Surgical treatment of myelopathy with cervical spondylosis

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SUMMARY The results of treatment over a period of 10 years of 102 cases of cervical spondylosis with myelopathy are presented, with a complete follow-up in all cases to two years after the end of that period. Results similar to those previously recorded were obtained with treatment by a light Minerva plaster collar, or laminectomy, but the best results, 73% sustained improvement, were obtained in 65 cases treated from an anterior approach, by Cloward's operation. Of 48 patients showing sustained improvement, 38 returned to, and remained at work. Cloward's operation was first undertaken at the beginning of the 10 year period, and was increasingly adopted as a primary procedure. It became evident that benefit from any treatment in cases with symptoms of long duration was likely to be limited, and the best results were in cases with less than a year's history who had Cloward's operation (86% sustained improvement). The necessity for careful clinical and radiological diagnosis, and operative technique, is emphasized, also the desirability of careful scrutiny of assessments in series of this disorder.

Treatment of myelopathy from cervical spondylosis by immobilization in collars, short or long, may be followed by lasting improvement in some cases (Campbell and Phillips, 1960). Decompressive laminectomy, with or without division of dentate ligaments is followed by improvement, occasionally marked, in about one-third to a half of cases (Northfield, 1955). However, results were uncertain, and benefits apt to be limited. Some (O'Connell, 1956; Bradshaw, 1957; Lees and Turner, 1963; Nurick, 1972b) have questioned the superiority of operative treatment over conservative management. The anterior surgical approach to the cervical spine (Cloward, 1958; Smith and Robinson, 1958) overcame the difficulty and danger of attempts to remove osteophytes and disc substance in front of the cord by a posterior (laminectomy) approach. In Cloward's operation the half-inch drill hole allows good access for inspection and thorough removal of disc and osteophytes. Grafting with a bone dowel gives immediate firm fixation, without need for a collar postoperatively. Reports of good results from this procedure have been published (Mayfield, 1965; Crandall and Batsdorf, 1966;

Verbiest and Geuse, 1966; Guidetti and Fortura, 1969) and some adverse reports (Galera and Tovi, 1968).

METHODS

The present series (Table 1) includes all cases treated in the Neurosurgical Unit in Bristol over the 10 year period 1961-70, with a few exceptions listed below, and all followed up to 1972—that is, from two to 10

TABLE 1
RESULTS OF TREATMENT (1972)

Treatment	No.	Improved		Unchanged (no.)	Worse (no.)
		Yes (no.)	No (%) (no.)		
Minerva collar	24	9	37	15	
Laminectomy	24	12 (3*)	50	6	6 (5†)
Cloward's operation	65	48 (38*)	74	8	9 (4†)

* Working.

† Died.

years—or to death, including all cases where death was attributable to the myelopathy (nine cases), whenever this occurred; or to intercurrent disease (11 cases) where death occurred more than two years (average three years) after operation; (four cases where unrelated deaths occurred less than two years postoperatively have been excluded from the survey).

Three patients were lost to follow-up (in one his condition had remained unchanged at six months, one was improved and working at one year, one improved and fit for work at 18 months). Six patients who had both laminectomy and Cloward's operation (two improved, two unchanged, and two deteriorated) have also been excluded from the tabulation of results.

Cases of acute extension injury in patients who had cervical spondylosis—that is, where symptoms and signs of cord damage were present *immediately* after injury—have not been included. In such cases the condition may remain unchanged or it may improve spontaneously without treatment. Inclusion of such cases, as has happened in other series, obviously would affect conclusions reached as to the natural history of the disorder or the results of treatment, conservative or operative. On the other hand, there is a history of trauma in 12 cases in the present series at some time preceding the onset of symptoms. In these cases the myelopathy is progressive and treatment beneficial.

RESULTS

More patients were treated by light Minerva plaster collars in the earlier part of the 10 year period. About one-third of these had sustained improvement without relapse. Of those with no improvement, or relapse, 11 had later operation.

In the later years, operation has been performed as a primary procedure in most cases. Nine cases with acute prolapse of the nucleus pulposus are included. All did well, three after laminectomy, and six after Cloward's operation.

The figures for laminectomy are unfairly weighted in that they include a higher proportion of older patients, 14 over 60 years of age, as against 20 over 60 years old in the 'Cloward's' group, and a number of advanced cases, quite unsuitable in the light of experience for any operation. Thus, of four patients who died four days to nine weeks after laminectomy, two were already bedbound preoperatively with advanced quadriplegia, one with generalized and coronary atheroma was found to have a massive cord infarction at necropsy, and another with asthma,

emphysema, and vascular hypertension died of bronchopneumonia nine weeks postoperatively. The fifth death attributable to the myelopathy occurred nine years after laminectomy in a patient who had had some spastic disorder of the limbs since birth and suffered an exacerbation of his disability immediately after the operation.

