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Review Article

SURGICAL OUTCOMES BETWEEN BOTH POSTERIOR SURGICAL APPROACHES FOR TREATMENT OF MULTIPLE CERVICAL SPONDYLOTIC MYELOPATHY (MCSM): A REVIEW

Dr. Niraj Shah*[1] and Shreesha Swar[2]

*[1]*Clinical School of Medicine, Yangtze University, Jingzhou 434000, Hubei Province, China*

[2]*Third Orthopaedic Department, Jingzhou Central Hospital Hubei Province, Jingzhou 434020, China*

ABSTRACT

Background:

Cervical spondylosis is recognised as the leading cause of myelopathy and spinal cord dysfunction worldwide. Chronic spinal cord compression results in chronic inflammation, cellular apoptosis, and microvacuolar insufficiency, which are thought to the biologic basis for Cervical Spondylotic Myelopathy (CSM).

Questions/Purposes:

Our purpose was to address the key principles of CSM, including natural history and presentation, pathogenesis, optimal surgical approach, results and complication rates of posterior surgical approaches for CSM so that the rationale for addressing CSM by a posterior approach can be fully understood.

Methods:

We conducted a systematic search of PubMed/MEDLINE and the Cochrane Collaboration Library for literature published through February 2014 to identify articles that evaluated CSM and its management. Reasons for exclusion included patients with Ossification of the Posterior Longitudinal ligament (OPLL), patients with degenerative disc disease without CSM, and patients with spine tumor, trauma and infection. Meeting abstracts/proceedings, white articles and editorials were additionally excluded.

Results:

The search strategy yielded 507 articles, which was reduced to 32 articles, after our exclusion

criteria were introduced. CSM is considered to be a surgical disorder due to its progressive nature. There is currently no consensus in the literature whether multilevel spondylotic compression is best treated via an anterior or posterior surgical approach.

Conclusion:

Multilevel CSM may be safely and effectively treated using a posterior approach, either by Laminoplasty or with a Laminectomy and fusion technique.

Keywords: Cervical Spondylotic Myelopathy, Natural history, presentation, pathogenesis, posterior surgical treatment options, optimal management

INTRODUCTION

Cervical myelopathy was first described by Stookey in 1928, after the cord became compressed by cartilaginous nodules of degenerated disc material [1]. However, it was not until 1952 that the association between cervical spondylosis and myelopathy was established by Brain [2]. Cervical spondylosis is now recognised as the leading cause of myelopathy and spinal cord dysfunction worldwide [3]. Cervical spondylotic myelopathy (CSM) accounts for 10% - 15% of cervical syndrome. Its etiology is usually age-related degenerative spondylosis. Calcification of the posterior longitudinal ligament, progressive cervical spine deformity, cervical disc herniation, trauma, spontaneous intra-spinal hemorrhage, and infectious abscess are less common causes. It was reported that the ages of patients with CSM ranged from 20 to 90 with the median age in the mid of 50 s. the most liable crowd are the people in their 6 or 7 decades of life, and CSM often progress during an unpredictable time course [4].

