ORIGINAL PAPER
PŮVODNÍ PRÁCE

Cervical Spondylotic Myelopathy: The Outcome and Potential Complications of Surgical Treatment

Spondylogenní krční myelopatie: výsledky a potenciální komplikace chirurgické léčby

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ABSTRACT

PURPOSE OF THE STUDY

Cervical spondylotic myelopathy is the most common cause of spinal cord dysfunction in patients over 60 years old. Symptoms often develop gradually and insidiously and are characterized by neck stiffness, arm pain, numbness and clumsiness of hands, as well as weakness of the hands and legs frequently leading to a change in mobility. Surgery is performed primarily to prevent the progression of symptoms but also with the aim of improving existing symptoms.

Aim of our study was to assess the outcomes and potential complications of surgical decompression of cervical spondylotic myelopathy (CSM).

MATERIAL AND METHODS

Prospective data was collected from 71 patients who were treated surgically for CSM over a four-year period (June 2006 to June 2010). Only patients with confirmed spondylotic cervical myelopathy were included in the study; those with an inflammatory, infectious or neoplastic etiology were excluded. The Nurick scale was used as a primary outcome measure, and the improvement in upper limb function as a secondary outcome measure. Statistical significance was assessed using the paired t-test.

RESULTS

34/71 (47.9%) patients had an anterior decompression, 36/71 (50.7%) patients underwent posterior surgery and one patient (1.4%) received a combined approach:

The Nurick score: The mean score improved by 0.9 from 2.4 preoperatively to 1.5 postoperatively for the whole series. Three patients were able to return to work. The preoperative Nurick score showed a positive correlation with the postoperative Nurick score at one year (Pearson Coefficient = 0.85).

Upper limb symptoms: Postoperatively, 24 patients were free of any upper limb involvement compared with 6 patients preoperatively. The main improvement was in patients who prior to surgery had subjective symptoms with no objective signs of weakness or muscle wasting. 35/48 (72.9%) of this group showed improvement compared to 7/17 (41.2%) of patients who demonstrated objective weakness and/or wasting preoperatively.

Complications: The overall rate of complications was 18.2%. There were two mortalities as a result of pneumonia (2.8%), one patient had to be transferred to the intensive care unit for cardiac failure (1.4%), fixation failure occurred in two patients (2.8%), worsening of myelopathy occurred in two patients (2.8%), C5 temporary radiculopathy presented in two patients (2.8%), superficial wound infection developed in one patient (1.4%) and three patients (4.2%) complained of severe axial pain in the postoperative period.

DISCUSSION

Our results demonstrate that the greater the preoperative disability the greater the final disability is expected to be. Cord signal change, as an indicator of the pathological severity of the disease, correlates with a worse functional outcome. The degree of improvement postoperatively (i.e. the functional change) does not show a significant correlation with the initial preoperative status. It appears however, that there is a better chance of improvement in patients with no objectively detectable weakness or muscle wasting. The rate of complications encountered in this series is comparable with those in the literature, which renders them valid for quoting when considering surgical treatment for CSM.

CONCLUSION

Surgical decompression offers a real chance of improvement in the functional outcome of CSM, especially during the earlier stages of the disease. The surgical decision needs to be considered carefully due to the advanced age of the patient population and the greater burden of co-morbidities, which increase the surgical risks significantly.

Key words: myelopathy, Nurick, cervical, surgical decompression, upper limb in myelopathy.

