Original Article

A systematic review and meta-analysis compare surgical treatment and conservative treatment in patients with cervical spondylotic myelopathy

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Background: Cervical spondylotic myelopathy (CSM) can be managed by conservative treatment or surgical treatment. This study aimed to compare the clinical effects of conservative treatment versus surgical treatment for patients with CSM.

Methods: Reports of randomized controlled trials and retrospective cohort studies that compared surgical treatment versus conservative treatment for CSM were collated from medical databases. The following data were extracted from eligible studies: pre- and post-treatment Japanese Orthopedic Association (JOA) scores, recovery rate, American Spinal Injury Association (ASIA) scores, and ASIA grade change. Results were expressed as risk ratio (RR) and mean difference (MD) with 95% confidence intervals (CIs).

Results: A total of 10 studies were included in this meta-analysis, with a total of 517 patients. Patients who received surgical treatment had lower pre-treatment JOA scores compared to patients who received conservative treatment (P=0.01). However, there was no difference in the post-treatment JOA scores between the two types of treatment (P=0.70). This demonstrated that the increase in JOA score was greater in the surgical group compared to the conservative group. Additionally, patients in the surgical group had a higher recovery rate than patients in the conservative group (P<0.00001). Although this investigation showed no significant difference in ASIA score between the two groups (P=0.30), there was a definite difference in ASIA grade change after sensitivity analysis.

Discussion: This meta-analysis suggested that surgical treatment may be more advantageous than conservative treatment in patients with CSM. However, these findings should be verified with larger, multi-centered, follow-up, controlled trials.

Keywords: Surgical treatment; conservative treatment; cervical spondylotic myelopathy (CSM); meta-analysis

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Introduction

Cervical spondylotic myelopathy (CSM) is a common chronic progressive disease. It accounts for 10% to 15% of cervical spondylosis, although the etiology of CSM is not clear, it is generally believed to be related to cervical disc degeneration, a high range of motion, or instability of the cervical spine (1-3). Disorders of blood circulation in the spinal cord can also affect the progress of CSM (4). The gradual progression of spinal degeneration affects the diameter of the spinal canal and the range of motion of the cervical spine, and thus, increases the risk of disease (5,6).

CSM is commonly managed by conservative treatment or surgical treatment. MRI is the first choice for the diagnosis of cervical spondylotic myelopathy, with the rapid development of imaging, the diagnosis and surgical management of CSM has also improved (7,8). While surgery has become the treatment of choice for clinicians, there is still some debate regarding the type of surgical method to apply (9,10).

As cervical osteoarthritis degeneration may cause irreversible spinal cord injury, any delay in surgical treatment often leads to poor prognosis (11,12). Therefore, early decompression is usually recommended for patients with moderate or severe CSM (13). However, in patients with mild, non-progressive, or slowly progressive CSM, the condition tends to take a relatively benign natural course and the advantages of surgical treatment over conservative treatment has not been determined (14,15). In such patients, conservative treatment appears to be the preferred choice because it avoids surgical complications and is associated with less financial burden (16,17).

At present, there is no consensus on which method is more favorable for the management of patients with CSM. This meta-analysis compared conservative treatment with surgical treatment in patients with CSM so as to provide evidence-based guidelines for spinal surgeons, which may help patients with CSM. We present the following article in accordance with the PRISMA reporting checklist (available at https://dx.doi.org/10.21037/apm-21-1365).

Methods

Literature search strategy

A systematic search of the online databases, including PubMed, Embase, Web of Science, and China National Knowledge, was performed from January 2000 to March 2021. The following keywords were used: surgical treatment, conservative treatment, and CSM. The search words were combined using Boolean operators "and". There were no language restrictions on the literature search. Manual searches of the reference lists of retrieved articles were performed to identify any relevant studies that may had been missed by the search strategy.

Study selection

Articles that met the following inclusion criteria were included in the study: (I) patients were diagnosed with CSM; (II) patients in the experimental group were treated with surgery, and patients in the control group were given conservative treatment; (III) indicators were used to assess the efficacy of surgical treatment and conservative treatment; and (IV) full text articles were available.

Studies were excluded if it did not meet the inclusion criteria, the outcomes of interest were not reported, or the data could not be used. Review articles, abstracts, and duplicate publications were excluded.

