Pathological changes of cervical degenerative myelopathy and its conservative medical and surgical treatment and outcome

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ABSTRACT

Objectives. The objective of our study was to assess the neurological outcome following posterior cervical laminectomy for patients with cervical spondylosis and to determine the factors that improve the neurological outcomes after surgery for those patients.

Materials and methods. A retrospective study on 25 patients with cervical spondylosis operated on via posterior cervical laminectomy between 2006 and 2009 in Al-Shaek Zaed teaching hospital for neurosurgical specialization. The patient divided into male and female groups, into above 55 years and below 55 years groups and into early and late diagnosed and operated groups. Parameters recorded include patient age, sex, neurological symptoms (severity and duration), postoperative follow-up and surgical outcomes. The diagnosis were made by the clinical signs and symptoms and by cervical MRI studies.

Outcomes. The 30 patients was divided into 20 (66.7%) male and 10 (33.3) female patients, 15 patients (50%) above and 15 patients (50%) below 55 years, 25 patients (83.4%) involved C5-C7 levels and 5 patients (16.6%) involved C3-C5 levels. Preoperatively: 6 patients (20%) had mild-moderate radiculo-myelopathic features, 18 patients (60%) had moderate-severe radiculo-myelopathic features and 6 patients (20%) had very severe radiculo-myelopathic features. Postoperatively: 16 patients (53%) had good outcome, 8 patients (27%) had fair outcome and 6 patients (20%) had poor outcome.

Conclusions. Cervical spondylotic radiculopathy can be treated conservatively while CSM is treated surgically. Early surgery give better outcome. Lordotic cervical spine can be treated with posterior approach but kyphotic spine need anterior approach.

Keywords: cervical degenerative myelopathy, surgical treatment, conservative treatment

INTRODUCTION

Cervical spondylosis is degeneration or abnormal wear on cervical vertebrae (1,2). It is a common degenerative condition of the cervical spine, caused by age-related changes in the intervertebral disks (3). These changes caused by degeneration can over time press down on or compress one or more of the nerve roots causing radiculopathy. In advanced cases, the spinal cord becomes involved (myelopathy). A previous neck injury can make a person more likely to develop spondylosis, but the major risk factor is aging. By the age 60, 70% of women and 85% of men show signs of cervical spondylosis on X-ray (1,2).

Cervical spondylosis is the result of disk degeneration with associated degenerative changes in the facet joints, hypertrophy of the ligamentum flavum, and ossification of the posterior longitudinal ligament. All can contribute to impingement on pain-sensitive structures (eg, nerves, spinal cord) (3). Subperiosteal bone formation occurs next, forming osteophytic bars that extend along the ven-

tral aspect of the spinal canal and encroach on nervous tissue (4,5). These most likely stabilize adjacent vertebrae, which are hypermobile as a result of the lost disk material (6,7). In addition, hypertrophy of the uncinate process occurs, often encroaching on the ventrolateral portion of the intervertebral foramina (5). Nerve root irritation may occur as intervertebral discal proteoglycans are degraded (8). Ossification of the posterior longitudinal ligament can occur with cervical spondylosis, this condition can be an additional contributing source of severe anterior cord compression (9).

Age-related hypertrophy of the ligamentum flavum and thickening of bone may result in further narrowing of the cord space (4,10,11). Additionally, degenerative kyphosis and subluxation are fairly common findings that may further contribute to cord compression in patients with CSM (9,12).

Dynamic factors relate to the fact that normal flexion and extension of the cord may aggravate spinal cord damage. During flexion, the spinal cord lengthens, resulting in it being stretched over ventral osteophytic bars. During extension, the ligamentum flavum may buckle into the cord, pinching the cord between the ligaments and the anterior osteophytes (10,11). Stretch-associated injury has recently been implicated as a pathophysiologic factor in CSM (13).

Cervical spondylotic myelopathy (CSM) is the most common cause of nontraumatic spastic paraparesis and quadriparesis. In one report, 23.6% of patients presenting with nontraumatic myelopathic symptoms had CSM (14). In males, the prevalence was 13% in the third decade, increasing to nearly 100% by age 70 years. In females, the prevalence ranged from 5% in the fourth decade to 96% in women older than 70 years (3). At age 60 years, half the men and one third of the women had significant disease (15). Eventually, greater than 70% of men and women are affected, but the radiographic changes are more severe in men than in women (16).