INTRODUCTION

Cervical myelopathy is a relatively common diagnosis of spinal cord dysfunction that can lead to significant disability through a spectrum of clinical manifestations ranging from compromised dexterity and balance to more profound weakness, paralysis and incontinence. Although the condition can result from non-compressive pathology such as multiple sclerosis and vascular disease, spine surgeons are usually faced with the more common stenotic variety which is often secondary to spondylosis in the cervical spine – cervical spondylotic myelopathy (CSM). Treatment options vary based on clinical, radiological and patient-related factors. Conservative treatment remains a viable alternative in mild to moderate myelopathy with reasonable evidence supporting no significant clinical advantage of surgery in the short-term (6, 7). However, an experimental model has shown that prolonged

Table 1. The Nurick myelopathy scale

Grade	Root signs	Cord involvement	Gait	Employment
0	Yes	No	Normal	Possible
I	Yes	Yes	Normal	Possible
II	Yes	Yes	Mild abnormality	Possible
III	Yes	Yes	Severe abnormality	Impossible
IV	Yes	Yes	Only with assistance	Impossible

Table 2. Upper limb function grade

Grade	Description
0	Normal sensory and motor examination with no upper motor neuron signs
1	Sensory dysfunction with normal motor examination and no upper motor neuron signs
2	Upper motor neuron signs with no weakness
3	Motor weakness

