

# Bowstring effect for cervical angina



Bowstring effect of longus colli secondary to Luschka's joint hyperplasia a potential factor contributing to cervical angina

Running title: Bowstring effect for cervical angina

Highlights:

Thirty-eight patients affected by cervical vertebra disease were involved.

All the patients in Group cervical angina relieved syndromes after operation.

Bowstring effect of longus colli might be a factor contributing to cervical angina.

Abstract

*Purpose* : The aim of this study was to evaluate Luschka's joint hyperplasia and homolateral musculus longus colli atrophy and explore their role in cervical angina (CA) pathogenesis.

*Materials and Methods* : After informed consent, 38 patients affected by cervical vertebra disease were included. Of these, 19 cervical angina patients were included as Group CA. As a matched control group (Group C), another 19 patients were included. All Patients were maintained under general anesthesia and underwent anterior cervical fusion surgeries. The degree of Luschka's joint hyperplasia and homolateral musculus longus colli atrophy were evaluated using Japanese Orthopaedic Association Scores (JOA) score, Neck Disability Index (NDI) score, Visual Analog Scale (VAS) score, and radiological parameters were also evaluated.

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*Results* : There was no significant difference in Cobb's Angel, Sum ROM and Segment ROM between two groups. The osteophyte area of Luschka joint in Group CA was higher than that in Group C. The musculus longus colli area of the pathological cord segment in Group CA was lower than that in Group C. All the patients in Group CA relieved syndromes after operation, and there was no recurrence in follow-up. JOA score increased, while NDI score and VAS score decreased after operation in both two groups (  $P < 0.05$  ).

*Conclusion* : Anterior cervical surgery could effectively improve the symptoms of CA. Luschka's joint hyperplasia could result in bowstring effect of longus colli, which might be a pathogenic factor of CA. Evaluating the degree of Luschka's joint hyperplasia might assist in the diagnosis of CA.

*Keywords* : cervical angina; bowstring effect; Luschka's joint hyperplasia; pathogenesis

## Introduction

Chest pain is a frequent complaint in the Emergency Department (ED) in the world <sup>1</sup> . Each year, more than 7 million patients present to EDs with chest pain <sup>2</sup> . Only 20% to 25% of patients with acute chest pain will actually have acute coronary syndrome <sup>3-5</sup> .

Cervical angina (CA) is one potential cause of noncardiac chest pain being overlooked <sup>6</sup> . It is defined as chest pain resembling true cardiac angina but originating from disorders of the cervical spine <sup>7</sup> . Oille <sup>8</sup> firstly described the symptom in patients with chest pain of cervical nerve root origin. According

to the Jacobs's study<sup>9</sup>, common manifestations associated with CA included arm and neck pain, upper arm radicular symptoms and fatigue, parasternal tenderness and occipital headache<sup>10</sup>. Patients should be well aware of this presentation in their clinical examinations, unfortunately and in fact, a number of patients still appear to be diagnosed as coronary artery disease, and thus undergo unnecessary medications<sup>10</sup>. Generally, CA originates from a cervical discopathy with nerve root compression<sup>11, 12</sup>. The pathogenesis of cervical angina can be explained by the fact that cervical neural roots from C4 to C8 contribute to the sensory and motor innervations associated with anterior chest pain, and patients with true cervical angina are more likely to have disease at the C6 and/or C7 level<sup>12</sup>. Some reports have indicated that anterior cervical surgery to correct nerve root or spinal cord compression might be a useful measure for CA<sup>7</sup>. However, the diagnosis of cervical angina remains unresolved.

The present study evaluated the degree of Luschka's joint hyperplasia and homolateral musculus longus colli atrophy of 38 cases of cervical vertebra disease using Picture Archiving and Communication Systems (PACS), and aimed to explore their role in CA pathogenesis.

## Materials and methods

### *Subjects*

Between June 2008 and June 2013, a total of 553 patients who underwent anterior cervical fusion surgeries enrolled the match-paired retrospective cohort study. Reviewing the clinical charts in retrospect, 489 patients had

presented with complete follow-up (more than 12 months) data. Of these, 19 cervical angina patients were included as group cervical angina (Group CA). As a matched control group (Group C), another 19 patients were included according to age, gender, weight, most pathological cord segment, the number of pathological segment, the MRI high T2 signal and complications of Group CA.