Of the four patients who died of their myelopathy after Cloward's operation, only one was a postoperative death, in a debilitated patient of 69 years who had had progressive disorder for five years. She died three hours postoperatively with pulmonary oedema. One patient slowly deteriorated and died of hypostatic pneumonia seven years postoperatively, and two others whose condition had remained unchanged for six years, died in the seventh postoperative year.

In nearly all the operated cases where improvement occurred, it was maintained throughout subsequent years, only a few suffering late deterioration. In all cases, it is the state at the last review—that is, in 1972—or immediately before an unrelated terminal illness, that is tabulated.

Of the 12 patients who remained improved after laminectomy a good proportion did well. Three have remained at work. Another six did not return to work because they were too old (over 65 years). One patient of 80 years, and another of 75 years had marked and sustained improvement.

Nevertheless, the overall results were a good deal better after Cloward's operation, and in the latter five years of the series there were 46 such operations as against 11 laminectomies, now virtually restricted to cases with narrow canals and multiple constrictions. Of the 48 patients

TABLE 2
IMPROVEMENT AFTER TREATMENT
IN RELATION TO DURATION OF SYMPTOMS

Treatment	Duration of symptoms (yr)		
	under 1	1-2	over 2
	Improvement		
Minerva collar	7/13 (54%)	2/5	0/6
Laminectomy	8/12 (67%)	1/4	2/8
Cloward's operation	37/43 (86%)	6/7	5/15

(74%) who had sustained improvement, 38 (58%) are known to have remained at work at the last review, and others who would have done so are over retiring age. The eight patients listed as 'unchanged' had not deteriorated during the 10 years' review (or until a final unrelated illness).

Analysis of results of treatment in relation to duration of symptoms is revealing (Table 2). There was no benefit from a Minerva plaster collar in six cases with a history of over two years, improvement in only two of eight such cases after laminectomy, and in five of 15 after Cloward's operation. Results were better with patients treated between one and two years after onset of symptoms, and best in those treated within less than a year from the onset. Of 68 cases in this last group, 52 (76%) had improvement which was maintained. By far the best results followed Cloward's operation (86% improved).

DISCUSSION

There are difficulties in assessing the benefits of treatment in myelopathy with cervical spondylosis, in comparing the results of one form of treatment with another, and with the natural course of the disorder untreated. A number of careful surveys by physicians (Bradshaw, 1957; Lees and Turner, 1963; Nurick, 1972b) have emphasized the variable and sometimes benign course of the condition, and the limited improvement in overall results from laminectomy. It is often difficult to evaluate the criteria of different observers. Lees and Turner speak of 'this relatively benign condition', yet of their 44 cases, 25 had 'severe' disability at some time and in most this remained. They defined severe disability as such a degree of paresis 'that the patient could hardly walk or needed sticks or crutches'. Even 'moderate' disability consisted of 'considerable difficulty in using hands or legs'. Bradshaw and Nurick, respectively, used gradings according to the patient's capacity for walking, with or without support. Nurick's (1972a) (Table 3) is simpler, and allows a fairly straightforward comparison between different cases and progress in each case, though there might be some variation in placing cases in his grades '2' and '3', and some latitude for improvement or deterioration within these grades. Nevertheless it allows a stricter comparison than 'excellent',

TABLE 3
GRADES OF DISABILITY (NURICK, 1972a)

Grade	
1	Signs of spinal cord disease but no difficulty in walking
2	Slight difficulty in walking which did not prevent full-time employment
3	Difficulty in walking which prevented full-time employment or the ability to do all housework, but which was not so severe as to require someone else's help to walk
4	Able to walk only with someone else's help or with the aid of a frame
5	Chairbound or bedridden

'good', 'fair', as so often used. The results of the present series have therefore been tabulated according to Nurick's criteria as an additional control to supplement efforts already made, including comprehensive and prolonged follow-up, and data as to return to, and continuation at, work to make them meaningful. Tables 4 to 7 are self-explanatory. The figures between the dashed lines (added to Nurick's original Tables) indicate cases still in the same grade at reassessment or final review. Figures to the left of the dotted lines indicate those in a lower grade, figures to the right those in a better grade. Though the percentage of cases 'improved' judged by a rise in grade is less than assessed simply by recording improvement or otherwise in each case, as would be expected, the superiority of the outcome after Cloward's operation over conservative management or laminectomy remains striking.