One third of patients with cervicalgia due to cervical spondylosis present with headache, and greater than two thirds present with unilateral or bilateral shoulder pain (3). Intermittent neck and shoulder pain, or cervicalgia is possibly related to compression of the sinovertebral nerves and the medial branches of the dorsal rami in the cervical region (17). A significant amount of these patients also present with arm, forearm, and/or hand pain (17).

Another clinical syndrome seen is chronic suboccipital headache radiating to the base of the neck and the vertex of the skull (17). Radiculopathy most commonly involves sixth and seventh nerve roots, which are caused by C5-C6 or C6-C7 spondylosis, respectively. Patients usually present with pain, paresthesias or weakness, or a combination of these symptoms. Usually, the pain is more frequent in the upper limbs than in the neck, although it is frequently present in both areas (18,19). Greater than one third of patients with CSM have anxious or depressed moods related to their decreased mobility (20).

Another syndrome in cervical spondylosis is central cord syndrome. This syndrome typically occurs when an elderly patient experiences an acute hyperextension injury with preexisting acquired stenosis due to ventral osteophytes and infolding of redundant ligamentum flavum, resulting in acute cord compression. The syndrome consists of greater upper extremity weakness than lower extremity weakness, varying degrees of sensory disturbances below the lesion, and myelopathic findings such as spasticity and urinary retention (21).

Rarely, dysphagia or airway dysfunction has been reported secondary to cervical spondylosis (22-26). Dysphagia may occur when large anterior osteophytes cause mechanical compression of the esophagus or periesophageal inflammation causes motion over the osteophytes.

Cervical spine magnetic resonance scanning (MRI) is the study of choice for diagnosis. If MRI is not available, CT myelography. Regular x-ray images will demonstrate the state of the bones and disk spaces and allow for measuring of the central canal diameter. X-rays made with the neck flexed or extended are used to explore stability of the spine and abnormal movement of one vertebra on another (subluxation). EMG and nerve conduction studies are particularly useful to diagnose peripheral entrapment complicating cervical spondylotic radiculopathy. This combination is sometimes called "double crush" (27).

The management will be conservative unless there is severe anatomical cord pinching with supporting signs (27). Correction of sleeping posture is often successful in alleviating pain. Muscle relaxant medication may be prescribed.

An injection of corticosteroid locally around the dura (epidural injection), or around the facet joints

which themselves are a significant source of pain (27). Acute disc herniation with severe cord compression and clinical signs of myelopathy is best treated surgically.

For the chronic patient with mild myelopathic symptoms and signs, immobilization in a soft cervical collar should be the first therapeutic intervention. The collar should be worn all day and all night for about 3-4 weeks and the patient should then be reassessed. About 80-90% of patients improve with conservative therapy (27). Surgery may be diskectomy (removing the disk), laminectomy (decompression from the rear by removing the lamina which unroofs the vertebral canal), or a fusion procedure where two vertebrae are joined together. Fusion can be achieved either by operating from behind or from the front of the neck. Surgery should be considered for patients with spondylotic myelopathy or subluxation which does not respond to conservative treatment (27).

MATERIALS AND METHODS

A retrospective study of 30 patients who underwent operation of posterior cervical laminectomy for cervical spondylosis in Al-Shaek Zaed hospital for neurosurgical specialization, between January 2006 and January 2009. 20 of the patients (66.7%) were males and 10 patients (33.3%) were females. 15 of the patients (50%) were below 55 years and 15 patients (50%) were above 55 years. All of the patients were suffering from both radiclopathic and myelopathic signs and symptoms preoperatively (cervical spondylotic myelopathy CSM).

The diagnosis was early within few months (3 months) from the onset of myelopathic signs and symptoms in 18 patients (60%), while 12 patients (40%) presented and diagnosed later on from the onset of their myelopathic signs and symptoms.

Parameters recorded include patient age, sex, neurological condition preoperatively (severity and duration), postoperative follow-up and surgical outcomes. The diagnosis were made by the clinical signs and symptoms and by cervical MRI studies.