Data extraction and quality assessment

After title and abstract screening for potentially eligible studies, two reviewers independently read the full text articles and extracted the following relevant data: name of first author, study design, sample size, patient's age and gender, year of onset, the study duration, and the primary outcome. The methodological quality of included studies was evaluated with the Cochrane risk of bias assessment tool.

Statistical analysis

Meta-analysis was performed using Review Manager 5.4 software provided by Cochrane. If $P<0.05$ or $I^2>50\%$, it was assumed that there was a certain degree of heterogeneity among the studies, and the random effects model would be used for analysis. If $P\geq0.05$ and $I^2\leq50\%$, it was assumed that there was no heterogeneity or less heterogeneity between the studies, and the fixed effects model would be used for analysis. The risk ratio (RR) was used to analyze binary variables, mean difference (MD) and 95% confidence interval (CI) was used to analyze continuous variables, and U tests were used to test hypotheses. Sensitivity analysis was conducted by eliminating individual studies sequentially.

Results

Literature selection

A total of 1,145 studies were identified from the database search. Through abstract reading and analysis, 980 articles were excluded as they did not meet the inclusion criteria. A further 70 articles were excluded due to different study design or insufficient data available. Ultimately, 10 papers met the selection criteria and were included in this meta-analysis (18-27). The search process and full inclusion/exclusion criteria are shown in *Figure 1*.

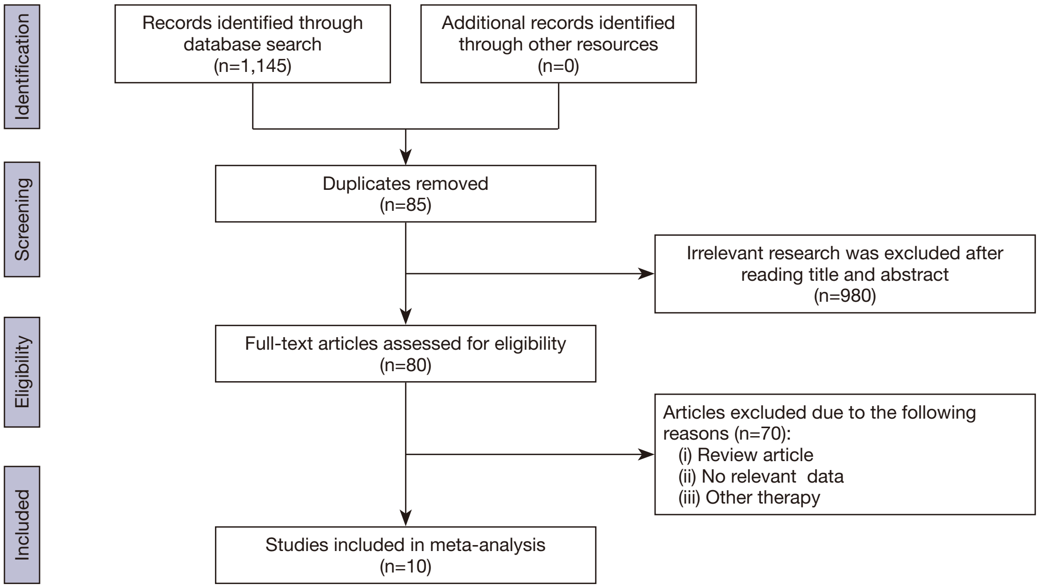

Figure 1 Flow diagram showing the literature selection process for this meta-analysis.

Characteristics of the included studies

The characteristics of the 10 included studies in this meta-analysis are presented in *Table 1*. All literature was published between 2000 and 2018. The studies contained a total of 517 patients, of whom 256 were treated with surgery and 261 patients were treated with conservative therapy. The primary outcomes included pre-treatment Japanese Orthopedic Association (JOA) score, post-treatment JOA score, recovery rate, American Spinal Injury Association (ASIA) score and ASIA grade change.

Assessment of risk of bias

According to the Cochrane risk of bias assessment tool, the methodological quality of the included studies was evaluated for bias risk. Among the 10 articles, high risk of performance bias, attrition bias, and reporting bias was found in 3 different studies (*Figure 2*). The summary risk of bias assessment for the 10 included studies is illustrated in *Figure 3*.

