Management of mild Cervical Spondylotic Myelopathy

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Abstract

Introduction: Most of the elderly individuals with cervical spondylotic myelopathy (CSM) suffer from a progressive, and irreversible spinal cord dysfunction and pain. The incidence is rising in tandem with the ageing population. Due to its debilitating effects on a person's physical, mental, and social aspects, it is quickly becoming a public health issue. Therefore, the primary objective is to diagnose the condition in its milder form, prevent its progression, and treat the symptoms aggressively. This article discusses the management of mild CSM, including our experiences, difficulties, current state of knowledge, and potential future developments.

Material and Methods: From the patients presenting with neck pain in the OPD, those with mild CSM according to modified Japanese Orthopedic Association (mJOA) scoring system were selected. Their disabilities were studies with commonly used scoring systems like Nurick grading, Neck Disability Index (NDI), and quality of life with SF-36v2. Only the degenerative cases were included, and other pathologies were excluded. Classical cervical disc prolapse with radiculopathy was also not included. Conservative management was initiated in all these patients and followed up for the improvement or deterioration.

Results:With the above selection criteria, 235 patients with mild CSM were included in the studies. There were 186 males and 49 females with ages ranging from 42 to 78 years. The clinical profiles were studied. The major signs and symptoms were neck pain, disturbed dexterity of hands, imbalance on walking and exaggerated reflexes. The impairments were stratified and found that the average mJOA score was 16.2, Nurick score was 2.8 and NDI was 33.6. The quality of life was judged using SF-36v2 and was 39.7. The patients were monitored for three, six, twelve, and twenty-four months with conservative care. The follow up was very poor and only 46 out of the total 235 patients could be followed up to two years. Thus the result obtained could not derive any significant information. The symptoms like pain significantly reduced and there was improvement in overall scores including the quality of life. There were no case of deterioration during the conservative treatment. Thus, there was no discernible advancement that called for surgery.

Conclusion:Mild CSM is a common, under diagnosed and usually ignored entity which affects big portion of elderly population. It specifically impacts the mental and social aspects that impairs one's quality of life, as well as the functional and emotional aspects. They are initially being treated conservatively and closely monitored for signs of worsening and advancement. Most of the patients respond to conservative treatment but those having risk factors for progression and bad prognosis, should remain vigilant of any features of deterioration. The treatment plan must be timely modified if a patient's clinical condition deteriorates preventing life-long sufferings.

Keywords: Mild CSM, mJOA score, Conservative management

Introduction

Cervical spondylotic myelopathy (CSM) is a degenerative, progressive and irreversible condition affecting middle aged and elderly individuals. CSM is a clinical diagnosis, and it is categorised using modified Japanese Orthopaedic Association (mJOA) grading system[1], the Neck Disability Index (NDI)[2], Nurick scale[3], and the Short Form Health Survey version-2.0 (SF-36v2)[4]. To guide the management, CSM is further classified into mild, moderate, and severe degrees using mJOA grading. The natural course of CSM is variable and it is important to identify the risk factors and bad prognostic indicators, and remain vigilant for progression. Although most cases of mild CSM can be treated non-operatively, some deteriorate, do need surgery. This study is focused on improving our understanding and management of mild CSM by utilising the above concept.

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Material and Methods

The patients attending neurosurgical OPD from 2012 to 2019, for neck pain were evaluated. Of these, with mild CSM according to mJOA score, were included. Those with moderate or severe CSM, those with associated trauma, infection, inflammation, vascular pathologies, or malignancy of cervical spine, were excluded in the study. Those with purely

radiculopathy due to disc prolapse were also not excluded. These patients were evaluated clinically and radiologically and followed up in average of two years. During follow up, changes in the scoring systems, radiological findings, other clinical parameters and risk factors associated were evaluated. Those who deteriorated clinically were planned for surgery.