The decision for surgical treatment was taken depending on the following indications: 1. Intractable pain. 2. Progressive Neurological deficits. 3. Documented compression of the cervical nerve roots, the spinal cord or both. The position of the

patients at time of operation was prone position. Immediate post operative examination was done for all of the patients with regular follow up intervals of 6 months.

The neurological outcome were interpreted by follow up the patients pre- and postoperatively with the Nurick scale as a predictor of gait in cervical disc disease and with the modified Japanese Orthopaedic Association Scale (mJOA).

Thus functional improvement was divided into: good, fair and poor outcomes.

Good result includes Nurick scale grades 1 and 2, or decrease down Nurick scale 2 grades. Fair result includes Nurick scale grades 3 and 4.

Poor result includes Nurick scale grade 5.

The recovery rate of the operated patients can be calculated from the following equation:

The recovery rate = the postoperative mJOA – the preoperative mJOA x 100

18 (total mJOA score) – preoperative score Nurick scale

Grade 0: Signs or symptoms of root involvement without spinal cord myelopathy.

Grade 1: Signs of spinal cord myelopathy but no difficulty in walking.

Grade 2: Slight difficulty in walking that does not prevent full time employment.

Grade 3: Difficulty in walking that prevents full time employment or the ability to do daily activity such as house work but is not severe enough to require walking help.

Grade 4: Able to walk only with help or with walker.

Grade 5: Chair-bound or bed ridden.

RESULTS

TABLE 1. *Dstribution of patients according to gender*

Male	Female	Total
20 (66.7%)	10 (33.3%)	30 (100%)

Table 1 demonstrates that 2/3 of patients were males and 1/3 were females with M:F ratio of 2:1.

TABLE 2. *Age and gender distribution*

	Above 55 years	Below 55 years	Total
male	12 (40%)	8 (26.7%)	20 (66.7%)
female	3 (10%)	7 (23.3%)	10 (33.3%)
Total	15 (50%)	15 (50%)	30 (100%)

I. *Motor dysfunction score of the upper extremities*

Inability to move hands	0
Inability to eat with a spoon but able to move hands	1
Inability to button shirt but able to eat with a spoon	2
Able to button shirt with great difficulty	3
Able to button shirt with slight difficulty	4
No dysfunction	5

II. *Motor dysfunction score of the lower extremities*

Complete loss of motor and sensory function	0
Sensory preservation without ability to move legs	1
Able to move legs but unable to walk	2
Able to walk on flat floor with a walking aid (i.e., cane or crutch)	3
Able to walk up and/or down stairs with hand rail	4
Moderate to significant lack of stability but able to walk up and/or down stairs without hand rail	5
Mild lack of stability but walk unaided with smooth reciprocation	6
No dysfunction	7

III. *Sensation*

Complete loss of hand sensation	0
Severe sensory loss or pain	1
Mild sensory loss	2
No sensory loss	3

IV. *Sphincter dysfunction score*

Inability to micturate voluntarily	0
Marked difficulty with micturition	1
Mild to moderate difficulty with micturition	2
Normal micturition	3

FIGURE 1. *The modified Japanese Orthopaedic Association Scale (mJOA)*

Table 2 shows that 50% of patients presented below 55 years and 50% above 55 years and that most of the females in the study presented below 55 years of age while males presented usually above 55 years.

TABLE 3. *Level of cervical spondylosis*

	C3/C4, C4/C5	C5/C6, C6/C7
Male	4 (13.3%)	16 (53.4%)
Female	1 (3.3%)	9 (30%)
Total	5 (16.6%)	25 (83.4%)

The majority of patients (83.4%) present with C5-C7 spondylosis.

TABLE 4. *Preoperative Nurick scale*

	G1-G2	G3-G4	G5
Male	2	15	5
Female	4	6	1
Total	6 (20%)	18 (60%)	6 (20%)

TABLE 5. *The preoperative modified Japanese Orthopaedic Association Scale (mJOA)*

	mJOA Scale=15-17	mJOA Scale=12-14	mJOA Scale=10-11
Male	2	15	5
Female	4	6	1
Total	6 (20%)	18 (60%)	6 (20%)

Preoperatively, 20% of the patients present with mild-moderate myelopathic clinical features (Nurick scale G1-2, or mJOA Scale = 15-17), 60% with moderate-severe myelopathic clinical features (Nurick scale G3-4, or mJOA Scale = 12-14) and 20% with very severe myelopathic clinical features (Nurick scale G5, or mJOA Scale = 9-11).