Results of heterogeneity tests

To analyze the difference in pre-treatment JOA scores between the surgical and conservative treatment groups, a meta-analysis was performed to calculate the overall MD using the fixed effects model based on heterogeneity analysis. The MD was −0.33 with 95% CI, −0.58 to −0.08, while the P value of the overall effect was 0.01, I^2=27%, which demonstrated that the differences in pre-treatment JOA scores between the surgical and conservative groups were significant (*Figure 4*). The pre-treatment JOA scores were higher in the conservative treatment group compared to the surgical treatment group.

Similarly, a meta-analysis was conducted to examine the post-treatment JOA scores between the surgical and conservative groups. The results demonstrated that there was no significant difference in post-treatment JOA scores among the two groups (MD: 0.17, 95% CI, −0.70 to 1.05, P=0.70, random effects model), and the included studies were heterogeneous (P=0.0008, I^2=79%; *Figure 5*). The results did not change even after sensitivity analysis by removing the study by Wang *et al.* (26) (P=0.55, I^2=63%).

A total of 5 studies involving 306 patients reported the rate of recovery. Meta-analysis showed that compared to the conservative group, the surgical group experienced a higher recovery rate (%) (MD: 17.35, 95% CI, 11.78 to 22.93, P<0.00001, fixed effects model), without significant heterogeneity (P=0.18, I^2=36%; *Figure 6*).

A fixed effects model was used to evaluate the heterogeneity of the ASIA score. Insignificant heterogeneity was detected among the included studies (P=0.30, I^2=18%). The results showed that there was no difference between the surgical and conservative groups in terms of ASIA score (MD: 5.17 with 95% CI, −1.83 to 12.18, P=0.15; *Figure 7*).

Table 1 Characteristics of the included studies

Author	Study design	No. patients		Gender (M/F)		Age		Years of onset	Primary outcome*
		Surgical	Conservative	Surgical	Conservative	Surgical	Conservative		
Kadanka 2000	Prospective randomized study	21	27	16/5	22/5	52.7±8.1	55.6±8.6	1993 to 1997	1, 2
Konomi 2018	Retrospective cohort study	31	47	–	–	–	–	April 2012 to September 2015	3, 5
Mazaki 2013	Prospective study	11	11	8/3	8/3	62 [44, 82]	63 [22, 90]	April 2007 to May 2009	4, 5
Wang 2018	Follow-up study	33	9	–	–	–	–	June 2009 to March 2013	1, 2, 3
Kong 2013	Prospectively study	21	57	13/8	32/25	58.8±11.3	57.5±10.5	February 2007 and January 2009	1, 2
Gu 2014	Retrospective study	31	29	25/6	24/5	65.7±12.3	66.2±12.7	January 2003 and August 2010	3, 4, 5
Kawano 2010	Prospective study	17	17	11/6	15/2	–	–	September 2000 to December 2002	4
Elsawaf 2013	RCT	16	13	12/4	10/3	22 [15, 44]	25.8 [17, 49]	September 2005 to September 2010	1, 2
Li 2014	Retrospective comparative study	53	38	33/20	14/24	50.36±8.13	52.95±11.64	July 2008 to June 2011	1, 2, 3
Xu 2013	Retrospective study	22	13	14/8	10/3	49.2±7.8	53.5±4.7	May 2009 to April 2011	3, 4

* 1, pre treatment JOA score; 2, post treatment JOA score; 3, recovery rate (%); 4, ASIA score; 5, ASIA grade change. M, male; F, female; RCT, randomized controlled trial; JOA, Japanese Orthopedic Association; ASIA, American Spinal Injury Association.

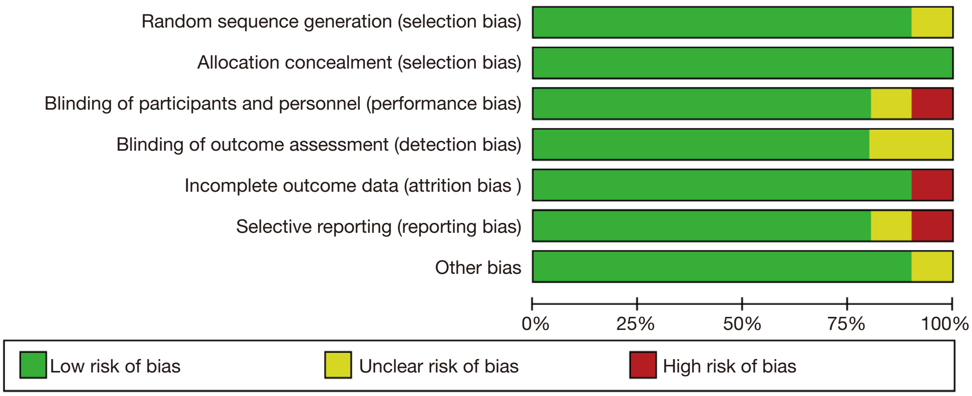

Figure 2 Risk of bias assessment of the included studies.