Treatment of myelopathy from cervical spondylosis demands a high standard of neurological and radiological diagnosis, and operative performance. During the period under review 23 additional patients were seen with cervical spondylosis and myelopathy attributable at least in part to other disorders, mainly intrinsic diseases of the spinal cord (Table 8). In some of these patients an additional diagnosis was known or suspected at the time of treatment, and in some it could be confirmed only after a long interval—for example, with the late development of dysarthria in cases of disseminated sclerosis (Campbell and Phillips, 1960). There was at least short-term benefit from treatment in some of these cases.

Myelography is essential, not only to exclude

TABLES 4-7

RELATIONSHIP OF INITIAL DISABILITY TO
DISABILITY AT TIME OF REASSESSMENT

4. Nurick: No operation

Follow-up grade	Initial grade				
	1	2	3	4	5
	1	7	5	1	1
	2	2	4		1
	3	3	5	3	
	4				
	5		1	1	2
<hr/>					
Worse 12 33% Unch. 16 45% Impr. 8 22%					

5. Nurick: Laminectomy

Follow-up grade	Initial grade				
	1	2	3	4	5
	1	11	10	1	
	2	1	2	2	
	3		1	2	
	4		1	1	2
	5		1	1	2
<hr/>					
Worse 10 22% Unch. 21 47% Impr. 14 31%					

6. Present series: Cloward's operation

Follow-up grade	Initial grade				
	1	2	3	4	5
	1	2	9	7	1
	2	1	4	15	1
	3		1	8	1
	4			2	2
	5			2	3
<hr/>					
Worse 9 14% Unch. 18 29% Impr. 38 57%					

7. Present series: Laminectomy

Follow-up grade	Initial grade				
	1	2	3	4	5
	1		1	2	
	2		2	3	
	3			4	1
	4			1	3
	5			2	3
<hr/>					
Worse* 6 24% Unch. 9 38% Impr. 9 38%					

*Three in grade 5 died.

spinal compression from other causes, but also to assess projections at all affected levels, whether of osteophytes or soft tissue. Operation is performed at one, two, or three levels as appropriate. While Cloward's operation with reasonable care should have an extremely low morbidity and no mortality, potential risks are not negligible, as is indicated by the accompanying list (Table 9). The anaesthetist should be warned not to extend the neck during induction and intubation. This can cause spinal cord compression (Symonds, 1953), even tetraplegia, and may explain some unexpected deaths after laminectomy for this condition.

Access in the neck to the anterior aspect of the vertebral bodies is not difficult but care must be taken to avoid damage to soft tissue structures on the way, either during dissection, or with re-

TABLE 8

OTHER NEUROLOGICAL DISORDERS WITH CERVICAL
SPONDYLOSIS

Disseminated sclerosis	9 (4*)
Motor neurone disease	4 (1*)
Subacute combined degeneration	1
Syringomyelia	3 (1*)
Arnold-Chiari malformation	1
Vertebrobasilar ischaemia	2
Peripheral neuritis	1
Astrocytoma of spinal cord	1
Cyst of spinal cord	1

* Cloward's operation.

TABLE 9

CLOWARD'S OPERATION: RISKS AND COMPLICATIONS

Extension of neck with anaesthetic induction
Damage to:
Pharynx or oesophagus
Recurrent laryngeal nerve
Sympathetic nerve
Carotid artery
Jugular vein
Brachial plexus
Faulty placing of drill holes
Damage to vertebral veins and artery
Inadequate removal of osteophytes or disc
Excessive removal of bone or disc
Damage to spinal cord (concussion)
Faulty fixation of graft
Collapse (wedging) of vertebral bodies
Haematoma of neck or ilium
Infection of neck or ilium

tractors, especially if a self-retaining rake retractor (Cloward's type) with sharp points is used. Medially, the pharynx or oesophagus may be perforated.

Postoperative hoarseness may result from damage to the recurrent laryngeal nerve. Horner's syndrome has been seen, attributable to damage to the sympathetic nerve.

The carotid artery may be greatly stretched and distorted when retracted laterally. It is at some risk with sharp pointed retractors, as is the jugular vein, which may also be damaged if small tributaries are torn close to their entry into the vein. Damage to the upper part of the brachial plexus has been seen, as the result of slipping of an inadequately held drill before it entered the bone.