Results

Of all those patients attending neurosurgery OPD with neck pain, 235 cases of mild cervical spondylotic myelopathy (CSM) according to mJOA scoring system, were included in this study. The age ranged from 40 years to 78 years (average 62 years) with 186 (79%) males and 44 (21%) females. The clinical presentations are tabulated below:

The symptoms and signs	No. of patients	Percentage
Numb hands	135	57.4%
Clumsy hands	86	36.6%
Gait disturbances	88	37.4%
Bilateral arm paraesthesia	44	18.7%
L'Hermitte's phenomenon	36	15.3%
Pain	224	95.3%
Atrophy of hand intrinsic muscles	64	27.2%
Hyperreflexia	216	91.9%
Positive Hoffman sign	118	50.2%
Upgoing plantar responses	186	79.1%
Lower limb spasticity	38	16.2%

The details of the other clinical and radiological findings are tabulated below:

Table: Base line clinical data and results

	No. of patients	Percentage
Age	40 to 78 years	
Sex Male Female	 186 49	79% 21%
Smoking	178	75.5%
Disc herniation	235	100%
OPLL	42	17.8%
Hypertrophied ligamentum flavum (HLF)	196	83.4%
Subluxation Grade 1 Grade 2 Grade 3	 168 54 13	
Congenital stenosis	35	14.8%
Mild modified Japanese Orthopaedic Association (mJOA) scoring 15 16 17	46 112 77	19.5% 47.6% 32.9%
Nurick scoring Grade 1 Grade 2 Grade 3	All had mild Nurick scoring 296 26 3	 88% 11% 1%
Neck Disability Index (NDI)		
Section 1 (Pain intensity)	3.2	
Section 2 (Personal care)	0.8	
Section 3 (Lifting)	2.3	
Section 4 (Reading)	2	
Section 5 (Headache)	0	
Section 6 (Concentration)	0	
Section 7 (Work)	1.7	
Section 8 (Driving	Most of them did not drive	
Section 9 (Sleeping)	1.4	
Section 10 (Recreation)	3.8	
SF-36v2	39.7	

It was difficult to include all the criteria laid in the scoring system as they were not applicable, for example, driving. So, the accuracy and interpretation of the scoring system have some limitation with our patients. All of the 235 patients were managed conservatively. They were advised for supervised physiotherapy, stop smoking, posture correction, neck bracing for two weeks, activity modification and analgesic when required. During follow-up, counselling was provided regarding CSM, including its potential for progression, irreversibility, identification of the early signs of worsening, and significance of continued care. They were followed in OPD basis in 1, 6, 12, 24 months.

X-rays were obtained in follow up only in those who continued to have pain. However, none of the patients showed aggravation of degeneration or spondylolisthesis.

Parameters	Pre-operative	6 months	12 months	24 months	Differences	P value
	Average	Average scores	Average scores	Average scores	Average	
mJOA score	16.2	16.2	16.7	16.5	0.03	<0.01
Nurick score	2.8	2.1	2.1	1.9	-0.9	<0.01
Quality of life (SF36v2)	39.7	41.2	42.6	43.7	4	<0.01
NDI	33.6	24.8	22.6	18.8	-14.8	<0.01

It is difficult is derive any conclusion from this results as out of 235 patients included in this study, 80% the patients were lost to follow up despite our best of the effort to educate and motivate them. Most of the patients whose symptoms remained stable, did not come for follow up. Thus, no proper and reliable statistical analysis could be obtained on the presentations and the results. However, none of these patients deteriorated enough to need surgery. The reasons for the poor follow up are probably , the elderly individuals who got better did not want to come back for follow up, those deteriorated feared for surgery, and

some adapted to their deformity and problems. The follow up period was only 2 years which was very short for a slowly progressive disease like CSM. However, we learned the value of conservative management in mild CSM and encouraged the patients to continue the non-operative methods. Educating the patients and their relative of the disease and its natural course was also very important and fruitful to prevent deterioration. We plan to continue with follow up for a longer time based on clinical and radiological parameters, recruiting more patients during our studies, and try identify the risk factors and prognosticating factors.

Discussion

Cervical spondylotic myelopathy (CSM) is a non-traumatic, chronic, irreversible and progressive cervical cord dysfunction that results from the degeneration of the cervical spine. An estimated 5% of population over 40 years age, are affected by it. It is the most prevalent type of spinal cord dysfunction in people over the age of fifty-five. More than 50% of non-traumatic spinal cord injuries and disabilities are caused by CSM. It is more commonly seen in Japan and USA[5,6,7,8,9,10]. According to The World Bank[11], the incidence is rising along with the ageing population and might pose a serious threat to public health by 2050. It significantly affects patients' social, mental, and financial well-being as well as that of their family and the community[12].

