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Prognostic Factors in the Surgical Management of Cervical Spondylotic Myelopathy: Our Experience

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Abstract

Introduction: Cervical Spondylotic Myelopathy is a common degenerative disorder of the cervical spine that can potentially cause devastating and irreversible impairment of neurological function. It's a major source of disability in adult population leading to acquire Spinal Cord Dysfunction. The anterior cervical discectomy and fusion (ACDF) is established gold standard for degenerative cervical spine diseases. A clear overview of other surgical techniques is lacking. Cervical disc Prosthesis is not inferior to disectomy and fusion probably some superior in terms of neck pain. *Material and methods:* This Prospective study was done in Gandhi Medical College and Associated Hamidia Hospital Bhopal from Sep 2014 to August 2018. We included 124 patients: 89 male and 35 female. The age range is between 16 and 84 years, and means age was 58. *Result:* Our study suggest that patients with Nurick Grade 2 cervical spondylotic myelopathy are likely to improve from surgery and the duration of myelopathy symptoms do not have relation with the severity of the disease but is an independent prognostic factor of surgical outcome. Nurick Grade 2 cervical spondylotic myelopathic patients have good chance of resolution of symptom ($p < 0.001$) following surgery. *Conclusion:* The cervical discectomy with interbody fusion for cervical spine disease reduces pain and improve quality of the life of the patients. In light of the tremendous suffering associated with cervical spine disease, the development of new non-pharmacologic strategies to alleviate chronic pain and improve the quality of life for cervical spine disease patients deserves immediate attention and encouragement. The use of SCS has been shown to reduce opioid use and improve function in patients with other pain conditions: a very important consideration in light of the current epidemic of opioid addiction and abuse. The most important predictors of outcome were preoperative severity and duration of the symptom, also the patients selection is a key factor in determining functional outcome with good result if the pathology, clinical presentation and the radiological changes correlate.

Keywords: Cervical spine surgery; Cervical spondylotic myelopathy; Clinical outcome; Prognostic indicators.

Introduction

Cervical spondylotic myelopathy (CSM) is the most common cause of spinal cord disfunction world wide in the elderly population.[1] The disease is caused by the degeneration of various components of the vertebra, intervertebral disc, the supporting ligaments and the facet joints.[2] Cervical spondylotic myelopathy (CSM) and cervical spondylotic radiculopathy (CSR) caused by compressive lesions from degenerative spondylotic changes have been surgically treated by various means: Anterior cervical discectomy with/without corpectomies subtotal corpectomies with strut grafting, multiple discectomies with or without inter body fusions, laminectomy, and laminoplasty.

In the majority of cases there is a slow stepwise deterioration in neurological function. However in some patients the disease is characterized by a stepwise progression of myelopathic symptoms. And approximately 5% of patients present with a dramatic and rapid functional decline.[3]

The onset of CSM is generally insidious and progresses in a stepwise fashion.[4,5] Upon diagnosis of symptomatic CSM, a physician often recommends surgical treatment to decompress the spinal cord.[6] Surgery has proven to be an effective intervention for the full range of myelopathy severity.[7]

Cervical spondylosis is an insidious degenerative disease that starts in the intervertebral disk and continues to the surrounding bone and soft tissue. The height of the intervertebral disk decreases when the natural aging process begins with decreasing disk height, diffuse intumescence forms in the disk, which causes the outburst of the disk from the annulus. Calcified disk herniations, osteophyte formations, arthritic changes, and hypertrophy in facets accompany this condition. Treatment for cervical spondylotic myelopathy (CSM) includes physical treatment and surgical decompression operations. Surgery is preferred in patients with refractory pain, progressive neurologic deficits, and detectable compression in the spine and nerve roots.

Although CSM is a frequently seen pathology in routine neurosurgery practice, anticipating patients' postoperative condition is difficult. In this study, we tested the effects of sex, age, symptom duration, number of compressed disk levels, spinal cord diameter, sagittal alignment, hypertension (HT), diabetes mellitus (DM), and intensity differences in magnetic resonance imaging (MRI) on the prognosis for CSM.

We hypothesized that preoperative symptom duration and CSM severity as graded according to the Nurick classification,[8] would correlate with the surgical outcome and that patients with more advanced disease stage and/or with prolonged duration of preoperative symptoms would have lower likelihood of improvement following surgery, when compared with patients in an earlier stage and/or with a shorter duration of CSM symptoms respectively.

Objectives

The objective of this study is to determine the most important clinical predictors of outcome in surgical management of compressive Spondylotic Myelopathy (CSM). This study will also address whether age, duration of symptoms, baseline severity score are certainly predictors and will also examine other clinical factors. The goal of surgical management with radiculopathy or myelopathy is decompression of the nerve root or cord, correction of anteroposterior flattening and distortion, correction of cervical instability and realignment of cervical spine.

