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Cervical spondylotic myelopathy patients with prior cerebral infarction: Clinical characteristics, surgical outcomes and prognostic value of "prior cerebral infarction"

Yu Wang[a,1], Wangfei Wang[a,1], Minyu Zhu[a], Jing Wang[a], Yang Zhou[a], Kelun Huang[a], Jianhong Wang[b], Honglin Teng[a,*]

[a] Department of Spine Surgery, First Affiliated Hospital of Wenzhou Medical University, Wenzhou, 325000, PR China
[b] Department of Orthopedics, Yuhuan County People's Hospital, Taizhou, 318000, PR China

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ABSTRACT

Objective: To investigate the clinical characteristics and surgical outcomes of patients with cervical spondylotic myelopathy (CSM) and prior cerebral infarction (CI); to identify whether "prior CI" correlates with poor surgical outcomes.

Patients and methods: Twenty-two patients with CSM and prior CI were retrospectively reviewed and included as the CI group while 100 CSM patients without CI were included as the control group (matched for gender, age, symptom duration and surgical approach). Extensive demographic and surgery-related data for patients in both groups were collected and compared. Multivariate logistic regression analysis was performed to assess all potential factors affecting surgical outcomes.

Results: Compared to the control group, the CI group had the following: significantly higher percentages of hypertension, "progressive myelopathy", "rapid progressive myelopathy" and "intramedullary T2-weighted hyperintensity on MRI"; lower mean "preoperative mJOA score" and "postoperative mJOA score"; higher percentages of "preoperative mJOA score $\leq 11''$ and "recovery rate of mJOA score $< 50\%$". In the CI group, 14 patients had CI within 6 months before CSM, and their percentage of "rapid progressive myelopathy" was higher than that of patients who had CI over 6 months before CSM. Logistic regression analysis showed that smoking, "symptom duration ≥ 12 months", "T2-weighted hyperintensity" and "prior CI" correlated with poor surgical outcome.

Conclusion: Rapid progressive myelopathy with advanced neurological impairment and "intramedullary T2-weighted hyperintensity" are common in patients with CSM and prior CI. Surgical outcomes in these patients are poorer than those of ordinary CSM patients. "Prior CI" is a risk factor for predicting poor surgical outcomes.

1. Introduction

Cervical spondylotic myelopathy (CSM) is one of the most frequent causes of neurological disorder in the middle-aged and elderly population. Unlike acute spinal cord injury, the precise pathogenesis of CSM is not fully understood. The possible mechanisms include mechanical force [1], ischemia [2,3], blood-spinal cord barrier disruption [4,5], inflammation [6] and neural apoptosis [7]. These complicated pathological changes lead to diverse clinical presentations, progressions and prognoses among patients with CSM. Decompression with or without reconstruction surgery is a well-established treatment for CSM. Nevertheless, varying surgical outcomes have been observed among patients despite complete spinal cord decompression. Researchers have found that advanced age, longer symptom duration before surgery, worse preoperative neurological condition, smoking, diabetes and "intramedullary T2-weighted hyperintensity or T1-weighted hypointensity on magnetic resonance imaging (MRI)" correlated with poor clinical outcomes [8–11].

Cerebral infarction (CI) is another common disease inducing neurological impairment especially in geriatric populations. It is rare that patients with CSM have prior CI. These patients may be initially misdiagnosed as having recurrent CI after neurological function deterioration due to CSM. Cardiovascular disease and atherosclerosis are important risk factors for CI. These pathologies may also give rise to

* Corresponding author.
E-mail address: 907173102@qq.com (H. Teng).
[1] These authors contributed equally to this work.

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occlusion or disorders of small vessels around the spinal cord, and they contribute to spinal cord ischemia and neural degeneration. Recently, blood-spinal cord barrier dysfunction and secondary neural degeneration in the spinal cord were observed following focal CI in a rat model [12,13]. Nevertheless, to our knowledge, there remains no clinical study focusing on CSM patients with prior CI.

In the current study, we included surgically-treated patients with CSM and prior CI and investigated their clinical characteristics and surgical outcomes by comparing them to CSM patients without prior CI. In addition, a multivariate analysis was conducted to identify whether "prior CI" correlated with poor surgical outcomes.

2. Materials and methods

2.1. Study population

From January 2009 to September 2016, 653 consecutive patients with CSM who were surgically-treated in our spine centre were retrospectively reviewed. Of these, patients with a prior CI were included. Any patient with a new onset of CI was excluded using brain MRI scan after myelopathy occurred or developed. Other exclusion criterias included the following: cervical spine injury, previous cervical surgery, sequelae of cerebral palsy, cervical spine infection or tumor, thoracic or lumbar neurological comorbidities and a follow-up of less than one year. Finally, 22 patients were included as the CI group. The age of this group (16 male and 6 female) ranged from 57 to 79 years with a mean age of 67.7 ± 8.3 years. Of these, 15 patients had fully recovered from CI while 7 patients had residual incomplete hemiplegia before onset or progression of neurological symptoms of CSM. Two patients were initially misdiagnosed with recurrent CI in other institutes, and were transferred to our spine centre after ineffective treatment. Ten patients underwent posterior laminoplasty; two patents underwent laminoplasty and lateral mass fixation due to cervical instability; eight patients underwent anterior cervical discectomy and fusion (ACDF); one patient underwent anterior cervical corpectomy and fusion (ACCF) due to unreachable migratory disc fragment; one patient underwent ACCF and laminoplasty due to severe anterior and posterior compression on spinal cord.