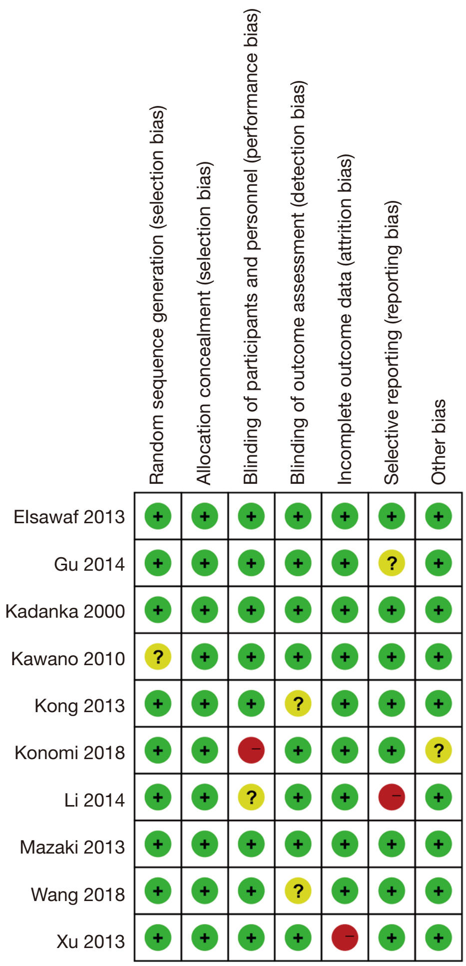

Figure 3 Risk of bias summary of the included studies.

A total of three studies reported ASIA grade change. In this meta-analysis, "change" was defined as an increase of at least one grade. The forest plot showed that there was no significant difference between the surgical and conservative groups in terms of ASIA grade change (RR was 2.08 with 95% CI, 0.56 to 7.68, P=0.27, random effects model; *Figure 8*). While the heterogeneity of the included studies was significant (P=0.003, I^2=82%), a sensitivity analysis was conducted by removing the report of Mazaki *et al.* (18), and the results changed significantly. The P value of the overall effect was 0.0002 and I^2 changed from 82% to 0% (P=0.47), which indicated that the homogeneity of the remaining two articles was improved. Furthermore, the results demonstrated that the surgical group promoted a better ASIA grade change compared to the conservative group.

Publication bias

A funnel plot was performed to qualitatively evaluate the publication bias for recovery rate. *Figure 9* shows that the shape was fairly symmetric, and the P value of Egger's test was 0.534, which indicated no significant publication bias existed in this meta-analysis.

Discussion

CSM is a common degenerative disease of the cervical spine, often seen in the elderly (2,3,6,28). The severity of

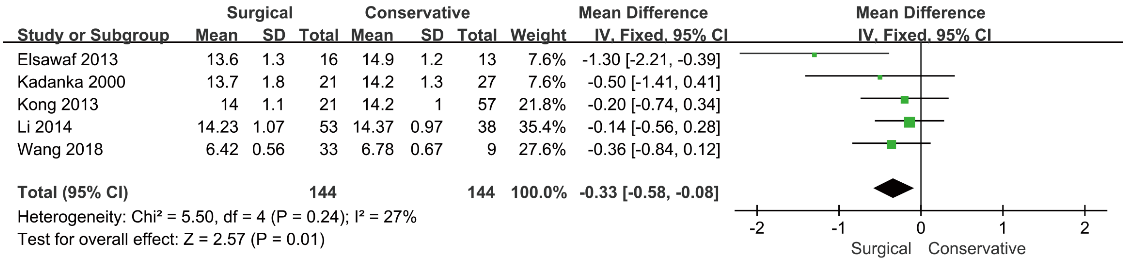

Figure 4 Forest plot showing the comparison in pre treatment JOA scores between the surgical treatment group and the conservative treatment group. JOA, Japanese Orthopedic Association.