Materials and Methods

This Study was carried out at Govt. Medical College, Bhopal from Sep 2014 to Aug 2018, which includes 124 patients 89 male and 35 female. The age ranges is between 16 and 84 years, and mean age was 58.

We included consecutive series of patients diagnosed as CSM who underwent surgery at our instauration between Sep 2014 and Aug 2018. Particular attention was paid to information regarding preoperative CSM diseases severity, as graded according to the Nurick classification (Table 1).

Table 1: The Nurick classification used to grade the severity of cervical spondylotic myelopathic disease

Grade	Description
0	Root signs and symptoms; no evidence of spinal cord involvement
1	Signs of spinal cord involvement but no difficulty walking
2	Slight difficulty walking that does not prevent full-time employment
3	Gait abnormality prevents employment, but assistance is not required to walk
4	Able to ambulate only with assistance
5	Chair-bound or bedridden.

Pre and Postoperative Nurick grades were recorded for each patient. Preoperative Nurick grades were defined as a grade before surgery. Postoperative Nurick grades were recorded clinically at the last follow-up.

In this study all 124 patients met the inclusion criteria (84 males and 34 females). The mean is 58 (16 to 84). The preoperative Nurick classification was grade 1 in 53 patients (43.1%), Grade 2 in 44 (35.2%), grade 3 in 23 (18.1%) and Grade 4 (3.6%). The mean duration of myelopathic symptoms before surgery was 15.4 months. An anterior cervical decompression and fusion (ACDF) was done in 102 patients (82.6%), 2 patients (1.3%), underwent posterior decompression laminectomy, and a posterior cervical decompression and fusion (PCDF) was done in 20 patients (16.1%).

Primary outcome measures of interest were: neck and/or arm pain, neck-pain-specific functional status, and self-perceived recovery. Secondary outcomes were sick leave and complications of surgery. Studies were combined into 2 clusters:

1. Surgical fusion methods compared with other surgical fusion methods.
2. Surgical fusion methods compared with artificial (prosthetic) cervical disc surgery.

We divided the data into 2 subgroups

1. Whether there was clinical evidence of improvement following surgery.
2. Postoperative improvement of disease by ≥ one nurik grade.

Another sub-analysis was performed to identify patients who were cured from CSM (i.e. Nurick Grade 0) by surgical intervention.

The statistical analysis was conducted using means and standard deviations (SD). A p–value < 0.05 was used to define significance.

Results

In our study the mean follow-up was 16.40 months.

We have 53 patients in grade 1 disease 9 (17.8%), shown improvement to grade 0 disease, while 44 (82.1%) had unchanged or deterioration. 44 patients with grade 2 disease, 26 patients (60.9%) were improved while unchanged/deterioration was found in 17 cases (39.1%). 23 Grade 3 patients, 11 (48.9%) showed improvement as compared to 12 patients (51.1%) without postoperative improvement. The 4 patients with Grade 4 disease only 1 (11.1%) showed improvement postoperatively, rest the majority (88.9%) had deterioration or no changed. The overall improvement to Nurick Grades 2 and 3 were 5.10 times (95%, $p < 0.001$) and 2.75 times (95%, $p = 0.034$) more likely to be cured from CSM, respectively, compared with patients with Grade 4 disease. The patients with preoperative Nurick Grade 2 and 3 were 3.28 times (95%, $p = 0.004$) and 6.61 times (95%, $p = 0.111$) more likely to have improvement (Table 2 & 3).

Table 2: Descriptive characteristics of the patient (CSM)

Characteristic*	
Patients (n)	124
Mean age at surgery (yrs) (SD; range)	58.0 (16-84)
Female (n, %)	34 (42.2%)
Previous spinal surgery (n, %)	
Cervical	16 (13.2%)
Thoracic	3 (2.4%)
Lumbar	10 (8.7%)
Radiculopathy (n,%)	92 (74.2)
Myelomalacia (n,%)	51 (41.1)
OPLL (n, %)	12 (9.7)
Mean duration of myelopathy (mths) (SD; range)	15.4
Type of surgery (n, %)	
ACDF	102 (82.6)
PCDF	20 (16.1)
Laminectomy	02 (1.3)
Mean levels involved (n) (SD; range)	2.60 (1.13:1 to 6)
Mean follow-up (mths) (SD; range)	16.40 (months)
Presence of neck pain (n, %)	71.8%

*OPLL, ossification of posterior longitudinal ligament; ACDF, anterior cervical decompression and fusion; PCDF, posterior cervical decompression and fusion.