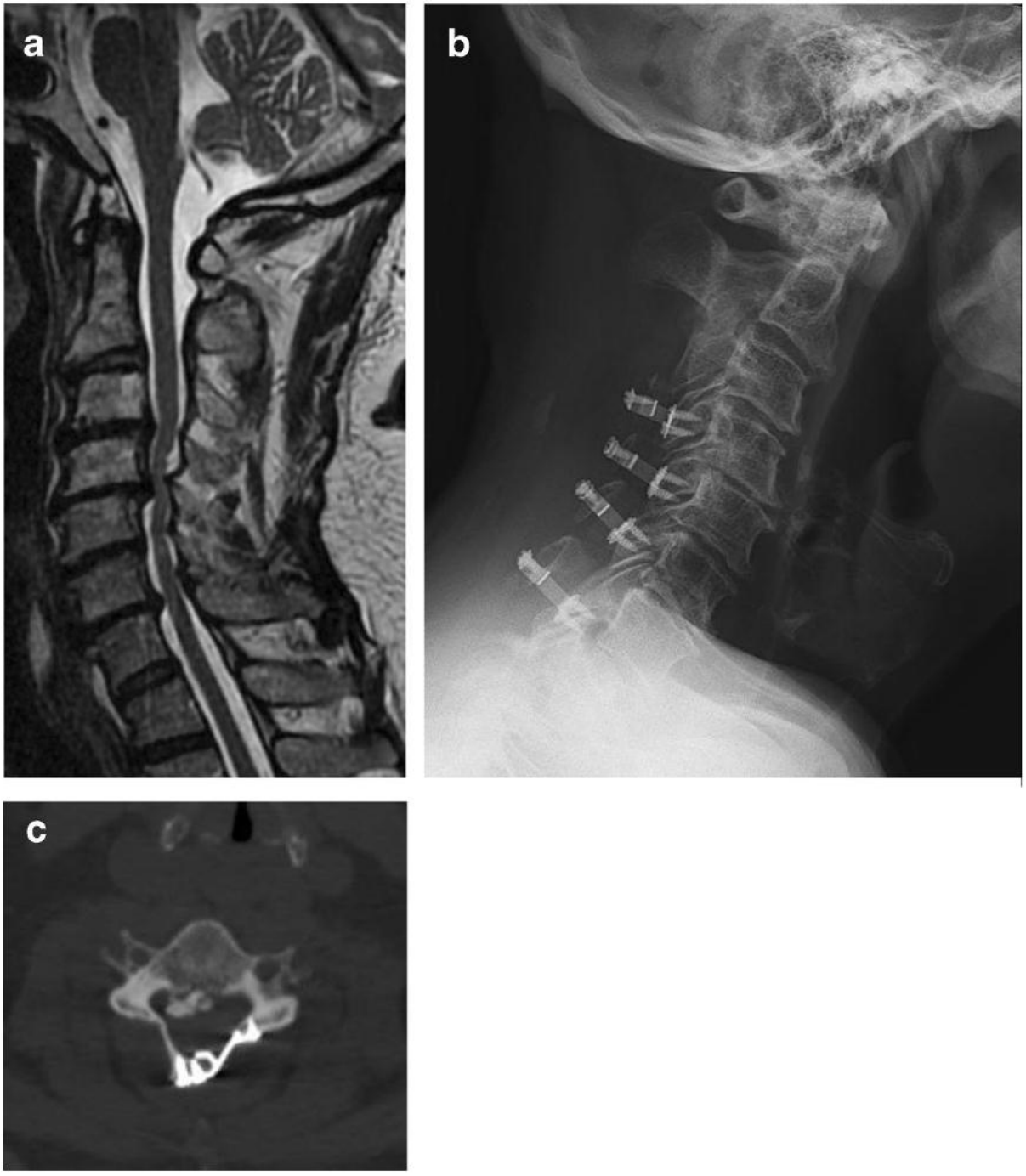

Figure 1: A: Preoperative T2 sagittal MRI cervical spine demonstrating multilevel spondylosis with dorsal compression. B: Postoperative lateral cervical spine radiograph following open door Laminoplasty. C: Postoperative axial CT scan following open door Laminoplasty.

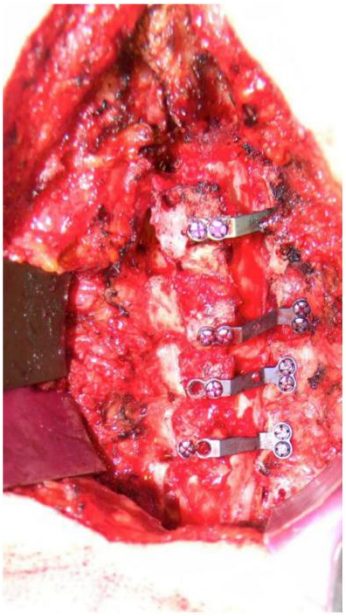

Figure 2: Intraoperative picture demonstrating laminae held open by specially designed Laminoplasty plates during the open door Laminoplasty technique.

The main pathology of CSM is spinal canal compromise and spinal cord compression. Age-related disc degeneration leads to the collapse at the interspaces, degenerative endplate changes, osteophyte formation, arthritis, hypertrophy of the zygapophyseal and uncovertebral joints, thickening of the ligamentum flavum, and overlap and hypertrophy of the cervical facet complexes, which in turn causes the narrowing of the anterior-posterior diameter of the cervical spinal canal, the compression of spinal cord and the progressive vascular insufficiency. All these result in the cervical myelopathy and a series of symptoms. Severe symptoms, insidious onset, vulnerability of misdiagnoses and progress during an unpredictable time course are the main features of CSM [5]

The treatments of CSM comprise conservative treatment and surgery. Most patients with progressive cervical spinal cord compression need a surgery which includes anterior approach, posterior approach and combined ventral and dorsal decompressive procedure. The aim of surgery is decompression of the spinal cord and elimination of the anterior-posterior flattening and distortion of the cervical cord. Re-alignment of the cervical spine, stabilization of cervical spinal instability, and/or correction of cervical spinal deformity can also achieved through surgical procedures. However, the choice of different surgical methods to fulfil the clinical requirements sometimes is pretty hard to make. In this study, we explored the efficacy and safety of

different approaches of surgery and the factors that affected the surgical results [6, 7].