a|b|c
d|e|f

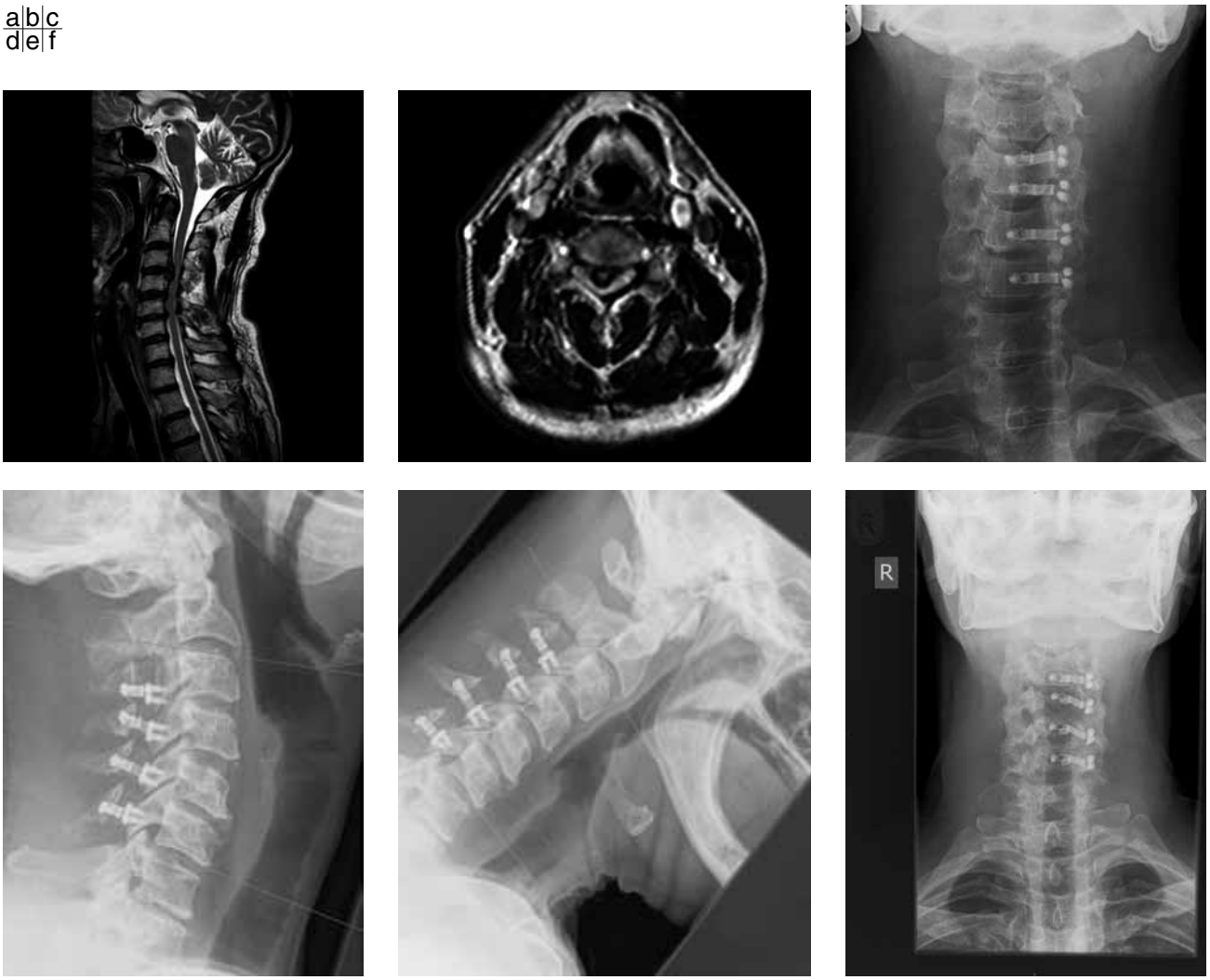
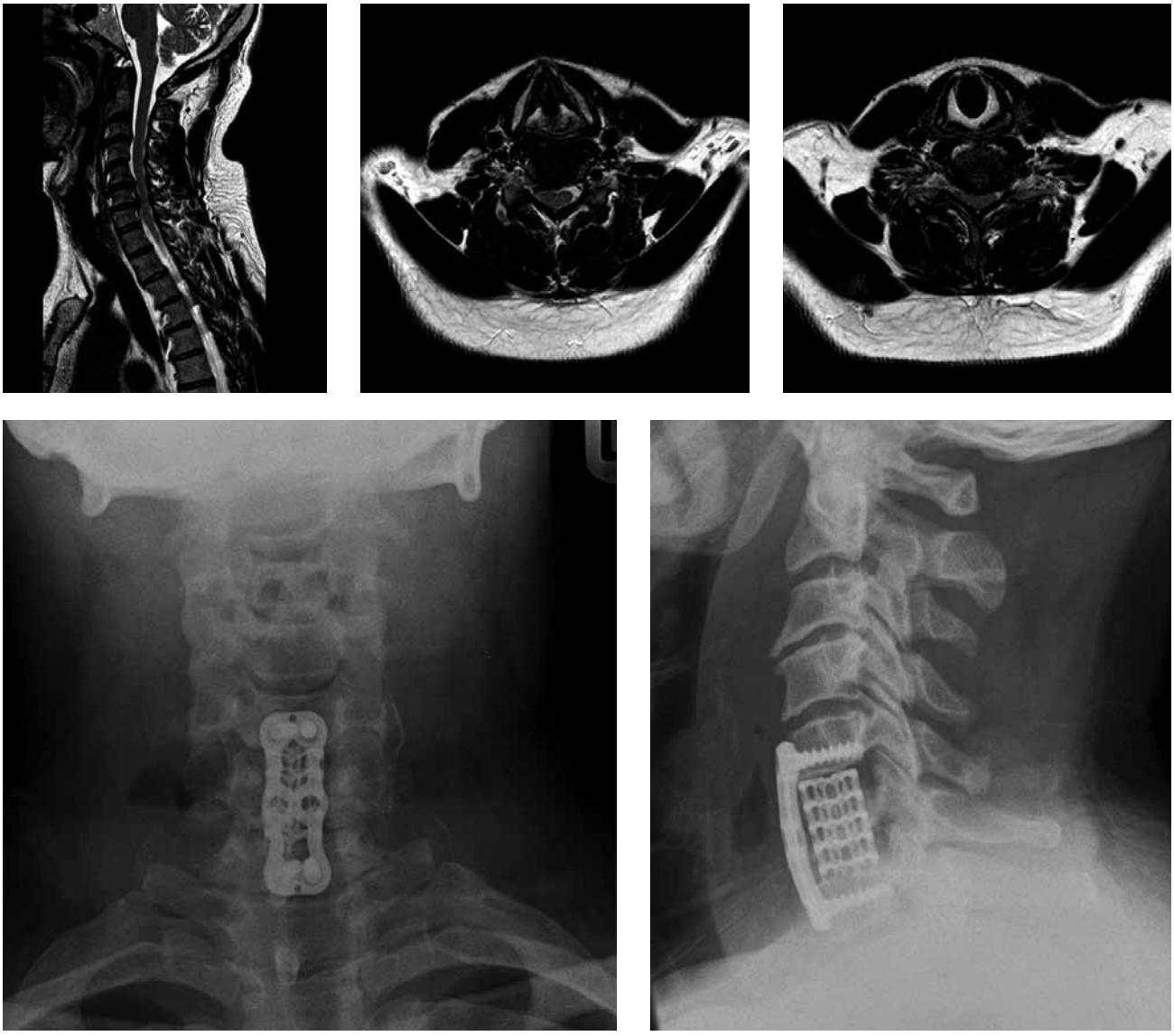