The inclusion criteria were as follows: (1) have cervical angina as their primary complaint; (2) consent to the standardized evaluation program at the cervical angina clinic<sup>13</sup>. The exclusion criteria were as follows: (1) malignant disease; (2) cervical infection (specific/non-specific) or inflammatory joint disease; (3) cervical spine trauma; (4) severe osteoporosis; (5) combined with heart disease.

### *Surgical Technique*

All Patients were induced and maintained under general anesthesia. All surgeries were performed by one surgeon using as described previously<sup>14-16</sup>. A right-side oblique incision was pursued for the anterior cervical spine, followed by Robinson's anterior decompression and inter body fusion or subtotal spondylectomy with autologous iliac bone grafting. In ossified posterior longitudinal ligament, the essential technique was resection of the ossified plaque anteriorly with complete decompression of the spinal cord<sup>16</sup>. The surgery was approved by local Ethical Committee and was performed in accordance with the ethical standards. All patients gave their informed consent prior to their inclusion in the study.

*P ostoperative treatment*

Postoperative patients were treated with intravenous antibiotics for 3 days, and then replaced with oral antibiotics as anti-inflammatory therapy. The drainage tube and drainage fluid properties were carefully monitored, and cerebrospinal fluid leakage and neck hematoma were timely treated. The drainage tube was pulled up 24 hours after operation. Dehydrating agent was used to relieve reactive oedema caused by spinal cord decompression. Small dose of hormone therapy was employed for three days. Cervical X ray films were needed after operation, and a neck collar was fixed for six weeks. Follow-up exam was scheduled for more than 12 months.

*D etection index and postoperative evaluation*

CT (SIEMENS SOMATOM sensation cardiac 64, 120 kV, 300 mA, slicethickness: 1 mm, reconstruction slice: 1 mm, C1-T1) and MRI were performed in all patients. For MRI, T1- and T2-weighted images in at least two planes (in most cases a sagittal and an axial slice, Figure 1) were obtained from each patient. The Cobb's Angel, Sum ROM, Segment ROM, Area of LJO and Area of LC were measured through X-ray filter, CT scan and MRI by two independent orthopedic surgeon<sup>17</sup>. Disease-specific clinical data one week preoperatively and postoperatively collected measures included modified Japanese Orthopaedic Association Scores (JOA) score, Neck Disability Index (NDI) score, Visual Analog Scale (VAS) score<sup>18</sup>.

*Statistical analysis*

Data were analyzed using SPSS 18.0 (SPSS Inc., Chicago, IL, USA).

Continuous data are reported as means  $\pm$  standard deviation (SD). Paired t tests were used for comparing paired variables in the same vertebrae. Value of  $P < 0.05$  was taken as statistical significance.

## Results

### *Subjects' characteristics*

Table 1 showed the characteristics of the included 38 patients. There was no difference in age, gender, weight and the number of pathological cord segment between Group CA (n= 19) and Group C (n= 19). There were 11 cases whose pathological cord segment located in C5/6, 8 cases in C6/7, 4 cases in single segment and 12 cases in 2 segments in both two groups. The median follow-up were  $38.42 \pm 15.06$  months and  $33.32 \pm 12.69$  months in Group CA and Group C, respectively.

### *Clinical presentation before and after surgical treatment*

As shown in Table 2, there was no significant difference in Cobb's Angle, Sum ROM and Segment ROM between the two groups. The osteophyte area of Luschka joint were  $11.14 \pm 4.11 \text{ mm}^2$  and  $9.56 \pm 3.49 \text{ mm}^2$  in left and right respectively of Group CA, which were  $6.1 \pm 2.19 \text{ mm}^2$  ( $P < 0.001$ ) and  $5.94 \pm 2.59 \text{ mm}^2$  ( $P = 0.002$ ) higher than those in Group C. The musculus longus colli area of the pathological cord segment were  $51.56 \pm 14.79 \text{ mm}^2$  and  $58.58 \pm 13.98 \text{ mm}^2$  in left and right respectively of Group CA, which were  $4.83 \pm 13.43 \text{ mm}^2$  ( $P < 0.001$ ) and  $77.14 \pm 15.34 \text{ mm}^2$  ( $P = 0.001$ ) lower than those in Group C. The osteophyte area of

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Luschka joint in left of Group CA was higher than that in right, and the homolateralmusculuslonguscolliarea of the pathological cord segment was lower than contralateral area, while the differences were not statisticallysignificant.