The purpose of this report was to perform a systematic review on the posterior surgical management of CSM. However, this can only be satisfactorily accomplished if one has a thorough understanding of the natural history, presentation, pathophysiology and management options of CSM. We, therefore, addressed the following key clinical questions in adult patients with cervical spondylotic myelopathy: (1) What is the natural history and typical presentation of CSM? (2) What is the pathogenesis and pathobiology of CSM? (3) What is the optimal surgical approach for patients with CSM? (4) What are the results and complication rates of posterior surgical approaches to CSM? [8]

LITERATURE REVIEW

The posterior approach includes laminoplasty and laminectomy. Yukawa et al. compared the surgical outcomes of laminoplasty and skip laminectomy, no significant differences were seen between the two groups, in terms of operative invasiveness, axial neck pain, cervical alignment, and range of motion, and clinical results in the patients of CSM without developmental stenosis. The laminoplasty includes unilateral open-door laminoplasty and bilateral open-door laminoplasty. The preference of the two different techniques is up to the experiences of the operators [9-12].

The posterior approach is thought to be ideally suited for patients with multilevel CSM, patients with preservation of cervical lordosis and for patients with alkylosed spines [13,14,15]. Awareness of preoperative cervical sagittal alignment is crucial in surgical decision making, as a posterior decompression in a kyphotic spine does not allow the cord to migrate posteriorly and, if the kyphosis progresses, further compression on the cord may ensue causing worsening neurologic decline [16]. The two most common posterior cervical surgical procedures for the treatment of CSM are cervical laminoplasty and cervical laminectomy and fusion. Decompressive laminectomy alone has fallen out of favor because of post laminectomy kyphosis, which may occur in 10 to 45% of patients [17]. Matsunaga and colleagues compared 37 patients treated by laminectomy alone with 64 patients who underwent laminoplasty, with a mean follow-up of greater than 5 years. They found postoperative kyphosis rates of 35% in the laminectomy group and only 7% in the laminoplasty group [18]. Likewise, Kato et al. found 47% of patients developed postoperative kyphosis, although this did not correlate with neurologic deterioration [19].

Laminoplasty was developed primarily to avoid the issue of postoperative kyphosis, but also postoperative instability, postoperative laminectomy membrane and late neurological deterioration [20]. Laminoplasty may be performed by three techniques: the open door technique, the French door or sagittal spinous process splitting technique, and the expansive midline threadwire saw (T-saw) technique, which is a modification of the French door technique. Hirabayashi originally described the technically demanding, open door technique in 1978 [21]. This technique requires performing a bicortical trough on the open door side

and a unilateral trough on the contralateral, hinge, side. The bicortical trough is then opened and hinges on the unicortical trough, allowing for an increased spinal canal diameter. The lamina is then held open with a cortical bone graft spacer with or without specially designed laminoplasty plastes. The French door technique was described by Kurokawa et al. in 1982, and involves a high speed burr to develop a sagittal split in the spinous process, creating 2 hemilaminae [22]. Bilateral unicortical troughs are then developed at the edge of the lamina-lateral mass border, and then the hemilaminae are separated, like the opening of a French door, and held open with cortical bone grafts, that are secured with wire to the laminae. The third technique is a modification of the French door technique, and uses.

In a cost and outcome comparison study, Highsmith et al. analysed the records of 56 patients, 30 of whom underwent laminoplasty and 26 who underwent laminectomy and fusion, and found that both groups had similar improvements in Nurick scores, mJOA scores and Odom scores [23]. Patients who underwent fusion had significant improvement in VAS postoperative pain scores (5.8 ± 3.2 to 3.0 ± 2.3, $p < 0.01$) in comparison to laminoplasty patients (3.2 ± 2.8 to 3.4 ± 2.6, $p < 0.01$). However, complications were twice as common in the fusion group, and implant costs were nearly three times as high as in the laminoplasty group.

Recently, Manzano et al. performed a small prospective randomised trial in which they randomised 16 patients to laminoplasty or laminectomy and fusion, with 12 month follow-up, including data on Nurick scores, mJOA scores, Neck Disability Index and Short Form 36 [24]. They reported similar outcome measures in each group, but the laminoplasty group had significantly improved Nurick scores at 1 year. The laminectomy and fusion group had a 75% decrease in cervical range of motion between C2 and C7, whereas the laminoplasty group had only a 20% reduction [25].