TABLE 6. *Distribution according to time of diagnosis*

	Early diagnosis	Late diagnosis
Males	12 (60%)	8 (40%)
Females	6 (60%)	4 (40%)
Total	18 (60%)	12 (40%)

18 patients (60%) diagnosed early and 12 patients (40%) diagnosed late.

TABLE 7. *Patients with myelomalacia on MRI*

	Pt. with myelomalacia	Pt. without myelomalacia
Male	5	15
Female	1	9
Total	6 (20%)	24 (80%)

Table 7 shows that 20% of patients had myelomalacia on MRI and 80% of patients had no such changes on MRI.

TABLE 8. *Surgical outcome*

	good	fair	poor
Male	9	6	5
female	7	2	1
Total	16 (53%)	8 (27%)	6 (20%)

Postoperatively, 16 (53%) of the patients had good outcome, 8 (27%) of the patients had fair outcome and 6 (20%) of patients had poor outcome.

TABLE 9. *Relation between outcome and early diagnosis and intervention*

	good	fair	poor
Male	9	3	0
female	5	1	0
Total	14 (77.8%)	4 (22.2%)	0 (0%)

Table 9 presents that 77.8% of the patients who are diagnosed and operated early had good outcome and no patients had poor outcome.

TABLE 10. *Relation between outcome and late diagnosis and intervention*

	good	fair	poor
Male	0	3	5
female	2	1	1
Total	2 (16.7%)	4 (33.3%)	6 (50%)

Table 10 and figure 1 show that only 16.7% of those patients who diagnosed and operated later on had good outcome and 83.3% had fair to poor outcome.

TABLE 11. *The effect of myelomalacia on the outcome*

	good	fair	poor	Total
Pts. with mmalacia	0 (0%)	1(16.7%)	5(83.3%)	6 (100%)
Pts. without mmalacia	16(66.7%)	7(29.2%)	1(4.1%)	24(100%)

Table 11 shows that no patient with myelomalacia had good outcome postoperatively and 83.3% of patients with myelomalacia had poor outcome postoperatively. In comparism, 66.7% of patients without myelomalacia had good outcome postoperatively, and only 4.1% had poor outcome.

DISCUSSION

In our study, the 30 patients was distributed as 20 male (66.7%) and 10 (33.3%) female patients, with M:F ratio of 2:1, the mean age of our patients was 52 years (range, 37-66 years). This agrees with the study of Kanishka E Williams, Rajesh Paul and Yashbir Dewan, which demonstrate that the mean age of patients suffering from CSM was 54 years (range, 35-72 years). Men were three times more affected than women (M:F ratio 3:1) (28). In males, the prevalence was 13% in the third decade, increasing to nearly 100% by age 70 years. In females, the prevalence ranged from 5% in the fourth decade to 96% in women older than 70 years 3). At age 60 years, half the men and one third of the women had significant disease (15). A 1992 study noted that spondylotic changes are most common in persons older than 40 years. Eventually, greater than 70% of men and women are affected, but the radiographic changes are more severe in men than in women (16).

In our study, the level of the cervical spondylosis was C5/C6-C6/C7 in 25 cases (83.4%) and the C3/4-C4/5 was affected in 5 cases (16.6%). These results differ from the study of Kanishka E Williams, Rajesh Paul and Yashbir Dewan, which demonstrated that the most common level of involvement was C4-C5 (10 patients, 41.66%) followed by C3-C4 level (7 patients, 29.66%). C5-C6 level involvement was seen in three patients (12.50%), and four patients had multilevel involvement (16.67%) (28). Radiculopathy most commonly involves sixth and seventh nerve roots, which are caused by C5-C6 or C6-C7 spondylosis, respectively. Patients usually present with pain, paresthesias or weakness, or a combination of these symptoms (18).