Pathophysiology

Degeneration of spine results in alterations to the composition, dimensions, and shape of bones, ligaments, and cartilages. This results in spine to be unstable, deformed, and stenotic. The normal diameter of the cervical spinal canal is between 13 and 20 mm. Significant cervical canal stenosis is defined as the sagittal diameter being less than 13 mm. The most frequent degenerative alteration, disc herniation, affects 75% of these patients[13]. Other effects of degeneration include Spondylosis (68%), ossified posterior longitudinal ligaments (OPLL) (21%), hypertrophy of the ligamentum flavum (18%), subluxation (4%), etc[13].

The neural structures are mechanically compressed by these degenerative changes, particularly spinal stenosis. The effect on the spinal cord and root varies depending on the duration the compression, the degree of compression, the rate at which the compression advances, the consistency or erratic nature of the compressive force, and whether the compression is static or dynamic. Additionally, ischemia of the spinal cord may result from a vascular compression. Mostly, vascular and mechanical forces operate in tandem. This sets off a series of molecular events that result in neuronal excitotoxicity and apoptosis, permanently harming spinal cord neurons and glial cells and contributing to the development of CSM[14,15,16,17,18].

The majority of CSM patients (61%) involve one or two spinal levels. About 25% of them develop clinical symptoms as a result of mechanical compression and/or vascular compromise of the spinal cord[19,20,21].

Natural history

Natural history of CSM is unpredictable and rather erratic. A dismal prognosis is faced by the majority (20% to 67%) of cases[22,23,24]. Approximately 20% experience a gradual, increasing loss of neurological function, 25% have a sudden start of symptoms followed by extended periods of quiescence, and 55% suffer a stepwise decline in neurological function[25,26]. About 87% of people ultimately develop moderate to severe disability. However, some reports indicate that between 30% to 82% of individuals with mild CSM, even when followed for a decade, still exhibit no significant decline in their neurological condition[27]. Therefore, it is thought that a lengthy duration of follow-up is preferable[28,29,30].

Progression is more predictable with OPLL but this still is variable. In those with severe OPLL-related cord compression or canal stenosis, myelopathy develops in 8% of cases by 12 months and in 22.6% by 44 months[31,32]. It is seen that when the range of motion of the cervical spine is severely limited due to OPLL, there is no further progression of myelopathy even when followed up 10 years. It emphasises the role of dynamic factors in development and progression of myelopathy, as well as the positive role of internal rigid fixation in cases of unstable OPLL[13,25,33,34].

Risk and prognostic factors

There are some risk factors that predispose and accelerate the process of myelopathy. Identifying these subsets of patients possessing the risk factors, helps to closely monitor them for any progression of myelopathy and timely change the treatment strategy to prevent further deterioration[34,35,36,37,38,39]. The following are the known risk factors:

1.It was determined that male sex, advancing age, and relative socioeconomic deprivation were independent risk factors for CSM.

2.Genetic factor- SNPs of potential interest were identified in GTPBP1 and an intergenic region on chromosome 18, but these assocaiations did not reach genome-wide significance[40].

3.Radiological factors: Circumferential spinal cord compression in the maximal compression region on axial MRI is a well-established and significant prognostic factor in CSM. The risk of developing CSM is increased when the AP diameter of the cervical canal is less than 12 mm, the cross-sectional area in the maximum compression segment is less than 30 mm^2, the vertebral body-to-canal ratio is less than 0.82[41], and the ratio of the spinal cord's AP diameter to its transverse diameter is less than 0.4[38,40,42].Additionally, a reduced diameter of the cerebrospinal fluid column, a lower segmental lordotic angle, an angular-edged spinal cord, severe ventral spinal compression, a higher percentage of vertebral slip, segmental kyphosis in the maximum compressed segment, and instability are other imaging findings that are associated with a poor prognosis[43].

4.When degenerative changes occur on an already-existing congenital or acquired narrow canal, such as in the case of achondroplastic dwarfs, Klippel-Fiel syndromes, cranio-cervical abnormalities, etc., CSM develops more quickly and early[15,17,18,24,44,45]. In such cases, myelopathy can develop quickly and more extensively after even slight cervical spine injuries, leading to significant neurological deficits.