Fig. 1. a-b-c : MRI scans of a 44-year-old man in sagittal (1a) and axial projections are demonstrating cervical canal stenosis at C5-C6 (1b) and C6-C7 level (1c) with posterior osteophytes and some ossification of posterior longitudinal ligament (confirmed on CT scan). 1 d-e: Corpectomy with mesh cage reconstruction and plating seen on AP and lateral views provided adequate decompression of the spinal canal.



a|b|c
d|e

Fig. 2. a-b: MRI scan of a 51-year-old gentleman showing extent of spinal canal narrowing and cord signal changes on sagittal (2a) and axial (2b) images.
c-d-e : X-rays taken following laminoplasty C3-C6 with C3-C6 mobility 13 deg in flexion and 15.5 deg in extension, 2 years follow up.

cord compression can lead to irreversible histological spinal cord changes such as intradural fibrosis, demyelination, and loss of neurones within the spinal cord (1). Decompressive surgery can help prevent these changes and has been shown to halt or even reverse the deterioration in myelopathy patients and encourage an improvement in functional and neurological status (8, 17).

The aim of this study is to determine the clinical outcomes and complications following the surgical treatment of a consecutive cohort of patient suffering with CSM. An additional aim is to investigate the effect of the surgical approach used as well as the presence of spinal cord signal change on MRI on the postoperative neurological improvement.

MATERIAL AND METHODS

Prospective data was collected on all patients who underwent cervical spine decompressive surgery for CSM through an anterior, posterior or combined approach over a four-year period (June 2006 to June 2010). Only patients with a primary diagnosis of CSM and a minimum follow-up of 12 months were included. Myelopathy cases secondary to non-degenerative aetiology such as infection, neoplasia, or inflammatory disorders were excluded.

Collected demographic data included patient age and gender, MRI signal change and the surgical technique employed. To evaluate functional recovery the following tools were used:

Table 3. Summary of surgical interventions on 71 patients suffering with CSM

Anterior surgery		**Posterior Surgery**	
Procedure	**Number of patients**	**Procedure**	**Number of patients**
one level ACDF	19	decompression without stabilisation	4
two level ACDF	5	decompression with stabilisation	24
three level ACDF	1	laminoplasty	8
one level disc replacement	3		
two level (ACDF+disc replacement)	1		
corpectomy	5		
TOTAL	34	TOTAL	36

N.B. One patient had anterior discectomy and fusion followed by posterior decompression and is not included in the table

The Nurick myelopathy grade. This is a validated myelopathy grading system based on abnormalities within the walking gait cycle (11). The score is outlined in table 1.

The upper limb function grade. This is a score devised to reflect the functional variation recorded in examining the upper limbs. The score is outlined in table 2.

Scores were collected pre-operatively, and at intervals of six months, one year and two years post-surgery. Data analysis was performed using the Data Analysis Pack of Microsoft Excel. The paired t-test was selected to analyse normally distributed continuous data (a p-value < 0.05 was considered significant) and Pearson's correlation coefficient to analyse the correlation between two variables. Continuous data is presented as mean (range).