An essential step in the operation is the identification by radiology in the theatre of the

level of a marker, a fine lumbar puncture needle, placed in a disc. There is also clearly no room for error in the depth of the drilling. The guard must be adjusted so that the drill projects a little less than the thickness of the vertebral bodies and disc allowing for radiographic magnification. This must always be checked carefully. Final removal of bone at the end of the drill hole is best done with a high speed burr. The drill hole must be made at the correct place straddling the disc, and at the correct angle so that it continues to do so throughout its depth. Otherwise it will be very awkward to get access equally to osteophytes above and below the disc; also excessive bone will be drilled out from one vertebral body and not enough from another—indeed, the end of the drill may slip along the intact cortical bone of one vertebra. (Particular care is required in dealing with two or three adjacent levels.) Inadequate fixation of the grafted dowel may result, also wedging of a vertebral body. If the drill is directed too far laterally there may be brisk bleeding from vertebral veins, and even damage to the vertebral artery, as well as inadequate fixation of the graft.

Removal of the osteophytes, disc cartilage, and fragments of annulus, adherent to the posterior common ligament and perhaps calcified, should be thorough. Good illumination and magnification with loupes or operating microscope are desirable. Curettes must be used with great care—any slip might irrevocably damage the cord. A high speed air drill is very useful. A small incision through the posterior common ligament to expose the dura mater ensures that no protruded soft tissue mass is left behind. Enthusiasm in removing disc capsule laterally is misplaced. It may lead to instability and poor fixation of the dowel graft.

Clearly, the dowel graft must be shorter than the depth of the drill hole and in tapping it into place so that its anterior cortical surface is just deep to the anterior cortex of the vertebral bodies, it must not go too far—but short of this, damage to the cord in some cases may be done simply by the concussion of the mallet blows. This is indicated by jerking of the limbs, and postoperative increase in spastic paresis. It is perhaps associated with remaining osteophytes in a narrow canal impinging on the cord.

Postoperative radiographs should be taken within the first few days to check the position of the graft(s). If inadequately fixed, these may be tilted and/or displaced anteriorly and need operative replacement. Partial collapse and wedging of vertebral bodies with development of local kyphosis may not matter if slight, but could make the last state worse than the first. If haemostasis is imperfect, drains may prevent haematoma in the neck, or over the donor site for the graft from the ilium. Haematoma, excessive retraction with bruising of tissues, or unduly prolonged operation may predispose to infection.

Most of these complications may be seen, as in the present series, without permanent ill-effects, but it should be obvious that, while this is an operation straightforward in principle, and not very difficult to perform, it must be done with care and absence of haste. It should be fully realized that it is not just a matter of exenteration of the intervertebral disc followed by bone fusion. Consistently good results can be expected only with meticulous removal of all compressing elements. Postoperative rehabilitative physiotherapy and occupational therapy makes a difference to some people, but in many some neurological improvement is apparent immediately after operation.

At least in the United Kingdom, the tendency has been to accept previous conclusions that myelopathy associated with cervical spondylosis is a benign or relatively benign condition, at least over long periods and little influenced by treatment. There are reasons for not accepting such conclusions unreservedly. They are sometimes confused by inclusion of cases of acute injury (Lees and Turner, 1963), by a bias towards severe disablement, or by prolonged disability not being stressed. The large number of cases with 'severe disability' in Lees and Turner's series has already been mentioned, and it is notable that eight of their cases treated with a collar had treatment continued for 1 to 10 years. On the other hand, it may be seen from Tables 4 to 7 in this paper that Nurick's series had a marked bias towards milder cases than the present series. Minor cases (Nurick's grade 1, and lesser degrees of grade 2) can be treated adequately by collars and avoidance of strain. In others, surgical relief of cord compression by a

narrowing of the spinal canal, which is the significant cause of the myelopathy (Nurick, 1970; 1972a), should be appropriate. The expectation of lasting benefit in patients having operation early, before severe disability, or before moderate disability is long established, has been found to be high in the present series.

CONCLUSIONS

It is concluded from the results of experience over 10 years, with a comprehensive follow-up review (minimum two years), that myelopathy associated with cervical spondylosis can be usefully treated, with lasting benefit.

The results of operation from an anterior approach, with careful and thorough removal of projecting osteophytes and disc substance are markedly superior to those of laminectomy or conservative management. Most striking is the relationship of the results to the duration of symptoms, which suggests that radical treatment of this sort should not be delayed by undue persistence in conservative management.

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