The preoperative neurological state of the patients in this study was as the following: 6 patients had G1-G2 Nurick scale or mJOA 15-17, 18 patients had G3-G4 Nurick scale or mJOA 12-14 and 6 patients had G5 Nurick scale or mJOA 10-11. The mean mJOA was 12.5. The postoperative results was as the following: 16 (53%) patients had good outcome (Nurick scale grades 1 and 2 or mJOA 15-17), 8 (27%) patients had fair outcome (Nurick scale grades 3 and 4 or mJOA 12-14) and 6 (20%) patients had poor outcome (Nurick scale grade 5 or mJOA 10-11). The mean mJOA scale was 15. So 10 (33.3%) patients in this study had been improved neurologicaly from Nurick scale grade 3-4, or mJOA scale 10-12, into Nurick scale grade 1-2 or mJOA scale 13-16, 14 (46.7%) patients settled on the same preoperative neurological state and in 6 (20%) patients there is no benefit from the operation. The recovery rate was about 45%-50% at a mean follow up of 6 months. In the study of Kanishka E Williams, Rajesh Paul and Yashbir Dewan, preoperative patients had a mean mJOA score of 9.67. Postoperatively patients had a mJOA score of 14.50. The mean recovery rate of patients postoperatively was 62.35% with SD of 32.82% (28). In a meta-analysis by Ratliff and Cooper, the mean recovery rate after cervical laminectomy and laminoplasty was reported to be 55% (range, 20-80%) (29). Chiba et al. although reported good recovery rates after laminoplasty, segmental motor paralysis, kyphosis, established before and after surgery, and late deterioration due to age-related degeneration remained challenging problems (30). Moreover,

techniques in current use for expansive laminoplasty operations on the cervical spine damage the extensor mechanisms, resulting in restriction of neck motion, loss of lordosis, and persistent axial pains (31). Houten JK and Cooper PR study demonstrated that the score on the modified Japanese Orthopedic Association scale improved in 97% of patients from a mean of 12.9 preoperatively to 15.58 postoperatively (P < 0.0001). In the upper extremities, function measured by the Cooper Scale improved from 1.8 to 0.7 (P < 0.0001), and in the lower extremities, function improved from 1.0 to 0.4 (P < 0.0002). There was a statistically significant improvement in strength in the triceps (P < 0.0001), iliopsoas (P < 0.0002), and hand intrinsic muscles (P < 0.0001). X-rays obtained at a mean of 5.9 months after surgery revealed no change in spinal alignment as measured by the curvature index. There was a decrease in the mean preoperative compression grade from 2.46 preoperatively to 0.16 postoperatively (P < 0.0001) (32). Researchers across multiple North American sites analyzed outcome in patients with CSM who had undergone surgical intervention. A total of 294 subjects have been enrolled at 13 sites across North America. To date, 235 patients (87 percent) have 1-year follow-up data available. The following outcomes have been reported: The mJOA scores improved from 13.0 (SD = 2.8) preoperatively to 15.5. The average Nurick scores improved from 4.1 to 2.7. The 30-meter walk test improved from 29 seconds to 25 seconds.

In our study, 18 (60%) patients diagnosed and operated early within 3 months and in 12 (40%) patients the diagnosis and surgical intervention delayed beyond 3 months. Better outcome occurs in those patients who diagnosed and operated early, where 14 (77.8%) patients had good outcome postoperatively, compared with only 2 (16.7%) patients with good outcome postoperatively of those who diagnosed and operated later on. This may be explained by effect of long standing degenerative changes and compression on the cervical spinal cord leading to the development of myelomalacia in those patients with prolonged degenerative process (delayed diagnosis) and this concept was supported by the result in this study, where 16 (66.7%) patients from those without myelomalacia had good postoperative outcome, while no patient (0%)

from those with myelomalacia had good postoperative outcome. The study of Houten JK and Cooper PR demonstrates that there was no correlation between neurological outcome and the presence of spinal cord signal change on T2-weighted MRI scans, patient age, duration of symptoms, or preoperative medical comorbidity (32).

CONCLUSIONS

Incidence of cervical spondylosis is more common and early present in male than in female patients.

Conservative treatment of 3 months is indicated for cervical spondylotic radiculopathy.

Cervical spondylotic myelopathy is a strong candidate for surgery.

Posterior approach laminectomy or laminoplasty is indicated for CSM with lordotic cervical spine and contraindicated in kyphotic spine.

CSM with kyphotic spine need anterior approach or posterior instrumentation and fusion.

C5-C6 and C6-C7 vertebrae is the most common cervical vertebrae affected by CSM.

Better outcome with early intervention in patient with CSM before irreversible cord ischaemic damage development.

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