Lawrence et al. suggested adopting an individualized approach when treating patients with CSM accounting for pathoanatomical variations (ventral vs. dorsal, focal vs. diffuse, sagittal, dynamic instability) because they found similar outcomes between approaches with regard to effectiveness and safety [26]. Awareness of preoperative cervical sagittal alignment is crucial in surgical decision making, and the posterior approach is thought to be ideally suited for patients with multilevel CSM, patients with preservation of cervical lordosis [27-29].

METHODS

We conducted a systematic search of PubMed/MEDLINE and the Cochrane Collaboration Library for literature published through February 2014. The search results were limited to human and animal studies in the English language. Reference lists of key articles were also systematically checked to identify additional eligible articles. The focus was on the identification of studies explicitly designed to evaluate CSM and the surgical management of this condition. Terms specific to CSM included the following: cervical spondylotic myelopathy or cervical myelopathy or (cervical and myelopathy). They were combined with terms specifying

the surgery (anterior or posterior) and (decompression and fusion or laminoplasty or laminectomy). Reasons for exclusion included patients with ossification of the posterior longitudinal ligament (OPLL), patients with degenerative disc disease without CSM, and patients with spine tumor, trauma and infection. Meeting abstracts/proceedings, white articles and editorials were additionally excluded.

DATA EXTRACTION

The following demographic information was extracted: study design, patient demographics, diagnosis, and operated levels, follow-up period and the rate of follow-up for each treatment group. We sought changes in Japanese Orthopaedic Association (JOA) scores, postoperative neck pain, changes in sagittal alignment and complication rates. We initially identified 507 articles, and this was reduced to 32 articles, after our exclusion criteria were introduced.

RESULT

There are more than 300 published studies on the topic of laminoplasty and laminectomy with fusion for CSM [30, 31, 32, 33, 34, 35]. However, there are only, to the best of our knowledge, four studies that compare the two groups within a single study, and all four were retrospective cohort studies. Heller et al. reviewed a matched cohort of 13 patients who underwent laminectomy and fusion versus 13 patients who underwent laminoplasty [36]. After a mean follow-up of 26 months, they found greater improvement in objective (Nurick scores) and subjective findings (strength, dexterity, sensation and gait) in the laminoplasty-treated group. They also reported no complications in the laminoplasty group, while the laminectomy and fusion group had 14 complications in nine patients, including increasing myelopathy, increased kyphosis, instrumental failure, non-union, persistent graft site donor pain, adjacent segment disease and infection. In a larger matched cohort study involving 121 patients over a 5-year period, Woods et al. reported on 39 patients who underwent laminoplasty and on 82 patients who underwent laminectomy and fusion, with a mean follow-up of 24 months [37]. Patient-reported outcomes were similar between the two groups, as were the complication rates, with 2 and 5 % requiring reoperation in the laminoplasty and laminectomy/fusion group, respectively.

COMPLICATIONS

One significant complication of laminoplasty is axial symptoms, including shoulder pain and spasm, and neck pain. Honsono et al. reported a 60% incidence of postoperative axial symptoms in laminoplasty patients [38]. In their meta-analysis of cervical laminoplasty, Ratliff and Cooper concurred with Honsono's findings, when they found a 25 to 60% incidence of axial neck pain [39]. Lawrence and Brodke have suggested that postoperative axial neck pain may be reduced by the preservation of the C2 and C7 muscle attachments during laminoplasty [31]. Sakura et al. supported this observation by finding a 11% reduction in

neck pain in patients that had preservation of their superior and inferior cervical spine muscle attachments [40]. Progressive kyphosis (10%) and decreased cervical range of motion (15 to 50%) are also associated with laminoplasty. In contrast to laminoplasty in which early mobility, avoidance of bleeding bone surfaces intraoperatively, and other techniques are employed to avoid a fusion, in patients undergoing multilevel spinal fusion, non-union may occur at a rate reported between 1-38% depending on a number of factors (Fig. 6). Another complication common to both techniques is C5 nerve root paresis, with deltoid paralysis and biceps weakness. The incidence varies between 3 and 11%, and is thought to result from the acute posterior translation of the spinal cord causing a traction palsy of the C5 nerve root [41, 42]. Satomi found a 7.8% incidence of biceps weakness in 206 patients that had undergone an open door laminoplasty [43]. Hatta et al. demonstrated that selective laminoplasties reduced the migration of the cord posteriorly from 2.7 to 1.1 mm and, concomitantly, decreased the incidence from 8 to 0% [44]. In summary, moderate and severe CSM may be effectively and safely treated using a posterior surgical decompression approach, either with a laminoplasty or laminectomy and fusion technique. Cervical sagittal alignment must be considered preoperatively when surgical strategies are being considered for CSM to prevent postoperative kyphosis and sagittal imbalance, which are now known to contribute to the progression of CSM.

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