5.Expansion of the intramedullary signal intensity of cervical cord in postoperative MRI, also suggests a poor prognosis[46].

6.Those people presenting with radiculopathy have higher risk of developing myelopathy by 12 months, compared to those who have no radiculopathy (62.5% versus 26.3%). Clinical and electrophysiological signs of radiculopathy also predict future development of myelopathy[30,42, 47].

CSM is primarily a clinical diagnosis due to the limitations of the diagnostic techniques that are now available for assessment and prognostication[9,18,33]. Depending on the clinical features, different classifications are adopted. For the functional assessment as well as degree and severity of disability, modified Japanese Orthopaedic association (mJOA) scoring1 , NDI (Neck Disability Index)[2,48] and Nurick grading[3] are used. mJOA divides CSM into, mild (15 to 17), moderate (12 & 14), and severe (less than 11) degrees. For quality of life, Life Short Form-36 version 2 (SF-36v2)49 are used5,[50,51,52].

Early identification of progression of mild CSM is crucial as it is a progressive and irreversible condition. However, clinical aspects of mild myelopathy are non-specific, mimicking many other clinical entities. There are no pathognomonic symptoms or signs to identify myelopathy at an early stage[53]. With very slow and progressive loss of function, the patients often adapt to the deficiency and do not appreciate the problem till the disability or the pain significantly affects activities of daily living. Thus the patients seek medical attention at a very late stage of the disease[54].

When investigating CSM, conventional MRI is regarded as the "gold standard." The findings, however, are only of established myelopathy and not of early phase of myelopathy. Conventional MRI show poor correlation with CSM clinical manifestations. Radiological evidence of myelopathy is seen in about 5% of asymptomatic patients also. Conventional MRI is not useful for evaluating alignment because it is performed on a supine patient. Furthermore, it is not a reliable indicator of neurological status before or after surgery[55,56,57,58]. As a result, conventional MRI has its own limitations in CSM, particularly detecting myelopathy at an early stage[59,60].

Thus, for evaluating spinal cord integrity, advanced MRI have been developed and tested to detect early myelopathic alterations[61,62]. These MRI make it possible to measure changes in spinal cord tissue particularly subclinical tissue injury, demyelination, axonal damage, and atrophy, making it possible to obtain quantitative microstructural changes at an early stage. They can be utilised for diagnosis, prognostic prediction, and monitoring for myelopathic development in people with asymptomatic cervical spinal cord compression. A few examples of these noble MRIs are:[63]

●Novel Quantitative MRI (qMRI) measures transverse area and assesses spinal cord integrity in mild CSM. It can accurately predict the possibility of deterioration and can help identifying those who are at high risk of deterioration and who may benefit from decompression[63,64,65].

●Diffusion Tensor Imaging (DTI) has a strong correlation of fractional anisotropy and modified Japanese Orthopaedic Association scores. It can be used for better evaluation of white matter integrity and microstructural changes and thus future decision-making regarding conservative or surgical management[66,67,68,69,70].

●Magnetisation Transfer (MT)is established as a marker of myelin integrity in mild CSM, thus detects an early stage of myelopathy[71,72].

●Susceptibility weighted imaging (SWI) offers great contrast-to-noise ratio and high spatial resolution pictures. The combination of phase and magnitude images provide useful information regarding the extravascular blood degradation products and calcium deposition, which are indicators of neuronal injury[73].

●Functional Magnetic Resonance Imaging (fMRI) measures Blood Oxygen Level Dependent (BOLD) signals[74] which can be further analysed to measure regional homogeneity (ReHo) and amplitude of low-frequency fluctuation (ALFF). These provide insight into different aspects of regional neural activity[66,75,76].

●Magnetic Resonance Spectroscopy (MRS) with Choline/N-acetylaspartate (Cho/NAA) has the best correlation with CSM severity[76]

Intramedullary signal intensity (ISI) changes are the changes that occur within the cord and observed in MRI. These alterations are also observed in syringomyelia, atrophy of the cord, myelomalacia, oedema, and demyelinating diseases. MRI T2-hyperintensity with T1-hyperintensity is indicative of more persistent damage and worse prognosis. It is related with more clinical deterioration than T2-hyperintensity alone[77]. Changes in multi-level signal intensity are predictive of worse surgical results and may indicate necrosis or cavitation in the spinal cord[38,41,78,79,80,81,82,83]. However, ISI does not necessarily correlate with that of clinical symptoms or postoperative outcomes[37,39,84,85,86,87].