RESULTS

Data on 71 consecutive adults managed surgically for CSM was reviewed. The mean age of the group at the time of surgery was 59 years (23 to 94 years). There were 42 women and 29 men in the series. The mean follow-up at the time of review was 19.3 months (13.8 to 24.8 months). A change in the cord signal on T2 was recorded in 47 (66%) of the study subjects. The surgical intervention varied based on the location of the compressive pathology as documented on the MRI, the cervical spine sagittal balance and the presence of existing foraminal stenosis. All surgical interventions were performed by the two senior surgeons. 39 of the 71 patients had a follow-up period of greater than two years.

During surgery, patients requiring more than one level anterior cervical fusion had a supplementary anterior locking plate fixation. If preoperative planning identified extensive calcifications of the disc or posterior longitudinal ligament; corpectomy was considered (Fig. 1). The decision to implant artificial disc prosthesis was considered when the compressive element was a soft disc herniation without severe narrowing of the disc space or degenerative changes in the facet joints, usually in a patient younger than 50 years (16). Laminoplasty was performed in subgroup of younger patients (less than 60 years old) who had lordotic spines and needed multi level decompression. (Fig. 2). Of the 71 patients, anterior cervical decompression was performed in 34; a single level anterior decompression (discectomy) was performed in 22 patients followed by an artificial disc replacement in three subjects and fusion using an inter-body cage in 19 subjects. Of the seven patients who underwent a decompression at two or more levels, six proceeded to have the levels fused using an inter-body cage supplemented by a locking plate while one had a fusion of the lower level and an artificial disc replacement at the level above. Of the 36 patients who required a posterior decompression; laminectomy was performed on 28 patients of which 24 required additional instrumentation (extension to the occiput in two cases). Eight patients had expansive laminoplasty in order to preserve mobility of the cervical spine. The procedures are summarised in table 3. Within our study cohort, two patients had combined surgery (anterior and posterior decompression done in separate settings); the first had an anterior decompression and fusion (C5/6) followed by a laminoplasty (C3 to C6). The second patient had an anterior decompression and fusion followed by posterior decompression (both at C4/5) as dictated by the compressive pathology.

Functional outcome post-surgery. The Nurick grade significantly improved in 58 patients (82%) following surgery ($p<0.001$). The mean improvement for the anterior approach group was 1.1 and for the posterior group 0.8, but there was no statistically significant difference observed ($p = 0.07$). The mean Nurick grade improved by 0.9 from 2.4 preoperatively to 1.5 postoperatively for the entire series. Three patients were able to return to work. The preoperative Nurick score showed a positive correlation with the postoperative Nurick score at one year (Pearson coefficient = 0.85; i.e. the better the Nurick score was preoperatively, the better the final postoperative Nurick score). No correlation was found between the preoperative score and the improvement gained on the Nurick scale – Pearson coefficient = 0.01: i.e. the difference between preoperative and postoperative Nurick scores did not seem to be affected by the preoperative score (Table 4). Table 4 shows the change in Nurick score after surgical intervention.

Sixty five patients had upper extremity symptoms and/or signs while six did not demonstrate any of these preoperatively (Table 5). The number of patients free of any upper limb involvement increased to 24 following surgery. The main improvement was seen in patients

Table 4. Change in Nurick Score from pre to post operatively

	Number of patients affected	
Nurick Grade	**Pre-operative**	**Post-operative**
0	4	14
1	9	22
2	17	21
3	24	6
4	13	7
5	4	1

Table 5. Upper extremity involvement our series before and after surgery

	Number of patients affected	
Upper limb function Score	**Pre-operative**	**Post-operative**
0	6	24
1	16	23
2	32	13
3	17	11

Table 6. Complications

Complications major	**Number of patients (%)**
Hospital acquired pneumonia (resulted in mortality)	2 (2.8%)
Cardiac failure	1 (1.4%)
Fixation failure	2 (2.8%)
Worsening of myelopathy	2 (2.8%)
	7 (9.8%)
Complications minor	
C5 radiculopathy/palsy	2 (2.8%)
Superficial wound infection	1 (1.4%)
Axial neck pain	3 (4.2%)
	6 (8.4%)
Total	13 (18.2%)

who reported subjective symptoms with no objectively detectable weakness or wasting. 35 out of 48 (73%) of these patients showed improvement compared to 7 out of 17 patients who had lasting objective weakness and/or wasting (41%). The change in upper extremity involvement after surgical intervention is shown in table 5.