All the patients in Group CA relieved syndromes after operation, and there was no recurrence in follow-up. JOA score increased from  $9.42 \pm 1.86$  to  $12.89 \pm 1.91$  ( $P < 0.01$ ) after operation in Group CA and increased from  $9.42 \pm 1.86$  to  $12.68 \pm 1.89$  ( $P < 0.01$ ) after operation in Group C. NDI score decreased from  $35 \pm 5.15$  to  $22.26 \pm 5.71$  ( $P < 0.01$ ) in Group CA and decreased from  $36.21 \pm 5.79$  to  $21.05 \pm 6.15$  ( $P < 0.01$ ). The recovery rate in Group CA was 44.9%, which was lower than that in Group C (57%,  $P > 0.05$ ). VAS score decreased from  $5.89 \pm 5.89$  to  $2.63 \pm 1.07$  ( $P < 0.01$ ) in Group CA and decreased from  $6.11 \pm 5.79$  to  $2.89 \pm 1.20$  ( $P < 0.01$ , Table 3). Besides, JOA score in Group CA was significantly higher than that in Group C ( $P < 0.01$ ), while this difference was not found in neither NDI nor VAS (Figure 2). There were a total of 3 patients with postoperative dysphagia, 2 patients in Group CA and 1 patient in Group C. All the 3 patients relieved evidently after conservative treatment.

## Discussion

The current match-paired retrospective cohort studyevaluated the degree ofLuschka'sjointhyperplasia and homolateralmusculuslonguscolliatrophy in 38 patients with cervical spine disease using JOA Scores, NDI, VAS scores and radiological parameters. The results showed thatthere was no significant difference in Cobb's Angel, Sum ROM and Segment ROM between two groups



(  $P < 0.05$ ). The osteophyte area of Luschka joint in both left and right of Group CA were higher than those in Group C. The musculus longus colli area of the pathological cord segment in both left and right of Group CA were lower than those in Group C. All the patients in Group CA relieved syndromes after operation, and there was no recurrence in follow-up. JOA score increased, NDI score and VAS score decreased after operation in both Group CA and Group C (  $P < 0.05$ ). Besides, JOA score in Group CA was significantly higher than that in Group C (  $P < 0.01$ ), while this difference was not found in neither NDI nor VAS (Figure 2). The present data suggested that evaluating the degree of Luschka's joint hyperplasia and homolateral musculus longus colli atrophy might assist in the diagnosis of CA. Luschka's joint hyperplasia could result in homolateral musculus longus colli atrophy and bowstring effect, which might be a pathogenic factor of CA. Anterior cervical surgery could effectively improve the symptoms of CA, while the subjective standards such as JOA could not well display the severity of the CA.

CA, a noncardiac chest pain, is the most common pathological condition underlying pseudoangina<sup>10</sup>. The mechanisms of pain production in cervical angina have been a matter of considerable speculation<sup>19</sup>. Cervical spine disorders may often be present with pain in the upper anterior chest and scapular areas, resembling true angina pectoris<sup>20</sup>. Some studies have suggested that pain in CA is a radicular pain, secondary to root compression by a herniated disk, osteoarthritic spurs, or compression in a narrow intervertebral foramen<sup>21</sup>. While other studies have speculated that the referred pain may be caused by painful foci in the neck caused by factors

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such as disk degeneration, facet syndrome, or anterior or posterior longitudinal ligaments<sup>22</sup>. Besides, some cervical angina is myelopathic pain<sup>23</sup>. However, more and more investigators believe that CA is mediated through the sympathetic nervous system.