For each patient in the CI group, 4–5 CSM patients without prior CI were matched based on the same gender, similar age (± 5 years), similar preoperative symptom duration (± 3 months) and similar surgical approach. Finally, one hundred CSM patients without prior CI who were also surgically treated from January 2009 to September 2016 were matched as the control group. The age of the patients in the control group (71 male and 29 female) ranged from 57 to 78 years with a mean age of 66.9 ± 5.3 years.

This study was approved by the local Ethics Committee and informed consent was obtained from all included patients.

2.2. Clinical data

Demographic data for subjects in both groups were collected as follows: gender, age, smoking, comorbidities of diabetes or hypertension, symptom duration before surgery, whether there was progressive myelopathy or rapid progressive myelopathy (defined as rapid neural function deterioration within four weeks and the patient could not maintain stand posture without support [14]), affected levels of cervical spine and intramedullary T2-weighted hyperintensity or T1-weighted hypointensity on MRI.

Surgical outcome-related data for both groups were recorded as follows: surgical approach (anterior/posterior/combined anterior and posterior), follow-up period, postoperative complications, preoperative modified Japanese Orthopaedic Association (mJOA) score, postoperative mJOA score at the last follow-up and recovery rate of mJOA score (recovery rate = (postoperative mJOA score – preoperative mJOA score) / (17 – preoperative mJOA score) × 100%). Poor surgical outcome was defined as the recovery rate of mJOA score < 50% [10]. For patients with residual incomplete hemiplegia caused by CI, mJOA score was evaluated based on the limbs of unaffected side. As gait function cannot be assessed based on unilateral limbs, 3 patients with residual gait impairment were excluded from the study of surgical outcome.

For the CI group, the time intervals from prior CI to onset or progression of symptoms of CSM in each subject were recorded. These patients were divided into two groups based on those time intervals (within or over 6 months).

2.3. Statistical analysis

Demographic and surgical outcome-related data were compared between the CI and control groups. An independent-samples *t*-test was used to assess normally distributed variables, the Mann-Whitney *U* test was used for non-normally distributed variables and the chi-square test or Fisher's exact-test was used for categorical variables. P values < 0.05 were considered statistically significant.

The percentages of progressive myelopathy between two groups with distinct time intervals from CI to CSM (within or over 6 months) were compared. Fisher's exact-test was used for categorical variables. P values < 0.05 were considered statistically significant.

Demographic factors, surgical approaches, preoperative mJOA scores and prior CI for all subjects were analysed using logistic regression to identify predictors of poor surgical outcome. "P < 0.05″ was adopted as the entry criterion in each forward stepwise analysis. P values < 0.05 were considered statistically significant.

All statistical analysis and calculations were performed using SPSS 18.0 statistic software (SPSS Inc., Chicago, Illinois, USA).

3. Results

As listed in Table 1, the demographic data showed no significant differences between the CI and control groups, including the following: gender, age, smoking, diabetes, mean symptom duration, "symptom duration ≥12 months", affected cervical spine level and "intramedullary T1-weighted hypointensity". Compared to the control group, the CI group had a significantly higher percentage of hypertension (77.3% vs. 54%, P = 0.045), higher percentage of progressive myelopathy (77.3% vs. 49%, P = 0.016), higher percentage of rapid progressive myelopathy (45.5% vs. 10%, P < 0.001) and higher percentage of "T2-weighted hyperintensity" (81.8% vs. 56%, P = 0.025).

As listed in Table 2, the surgical approach, mean follow-up, incidence of postoperative complications and mean recovery rate of mJOA score showed no significant difference between the CI and control groups. One patient suffered postoperative transient delirium and one suffered delayed wound healing in the CI group, with one postoperative urinary infection and two delayed wound healing in the control group. Compared to the control group, the CI group had a significantly lower mean preoperative mJOA score (9 ± 3.0 vs. 11.2 ± 2.4, P = 0.002), higher percentage of "preoperative mJOA score ≤11″ (78.9% vs. 48%, P = 0.013), lower mean postoperative mJOA score (13.3 ± 2.4 vs. 14.6 ± 2.0, P = 0.030) and higher percentage of "recovery rate < 50%" (47.4% vs. 24%, P = 0.037).

In the CI group, the symptoms of CSM presented after those of CI in 16 cases; there were initially stable CSM symptoms but with progressive myelopathy after CI in 6 cases. As shown in Table 3, the time intervals from CI to onset or progression of CSM were shorter than 6 months in 14 cases and longer than 6 months in 8 cases. The mean time interval of the "≤6 months" group was 2.9 ± 1.6 months (1–6 months) and was 66.8 ± 52.8 months (23–189 months) in the " > 6 months" group. Both the percentages of "progressive myelopathy" and "rapid progressive myelopathy" in the "≤6 months" group were higher than those of the " > 6 months" group (85% vs. 62.5 and 57.1 vs. 25%,