Cord signal change on MRI and clinical outcome. There was a statistically significant difference in the final Nurick grade between patients who had cord signal change on MRI (myelomalacia) versus those that did not ($p = 0.003$). The Nurick score was worse in patients with myelomalacia. The mean final Nurick score was 1.9 for myelomalacia patients and 1 for non-myelomalacia patients. However, the change in the Nurick score from pre- to post-surgery showed no statistically significant difference between the two groups ($p = 0.23$). The mean improvement was 0.8 for the myelomalacia group and 1 for the non-myelomalacia group.

Complications. The overall complication rate in this series was 18.2%. Complications included two mortalities secondary to severe post-operative chest infections, most probably caused by aspiration. One of the patients suffered severe heart failure postoperatively for which they were admitted to intensive care. They subsequently recovered and were discharged from the hospital three weeks following admission.

Early cage subsidence with anterior plate loosening after corpectomy was recorded in one patient three weeks after the primary surgery. That required a revision with cemented screw augmentation and autologous iliac bone grafting. The fixation was protected with a hard collar for three months.

Failure of distal screws following posterior fixation and subsequent extension to the upper thoracic spine occurred in one patient with severe osteoporosis. Two patients had neurologic deterioration secondary to cord dysfunction. In one patient the deficit was temporary due to postoperative haematoma and improved after surgical evacuation on the fourth postoperative day; in the other it was due to cord infarction and was permanent. Two cases suffered temporary C5 nerve root symptoms. One of these patients experienced C5 palsy and deltoid weakness postoperatively after posterior instrumented decompression. A CT scan revealed a fractured C5 lateral mass. Symptoms resolved spontaneously after six weeks. In the second patient the symptoms were purely sensory with radicular pain and no weakness. Symptoms improved after about eight weeks and no further intervention was needed. One patient suffered from superficial wound infection that was treated non-operatively with antibiotics. Three patients continued to have significant axial neck pain postoperatively; two of them had undergone posterior surgery and the other an anterior procedure. There was satisfactory improvement in two with adequate pain control but the third patient continued to have intensive pain. There were no reports of any symptomatic recurrent laryngeal nerve palsy or persistent swallowing difficulty at final follow up (Table 6).

DISCUSSION

Cervical spondylotic myelopathy is a common pathological entity that can result in significant disability in the adult population. It can present in a variety of ways but the most common presentations are gait disturbance and functional deficits of the upper extremity, particularly the hand. In this study we have analysed the data from a group of consecutive patients with a diagnosis of CSM

and we have used the Nurick score as a primary outcome measure as it is specific for the disease and demonstrates the most important aspect of the disability which is the gait change.

Upper extremity dysfunction is an important aspect of the disability caused by the disease and can vary over a spectrum ranging from purely subjective symptoms to clinically overt weakness and wasting. These symptoms can be due to long tract ischaemia, venous stasis, and/or anterior horn cell dysfunction (14, 20). We have used a grading system for upper extremity dysfunction to make it easy to measure.

Despite the fact that almost all published literature recommends surgical treatment for advanced myelopathy, there remains a valid clinical question over how to manage moderate spondylotic compressive myelopathy, as there have been a number of studies to support conservative treatment. A prospective randomised study by Kadanka et al. has suggested that there is no significant difference in the outcome between surgically and conservatively treated patients with mild to moderate cervical myelopathy. (6, 7)

It is well established that surgical treatment, particularly in advanced cases, rarely offers a cure. It aims to arrest further functional deterioration by removing mechanical compression. The more severe and longstanding the disease, the greater the risk of permanent deficit that the patient will be left with regardless of the intervention performed.(15, 19)