The present study found 19 cases of CA, accounting for 3.8% of the surgical patients at the same period, which is similar to the scale of Nakajima<sup>10</sup>. Among the 19 patients, 11 cases pained in the praecordia and accompanied by sweating, 5 cases pained in interscapular region and 3 cases pained in epigastrium. There were paroxysmal and continuous. It was worth mentioning that the preoperative JOA score was significantly higher in Group CA than that in Group C, while there was no significant difference in JOA score and improvement rate between the two groups. JOA could only reflect the onset of the sensorimotor function and bladder function but not reflect the severity of the chest pain. The results found that the preoperative neurological function of Group CA was better than Group C, while the improvement rate of JOA period was lower than Group C.

CA appears to be relatively unknown clinical syndrome compared with other angina. Prompt and accurate diagnosis requires a strong sense of suspicion in patients with inadequately explained chest pain. Routine MRI examination, or even if myelopathy is suspected, is insufficiently informative for the functional assessment of CA, a number of patients even appear to be diagnosed as coronary artery disease. Nine cases of patients were diagnosed in Department of Cardiology in the present study, and the other 10 cases presented chest pain without abnormal T wave, while the cervical spine MRI

found definite compression of the spinal cord. All the 19 patients in Group CA relieved pain syndromes after cervical vertebra surgery, which proved the diagnosis of CA.

It is necessary to indicate some limitations of this study. Firstly, as a match-paired retrospective cohort study, it was different to do completely same on the CA diagnostic criteria. Besides, although the population was highly selected according to the standards of match-paired retrospective cohort study, the patient sample was small, which would have caused selection bias. Furthermore, the osteophyte area of hyperplasia and the area of musculus longus colli were detected on MRI and CT respectively, and it was difficult to insure the same plane. Therefore, larger randomized studies and longer long-term studies are needed to evaluate the role of Luschka's joint hyperplasia and homolateral musculus longus colli atrophy in the medical and surgical management of CA.

In summary, the present data suggested that evaluating the degree of Luschka's joint hyperplasia and homolateral musculus longus colli atrophy might assist in diagnosis of CA. Luschka's joint hyperplasia could result in homolateral musculus longus colli atrophy and bowstring effect, which might be a pathogenic factor of CA. Anterior cervical surgery could effectively improve the symptoms of CA, while the subjective standards such as JOA could not display the severity of the CA.

Table 1 Clinical Characteristics of the Study Population

	Age (years)	Gender	Segment	No. of involved level	Follow Up (months)		
M	F	C5/6	C6/7	1	2	3	
Group CA	53. 37±8. 95	6	13	11	8	4 12 3	38 06
Group Control	53. 53±8. 41	6	13	11	8	4 12 3	33 69
P	0. 68						0. .

CA, cervical angina

Table 2 Image Examination of the Study Population

	Cobb's Angel	SumROM	Segment ROM	Area of LJO	Area of LC		
	Left	Right	Left	Right			
Group CA	12. 55±7. 52	28. 37±5. 72	3. 59±1. 81	11. 14±4. 11	9. 56±3. 49	51. 56±14. 79	58 98
Group Control	12. 56±8. 48	26. 37±6. 57	3. 64±1. 30	6. 1±2. 19	5. 94±2. 59	74. 83±13. 43	77 34
P	1. 00	0. 37	0. 97	0. 002	0. 002	0. 001	0.

001

Table 3 Function Scores of the Study Population

	Group CA		Group C			
	JOA	NDI	VAS	JOA	NDI	VAS
Pre-op	9.42±1.84	35±5.15	5.89±1.24	8.32±1.42	36.21±5.79	6.11±1.56
Post-op	12.68±1.89	22.26±5.71	2.63±1.07	13.05±2.41	21.05±6.15	2.89±1.20
Improvement rate	44.9%		57%			
P	¼œ0.01	¼œ0.01	¼œ0.01	¼œ0.01	¼œ0.01	¼œ0.01

JOA, Japanese Orthopaedic Association Scores score; NDI, Neck Disability Index score; VAS, Visual Analog Scale score

#### Figure legends

Figure 1 Area measuring of Luschka's joint hyperplasia and homolateral musculus longus colli atrophy A. targeting for biggest hyperplasia slice on CT axial; B area measuring of musculus longus colli according A.

Figure 2 Comparison between two groups in subjective scores, \* statistically significant.

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