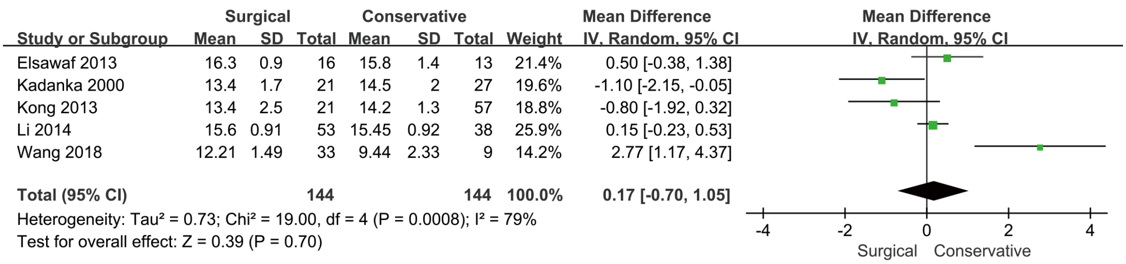

Figure 5 Forest plot showing the comparison of post treatment JOA scores between the surgical treatment group and the conservative treatment group. JOA, Japanese Orthopedic Association.

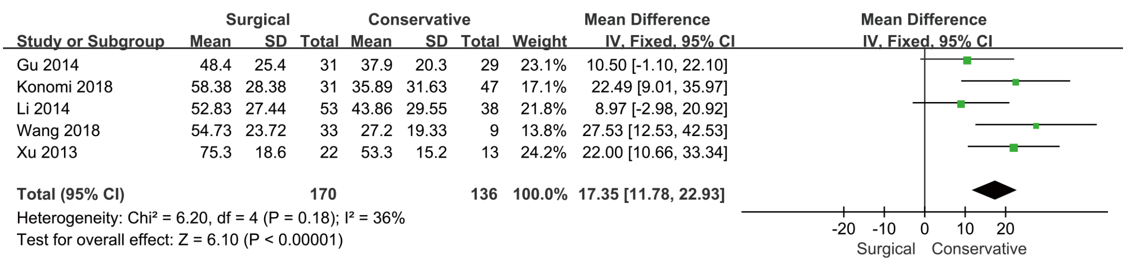

Figure 6 Forest plot showing the comparison in recovery rate between the surgical treatment group and the conservative treatment group.

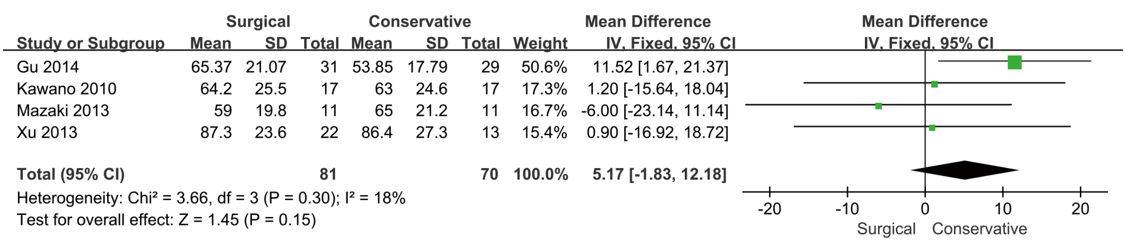

Figure 7 Forest plot showing the comparison of the ASIA score between the surgical treatment group and the conservative treatment group. ASIA, American Spinal Injury Association.

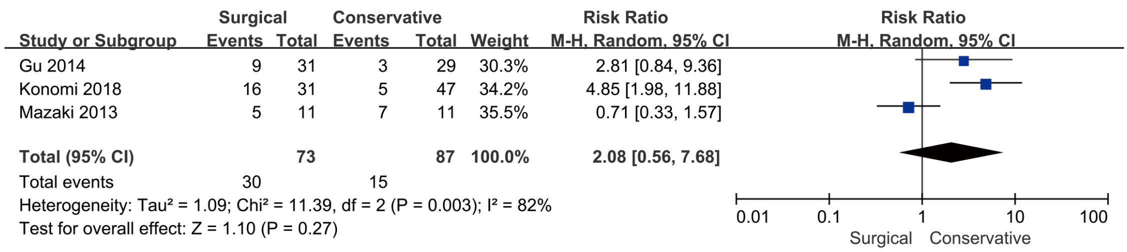

Figure 8 Forest plot showing the comparison of ASIA grade change between the surgical treatment group and the conservative treatment group. ASIA, American Spinal Injury Association.

