	4
Not performed	9	7
Myelography, most severe findings		
Normal	5	7
Wide root sleeve	11	14
Compression	6	5
Anterior indentation	37	39
Indentation + impression ant.	37	31
Subtotal and total block	4	4

Discussion

It is necessary to perform preoperative radiological examinations in patients with symptoms and signs of cervical disc disease. The plain X-rays could reveal other disorders causing the symptoms, *e.g.* malignant disease, fractures, or subluxations. Furthermore degenerative changes such as osteophytes, narrowing of intervertebral foramen[6, 12, 14], reduction of the size of the spinal canal[2, 6] and narrowing of the intervertebral spaces[6, 12, 14] could be demonstrated and be of great value in determining the right level in the patient for surgery.

The prognostic value of these findings is very small—maybe even non-existent; however, partly because these changes are common in asymptomatic patients[3, 13, 15], partly because the real cause of compression of the nerve roots and spinal cord could not be seen in many cases.

This study seems to confirm this point of view. X-rays of the cervical spine taken at extreme flexion or extension of the neck could in some cases be a valuable help when planning surgery[2, 4]. In this study, however, this examination was performed so inconstantly that an evaluation was considered to be unhelpful from the start.

Although Murphey *et al.*[18] advocated that in most cases of ruptured cervical disc preoperative myelography was not necessary, most clinical series have shown a high frequency of myelographic studies[1, 7, 14, 16, 19].

This fact is due to better technique, less side effects from the contrast media used and to the knowledge that only 60% of the patients with a myelographically and surgically verified disc lesion had pain in the corresponding dermatome, whereas the rest had pain in another dermatome[11].

The performance of myelography in 91% of the 1,106 patients shows that this department agreed for the past with the point of view expressed by McLaurin: that performance of myelography is the sine qua non prior to surgical treatment of cervical disc disease[17]. It goes without saying that at present the function myelography is to visualize the pathology which causes the clinical picture. This function is taken over by CT and may in future be taken over by MR even more. In the remaining cases a well-defined clinical picture with abnormal plain X-ray findings at one or two corresponding disc levels constituted the indication for surgery.

The diagnostic possibilities of the type of myelography must be considered when evaluating the result in relation to the myelographic findings. As expected we found that 86% of the patients had anterior impressions, subtotal or total block at air myelography, because this examination rather seldom provides the possibility of showing root affections and therefore had been used in patients in whom a midline lesion was expected. Oil myelography shows abnormalities of the roots, but in some cases of a normal myelogram a midline protrusion could remain undetected owing to the high density of the contrast medium[7]. These different possibilities engendered by the contrast media were encountered in 2.5% of the cases. Since 1977 metrizamide has been used and is now the contrast of choice when cervical myelograms are performed. At the beginning a selection based upon the patients' ability to extend the neck was made in order to choose the proper contrast medium, but the technique of using water soluble contrast media without loss of density has improved so that selection or patients has not been practised since 1979. The low viscosity of metrizamide provides a more accurate diagnosis—in this material wide root sleeves are diagnosed three times as often as in the group of patients examined with oil myelography which is statistically significant. This improvement, however, could make it difficult to distinguish between slightly abnormal and normal findings, which in turn could make the decision for surgery more difficult. In this material no differences in the results could be obtained when comparing the single myelographic findings in oil and water soluble contrast media, respectively.

During the 15-year period the material shows a change in the myelographic pattern. The number of patients with a single affected disc level increased from 20% to 40%[9].

A similar, but less pronounced change was found as regards radicular symptoms. This may indicate an ongoing strengthening of the indication for operation, but this change has not been followed by better surgical results[9].

As expected a great difference with respect to extensiveness and magnitude of myelographic findings is found between the different age groups—which shows the degenerative nature of the disease. The ranges of the normal myelographic pictures of the cervical region are, however, not defined. Analogous with the findings of the plain cervical spine X-rays[3, 4, 15] and a comparison between surgical and myelographic findings in the lumbar region[20] it must be expected that many of the myelographic findings in the elderly have no clinical significance. The results in the elderly are poorer in respect to function[9], so probably some of the elderly patients are operated upon on the basis of a "false", positive myelogram.

No relation between the duration of symptoms and the myelographic "landscape" was found. This indicates that the great differences in the results are not an effect of poor diagnosis, but a result of irreversible functional lesions in the nervous tissue caused by this rather rough method of measuring between myelographic findings and different radicular phenomena or lack of them. However, a difference is demonstrated between patients with radicular and spinal cord symptoms. This difference could not be due solely to different properties of type of myelography, but it confirms that spinal cord symptoms are most likely due to midline lesions[2, 15]. The latter type of patient had the poorest outcome[22] which explains the fact that the myelographic findings of anterior impression alone augur a relatively poor outcome.

In 2.9% of the patients the preoperative myelogram did not reveal any lesion. The outcome in these patients, however, was similar to that of the rest of the material, but the frequency of reoperation at a new disc level was 18%. This shows that it can be justified in few cases only to explore the patient despite a normal myelo-

gram, but the chance of exploring at the right level is poorer than in any other group of patients. These findings are in accordance with the findings of Friis *et al.*[11]. Hirsch *et al.*[14] also found that these patients quickly relapsed which resulted in poor outcome. Just as a negative myelogram does not in all cases contraindicate surgery, a positive myelographic finding in a patient with symptoms does not always indicate surgical treatment as the findings could be asymptomatic due to age or irrelevant because the symptoms were caused by another disease (*i.e.* multiple sclerosis) or the symptoms could have existed for so long that the patient would not benefit from surgery. These considerations explain why not all myelographically abnormal disc levels have been explored. This point of view is supported by the fact that 92 patients with two myelographically abnormal disc levels of which one was operated upon resulted in only five extra reoperations compared with the group which was operated on both disc levels.

In 9% of the cases a preoperative myelogram was considered unnecessary because the clinical findings and the plain X-ray showed the exact disc level and the outcome in this group was better than in the group in which myelography was performed. The greatest diagnostic certainty of cervical disc disease could be expressed as the presence of a combination of radicular phenomena and one relevant, abnormal myelographic disc level[21]. It is confirmed that these patients had the best surgical results. This substantiates that the proper preoperative selection of patients based on clinical and radiological findings gives the best indication for surgery in patients with cervical disc disease.

Conclusions

1. The plain X-ray gives no prognostic information in patients with cervical disc disease—but can be a valuable help in the decision for surgery.

2. Metrizamide gives the most accurate cervical myelogram and can be performed in nearly all cases.

3. The extensiveness and severity of the myelographic findings are correlated to age, but not to preoperative duration of symptoms.

4. The myelographic findings are different in patients with radicular and cord symptoms and signs.

5. The best result will be obtained if the indication for surgery in cervical disc disease is based on both clinical and radiological findings.

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