Electrophysiology is a useful predictor of the course of CSM because of the strong link it has with myelopathy severity[88]. It detects central sensory conduction impairment and prolonged motor latency in CSM in 43.8% and 37.5%, respectively[89,90]. In a study looking at progressive myelopathy, there was a correlation found between the SEP and a declining mJOA[91]. When spinal cord compression is present in asymptomatic patients, aberrant SEP and MEP can often be used to predict the development of CSM and guide the strategy of management. Thus, it might be helpful in identifying patients who are at risk of developing myelopathy[12,42]. However, because electrophysiology lacks anatomical data, it is unable to pinpoint the precise location of the lesion. While there is evidence supporting the usefulness of electrophysiology in predicting surgical outcomes, more research has to be done in this area[7].

Management

Pain relief and halting the progression of myelopathy are the two main objectives of CSM[92]. Surgery has been widely regarded as the accepted treatment for moderate and severe CSM, based on mJOA rating, provided that there are no additional contraindications[93]. However, there is a continuing discussion

on the most effective management approach for mild CSM[94,47]. The management of mild CSM, as advised by the standard guidelines[82,95] includes supervised trial of conservative management with structured rehabilitation. Majority of the literature suggests that most of these mild CSM eventually deteriorate irreversibly. Thus the major objective of treating mild CSM is to identify the patients who are most likely to deteriorate, detect the deterioration as soon as possible, and intervene before more spinal cord damage occurs[96].

Mild DCM is associated with significant impairment in quality of life. Quality of life is typically under-appreciated and its negative impact on functionality causes more mental and social problems than physical challenges[92,97,98]. Although there may not be a noticeable neurological impairment or deformity in mild CSM, it can still have a significant impact on small but critical functions such as mobility, balance, gait instability, numbness (81%), weakness (65%), and clumsy hands (54%), which can impair fine motor skills, balance, and dexterity[99]. Day to day activities are likely to be severely hampered in mild CSM due to the disruption in hand function. This disability negatively impacts professionals who perform fine work with their hands, such as musicians, doctors, engineers, etc. 44% of patients with mild CSM experience pain, which is known to significantly lower physical health-related quality of life (QOL)[100,101]. Therefore, in cases of mild CSM, the criteria for surgery must take into account associated pain and both mental and functional state, with the ultimate goal of improving quality of life[95,92,102]. Surgery has shown to have significant gains in functional status, level of disability, and quality of life.

For individuals with a mild CSM, single-level myelopathy, and intramedullary signal change on T2-weighted magnetic resonance imaging, nonoperative treatment produces comparable results to surgical treatment[80]. The non- operative management includes[81] :

Physical Therapy	Strengthening the neck muscles, improving posture, and increasing flexibility which help alleviate symptoms and improve functional outcomes.
Medications	Non-steroidal anti-inflammatory drugs (NSAIDs) and Muscle relaxants
Neck Bracing	For short time, two weeks, till pain is controlled
Activity Modification	Modify activities to avoid exacerbating symptoms like avoiding heavy lifting, repetitive neck movements, or activities that put excessive strain on the cervical spine.
Education and Counselling	Alleviates apprehension by helping manage expectations and address any concerns or fears, improves understanding of the problem and motivation, and helps to detect failure of conservative management early.

Anti-inflammatory medications have been proposed in CSM because myelopathy causes a variety of inflammatory and cytotoxic alterations, yet there is no evidence to substantiate this theory. Randomised, placebo-controlled trials have not been conducted on any of the regularly prescribed medications. Riluzole is a neuroprotective medication that is currently being studied in a multicenter randomised controlled study (http://clinicaltrials.gov/ct2/show/NCT01257828) to see if it can help after decompressive surgery in mild CSM. Riluzole is believed to reduce glutamate excitotoxicity because it inhibits glutamate receptors and enhances glutamate receptor activity. In patients with moderate-to-severe CSM, riluzole did not enhance functional recovery above and beyond decompressive surgery in this research. It needs more research to determine whether riluzole offers any additional advantages for these patients[103].