Table 3: Comparison of patient characteristics between improvement groups

Variable* p	**No improvement**	**Improved**	**p value†**
Total (n = 124)	76 (55.16%)	48 (38.5)	
Mean (SD) age at surgery (yrs)	58	58	0.943†
Female (n, %)	21	13	0.530
Previous surgeries (n, %)			
Cervical	11	5	0.155
Thoracic	2	1	0.354
Lumbar	6	4	0.265
Radiculopathy (n, %)	52	38	0.065
OPLL (n, %)	7	5	0.576
Type of surgery			
ACDF	58	42	Reference
PCDF	14	6	0.154
Combined approach	3	0	0412
Mean (SD) levels (n)	2.58 (1.22)	2.60 (0.98)	0.872†

Variable* *p*	No improvement	Improved	*p* value†
Mean (SD) follow-up (mths)	17.53 (15.90)	12.12 (13.68)	0.005†
Follow-up duration (n, %)			
≥ 1 year (n = 115	80 (69.6)	35 (30.4)	0.010
≥ 2 years (n = 50)	37 (74.0)	13 (26.0)	0.035
Neck pain (n, %)	107(71.8)	69(72.6)	0.960
Preoperative Nurick grade (n, %)			
Grade 1	88 (57.52)	19 (20.00)	Reference
Grade 2	34 (22.22)	53 (55.79)	<0.001
Grade 3	23 (15.03)	22 (23.16)	<0.001
Grade 4	8 (5.23)	1 (1.05)	>0.999

Fig. 1: MRI cervical spine showing C5-6, C6-7 DISC Prolapse with Increased Signal Intensity in T2 Images.

Fig. 2: MRI cervicval spine showing global cervical canal stenosis, anteriorly due to ossified posterior longitudinal ligament and osteophytes, and posteriorly due to ligamentum flavum hypertrophy along with signal changes in the cord in the compressed segment.

Fig. 3: X-ray cervical spinal shows cage insertion after anterior cervical discectomy.

Fig. 4: X-ray cervical spine showing fusion after 4 month at C5-6.

Discussion

A CSM is a disease of cervical spinal cord that results from the compression of the degenerative cervical spine Our study suggests that patients with preoperative Nurick Grade 4 diseases have bleak chances of improvement with surgical intervention. Those with grade 2 or 3 disease have the greatest chance of improvement from the surgery. The duration of symptoms is an independent prognostic indicator for outcome. Patients with a longer duration of symptoms had a worse prognosis for postoperative improvement compared with

patients with a shorter duration of symptoms and severe baseline score are more likely to have an unfavorable surgical results. The motor-evoked potentials have been shown to indicate the severity of disease and to predict the postoperative outcome in CSM patients.[9] The previous surgical outcome studies investigating the impact of preoperative CSM symptom duration have a limited sample size, making definitive conclusions difficult to draw.[10–12]

Patients with multi segmental levels of the high signal intensity on T2- weighted MR images tended to have poorer surgical results. However the transverse area of the spinal cord at the level of maximum compression was a better prognostic indicator. Low-signal intensity changes on T1-Weighted MR images sequences indicated a poor prognosis.[13] In our study, there was no relation between results and preoperative high signal intensity at T2-weighted MR imaging. The degree of postoperative recovery in the CSM seemed to be directly related to the age and severity of symptoms.

Choi et al.[14] identified the preoperative Nurick grade as a predicting factor for post-operative outcome. However there was no correlation with the duration of symptoms, which concurs with the finding of our series. A possible association between a longer myelopathic symptom duration and a less favorable surgical outcome, which is controversially discussed in literature is not new. Lee, Manzano and Green[15] concluded that the duration of symptoms greater than 18 months was associated with a poorer surgical outcome. In our series, the mean duration of myelopathic symptoms in the study sub-group with absent post-operative improvement was 16.3 months.

The improvement to complete symptom resolution in grade 3 patients was statistically significant (p = 0.034). Effective cervical canal diameter is very important factor determining the outcome after surgery in CSM.[16–18] The normal mid sagittal diameter in the cervical spine C3 to C7 is 17–18 mm. Canal diameter <10 mm is considered significant and is associated with varying neurological deficits. White and Panjabi, Fager, and Fergusson noted that effective canal diameter is one of the important prognostic factors, and better prognosis is seen when the effective canal diameter is above 11 mm. In our study, 24% of patients with effective canal diameter more than 11 mm showed improvement; whereas 92% of patients with effective canal diameter 9 mm or less either worsened or remained static.