An experimental study has shown that if compressive myelopathy is left for long enough then irreversible damage to the cord can result (1). Matsunaga et al. have compared surgical and non-surgical treatments for upper cervical myelopathy secondary to rheumatoid disease and found that the survival rate was 0% in those who were treated non-operatively after eight years and 37% in those treated operatively after ten years. (10) Another study by Omura et al. found similar results when assessing the same pathological entity with all patients that were treated non-operatively being dead or completely bedridden before the end point of the study. (13)

Previous clinical studies have shown an improvement in gait following surgical decompression. Emery et al. reported a return to normal gait in 46% of 82 patients treated and a definite improvement in 40%. (4) Okada found that 46% of 37 patients who had surgical decompression had normal lower limb function at routine follow-up. (12) Edwards et al. have suggested certain strategies when planning surgery based on the clinical and radiological findings in addition to the potential complications. (3)

In this study there was an improvement in the Nurick score in 55 patients (77.5%) and restoration or maintenance of gait balance (Nurick 0–1) in 36 patients (50.7%) at final follow-up. 18 patients (25.3%) improved by more than one point. Two patients had neurologic deterioration, one of whom suffered a temporary deficit secondary to a haematoma which needed surgical evacuation on the fifth day postoperatively. The second patient sustained a cord infarction and reported a permanent deficit at final follow-up. The overall change in the Nurick score was statistically significant at follow-up when compared to the preoperative score. The final Nurick score correlated positively with the preoperative score that indicates that the higher the initial disability the higher the final disability is expected to be. However, the degree of improvement (i.e. the functional change) did not show a significant correlation with the initial preoperative score. The cord signal change, as an indicator of the pathological severity of the disease did correlate with a worse functional outcome in our study and of Suri et al. who has reached similar findings (18).

There was a degree of impairment of the upper extremity function in 65 patients (91.5%). Upper extremity function improved in 48 patients (67%) and a normal function was present in 24 patients (34%) at final assessment, with only 11 (15%) having demonstrated a clinically detectable weakness. It appears that there is a better chance of improvement in patients with no objectively detectable weakness or wasting.

In this study we did not find a statistically significant difference in the degree of clinical improvement between the various surgical approaches. In a systematic review of cohort studies by Cunningham et al. in 2010, it was also found that all approaches yield similar neurological recovery rates. However, they concluded that there is a higher complication rate with laminectomy versus laminoplasty, and with corpectomy versus ACDF. There was also a higher rate of axial pain associated with posterior surgery in general. (2)

The surgical decision has to be approached carefully as, unfortunately, many patients with CSM are elderly with reduced physiological reserve and co-morbidities are common.

In a cohort by Fehlings et al. of 302 patients who had surgical treatment of CSM the overall complication rate was 15.6% (47 patients) with 11.6% (35 patients) being major and 7% (21 patients) being minor complications. (5) In this study, the overall perioperative complication rate was 18.2%. There was a 9.8% incidence of major complications which included death due to severe chest infection in two cases aged 87 and 88, congestive cardiac failure in one case, worsening of myelopathy in two cases and failure of fixation in two cases. The incidence of minor complications was 8.4% including superficial infection in one case, temporary C5 radiculopathy in two cases and persistent axial neck pain in three cases. These results are comparable with those of Fehlings' study which makes these figures valid for quoting when considering surgical treatment of CSM.

In the single case that underwent occipito-cervical fusion for degenerative instability of the upper cervical spine, the resulting neck stiffness was poorly tolerated. This necessitated the subsequent removal of the instrumented fixation and generated a reasonable improvement. This is consistent with the findings of Malcolm et al., who stated that half of their group of patients had a significant change of lifestyle following similar procedures due to neck stiffness. (9)

CONCLUSION

Our data indicate that surgical decompression is effective in arresting the progress of CSM and can offer a fair chance of improving the clinical outcome of the disease. Intervention at an early stage correlates with a better functional outcome. There is enough to gain even at early stages of the disease to justify surgical decompression. However, surgical decompression has to be considered carefully especially in older fragile patients with significant co-morbidities and patient counselling should be a fundamental step in the decision making process.

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