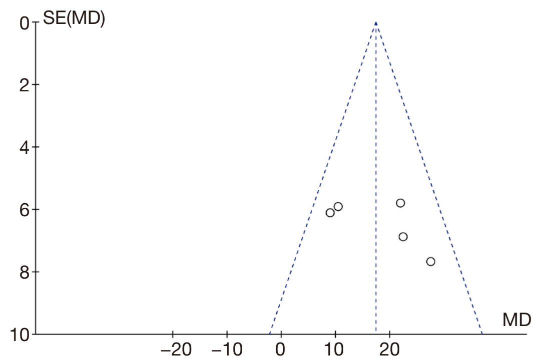

Figure 9 Funnel plot of publication bias.

the associated clinical symptoms and signs depends on the pathophysiology of the spinal cord (29). CSM, combined with long-term poor body posture, can result in spinal cord compression or spinal cord ischemia, which can then manifest as a variety of spinal cord dysfunctions.

The decision between surgical treatment versus conservative treatment is affected by many factors, including the disease state, efficacy of treatments, subjective experience of the patient, and a clear understanding of the etiology of the condition.

The traditional view has been that conservative treatment will not prevent the chronic progression of the disease, and surgery is the treatment of choice for most patients. Surgery is usually recommended within 6 months of the onset of disease, with improvements in patient quality of life observed after one year (30,31). Furlan *et al.* showed that surgical treatment of CSM patients resulted in better prognosis compared to conservative treatment (32). Kaner *et al.* believed that early surgery could improve neurological function (33). However, a retrospective analysis of patients with mild CSM found that 56% of patients did not need surgical treatment within 10 years after the initial conservative treatment (34). Furthermore, Kadanka *et al.* did not find any significant difference in patient outcomes between conservative and surgical treatment in the 3-year and 10-year follow-up of the same mild and moderate CSM patients (35,36).

This current meta-analysis examined 10 articles involving 517 patients with CSM. The results showed that the pre-treatment JOA scores in patients in the surgical group were significantly lower than those in the conservative group (P=0.01), but there was no significant difference in post-treatment JOA scores between the surgical and conservative groups, suggesting that the increase in JOA scores after surgery was higher than that after conservative treatment. The recovery rate of patients in the surgical group was significantly higher than that in the conservative group (P<0.00001), and these results were similar to reports by Liu *et al.* (37). Although this study demonstrated that there was no significant difference in ASIA scores between the two groups (P=0.30), there was a certain difference in ASIA grade change after sensitivity analysis.

Although our study confirmed that surgical treatment was superior to conservative treatment in improving functional recovery of CSM patients, we can not ignore the defects and possible risks of surgical treatment. Firstly, it was important for the choice of surgical methods, not only according to the number of involved segments, but also considering the operator's operation skills and proficiency, so as to achieve decompression and stability, and avoid surgical complications. Secondly, some studies have confirmed that patients with moderate or severe cervical spondylotic myelopathy were suitable for surgical treatment, however, for patients with mild, non-progressive CSM, surgical treatment had not shown advantage than conservative treatment (14). Therefore, for CSM patients, the choice of surgical methods and treatment timing was very important.

There were some limitations in this study. First, the outcome indicators were not sufficiently comprehensive. The main outcome indicators in the included studies were JOA score, recovery rate, and ASIA score and grade. However, hospitalization time, complications, mortality, and other indicators were less reported, and thus, there was a lack of safety measures. Second, the length of the follow-up period varied in different studies, and this may have affected the final results. Third, this meta-analysis was limited by the quantity and quality of the included studies, and the conclusions should be verified by larger, multicentered, controlled trials with longer follow-up periods.

In summary, surgical treatment is an efficient way for patients with CSM. Compared with conservative treatment, surgery showed a greater increase in JOA score, better recovery rates, and more obvious ASIA grade improvement.

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Footnote

Reporting Checklist: The authors have completed the PRISMA reporting checklist. Available at https://dx.doi.org/10.21037/apm-21-1365

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://dx.doi.org/10.21037/apm-21-1365). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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