Number of levels of compression

- CSM is commonly due to compression opposite C5-6 and C6–7 discs.
- The progress of the disease is, usually, contiguous and may be rostral or caudal.
- Fujiwara and Ahn have found that patients with one or two levels of cord compression had a better outcome than those with three or more levels of compression.[19,20]
- In our study, 80% of patients with a single level of compression improved, whereas 89% with 3 or more levels of compression worsened or remained static.

Intrinsic cord changes

- Intrinsic signal changes seen in T2-weighted MRI, reflects the pathological changes in the cord due to compression.
- Chen et al. studied MRI findings in 64 patients with CSM and classified intramedullary hyperintense signal changes in T2-weighted images into: Type I, where the hyperintense signal had a faint, fuzzy border and Type II, where the hyperintense signal had sharp well-defined border.[21]
- The Type I signal changes were indicative of edema and ischemia which are reversible and Type II signal change were indicative of myelomalacia which is irreversible.
- In our study 52% of patients with no intermedullary signal change improved, whereas 88% with Type II signal change worsened or remained static.

Surgical approaches: Standard surgical treatment for CSM has been either direct anterior excusion, with or without fusion or indirect posterior decompression.

A. *Anterior approach:* Now-a-days is widely used it can be achieved by using various techniques; anterior discectomy with or without fusion, anterior subtotal corpectomy, and anterolateral decompression. Anterior cervical discectomy with fusion is an excellent option for one-or two-level spondylosis. Anterior corpectomy technique requires bone fusion with or without spinal instrumentation, but degenerative changes at adjacent vertebral levels frequently result in long-term morbidity.

B. *Posterior approach:* Various techniques of posterior decompression have been reported

such as extensive or limited laminectomy, posterior foraminotomy, and more recently open door laminoplasty. Although the posterior procedure preservers the anterior motion segments and does not usually require bone-graft fusion. Laminectomy yields poor results from late deformity and late neurologic deterioration. Laminoplasty was developed to address cervical stenosis of three or more segments and compares favorably with anterior corpectomy and fusion for neurologic recovery. Laminoplasty had a lower complication rate then corpectomy and strut grafting but postoperative axial pain was observed in 46% of cases, kyphotic deformity developed in 8%.

Our Grade 1 study sub-population with myelopathic signs and gait problems was less likely to recover completely to Grade 0 compared with our Grade 2 patients. The patients in our study population with Nurick Grade 1 disease had a slow stepwise deterioration in neurological function, compared with patients with steadily progressing disease or dramatic, more rapid functional decline.

Outcome

Yagi et al.[22] found that long-term clinical outcome was significantly worse in patients with intramedullary signal intensity changes on MRI. The long-term clinical outcome was also significantly worse in patients with postoperative expansion of the high signal intensity area. High signal intensity area occurs from repeated minor trauma inflicted on the spinal cord from segmental instability. The postoperative progression at 2 years was 56.0% with progresion occurring more frequently in younger patients then in older ones. Rajshekher and Kumar[23] reported that long-term functional outcome even in poor-grade patients (Nurick grades 4 and 5) with cervical spondylotic myelopathy (CSM) or OPLL after central corpectomy has been reported to be good. The improvement to complete symptom resolution in Grade 3 patients was statistically significant (p = 0.034). Our Grade 1 study sub-population with myelopathic signs and gait problems was less likely to recover completely to Grade 0 compared with our grade 2 patients. The patients in our study population with Nurick Grade 1 disease had a slow stepwise deterioration in neurological function, compared with patients with steadily progressing disease or dramatic, more rapid functional decline.

Conclusion

From our results we present a grade-based prognosis for surgically treated CSM patients. Patients with Grade 2 disease are most likely to have full resolution of symptoms with surgical intervention compared with Grade 4 patients. In addition, individuals with Grade 3 disease will be more likely to be able to return to work as a result of surgical intervention. This information can be interpreted in two ways. Firstly, it supports early surgical intervention in patients with Nurick Grade 2 or less because if left to progress to Grade 3 disease, persistent gait abnormalities are likely. Similarly, if left to progress to Grade 4 diseases, chances of improvement are unlikely. Secondly, it may indicate that patients with grade 1 disease can be observed for disease progression before surgical intervention, reducing the rate of unnecessary surgery. Future prospective studies on this distinction are warranted to provide more information on the prognosis of patients with CSM and their benefit from surgery. The discectomy with interbody fusion for CSM reduces pain, improve quality of life in light of the tremendous suffering associated with cervical spine disease. The most important predictors of outcome/ prognostic were preoperative severity and duration of symptoms also the patients selection is a key factor in determining functional outcome with good results if the pathology, clinical presentation, and the radiological changes correlate.

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