If managed nonoperatively, the patient should be followed closely and monitored for neurological deterioration. The patient should be informed about the disease progression, the way to recognise it and to be on regular follow up.

Surgery

Each patient is unique, and the decision to have surgery should take into account the patient's symptoms, the course of their illness, and how they respond to conservative treatment. Surgery may be recommended even in asymptomatic instances who have radiologically significant compression[104]. Between 19.6% and 54% of patients require surgery when their condition worsens over the follow-up period while receiving conservative treatment[22,47,95]. If timely and appropriate surgery is performed, 18% of these demonstrate a notable reversibility of the vital functions within the first six months, leading to an improvement in overall quality of life as well as physical, social, and mental health[105]. This is evaluated by improvement in the mean SF-6D utility score[106], mJOA score, Nurick grade, SF-36v2 score, and NDI[107,108]. Improvement in pain has also been shown to be an important factor in patient's satisfaction following cervical decompression surgery in mild CSM and this is likely to be a key driver of the improvement in quality of life (QOL)[98]. As a result, surgery is now becoming standard of care for patients with mild CSM showing deterioration.

The approaches could be anterior or posterior and rarely circumferentially. This article does not address the indications or the specifics of these procedures. A systematic analysis evaluating the effectiveness of various surgical approaches for the management of CSM revealed that a number of widely recognised anterior or posterior approach surgical procedures yield comparable outcomes. The two most popular decompressive techniques are posteriorly approached laminectomy or laminoplasty and anteriorly approached discectomy or corpectomy[7,109,110]. To avoid complications like post-laminectomy kyphosis[44,45,110], instability and progression of compression, internal fixation through posterior approach can be performed. Both lateral mass and pedicle screw fixation are commonly used procedures that facilitate the reduction, robust stabilisation, and restoration of cervical lordosis.

These are prophylactic surgery and put the patients at a risk of complications of surgery. However, the cumulative incidence of problems is modest and the adverse effects of surgery are probably minimal[107].

On making the decision for surgery, one should be aware that only 36% of these patients improve of their symptoms over time postoperatively and over 64% either remain stable or continue to deteriorate in function over time after surgery[111]. Sustained cross-sectional area less than 30 mm^2 is correlated with poorer recovery of function even after decompressive surgery[112,113] . The chance of improvement is more if the symptoms are of

and have mild CSM.

The surgical outcome in patients with CSM is influenced by various factors, including the patient's age, the radiographic transverse area of the level of maximal compression of the spinal cord, and the duration of symptoms[3,95,114]. Clinical follow-up is required for all patients, with baseline or preoperative mJOA and Nurick scores being compared at six, twelve, and twenty-four months. The SF-36v2 and SF-6D forms can also be used in a similar manner to assess changes in quality of life[115,116117].

Complications

About 14% of patients experienced perioperative complications[95]. Advanced age, extended surgical times, and the use of combined anterior-posterior operations are associated with increased rates of complications[118,119,120,121]. Hospitalisation expenses, mortality, and length of stay all rise as a result of these problems[120]. Common postoperative complications include: worsening of axial neck pain, bleeding, pseudoarthrosis, cardiopulmonary event (3%), deeper infection, hardware failure, deep wound infection, postoperative deformity if internal fixation was not performed, worsening of myelopathy, especially related to the C5 root, adjacent segment degeneration, dural tear and CSF leak, and very rarely, death.

Conclusion

Along with the increasing proportion of elderly population, the incidence of CSM is rising. The disease is progressive and irreversible. However it cannot be detected at its mild form or early stage as the presentation is non-specific. The initial management is non-operative unless the disease progresses. The possibility of detecting the early changes of progression in mild CSM can not be clinically or by conventional MRI but only by electrophysiological monitoring and advanced MRI sequences, wich are not widely available. Therefore, until such facilities are available, clinically monitoring mild CSM patients should be done with vigilance and close attention, especially in those with high risk factors and bad prognostic signs. This will allow for early detection of the progression of mild CSM and an early as well as timely switch to surgery.

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