Int J Clin Exp Med 2018;11(3):2264-2270
www.ijcem.com /ISSN:1940-5901/IJCEM0026902

Original Article

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

Fan Zhang[1,2*], Xuan Huang[1*], Xiao-Gang Chen[3*], Qing-Xin Song[1], Feng-Ning Li[1], Yi-Xing Tang[1], Cang-Long Hou[1], Zhi Chen[1], Hong-Xing Shen[1]

[1]*Department of Orthopedics, Changhai Hospital, The Second Military Medical University, Shanghai 200433, China;* [2]*Department of Orthopedics, The First Affiliated Hospital of Kunming Medical University, Kunming 650032, Yunnan, China;* [3]*Department of Orthopedics, The Third Affiliated Hospital of Zhejiang Chinese Medical University, Hangzhou 310005, China.* **Equal contributors.*

Received June 28, 2016; Accepted September 5, 2016; Epub March 15, 2018; Published March 30, 2018

Abstract: Purpose: The aim of this study was to evaluate the degree of Luschka's joint hyperplasia and homolateral longus colli (LC) atrophy and explore their roles in cervical angina (CA) pathogenesis. Methods: After informed consent, 38 patients affected by cervical vertebra disease were included. Of these, 19 CA 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. Imaging examination including Cobb's angle, sum range of motion (ROM), segment ROM, area of Luschka's joint osteophyte (LJO) and LC were measured. Results: There were no significant differences in Cobb's angle, sum ROM and segment ROM between two groups. All symptoms were relieved in patients of Group CA and Group C after operation, and there was no recurrence in follow-up period. JOA score increased, while NDI and VAS scores 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 [1]. Each year, over 7 million patients present to EDs with chest pain [2]. Among them, only 20% to 25% of patients will actually have acute coronary syndrome [3-5]. The risk of misdiagnosing acute coronary syndrome often leads to noncardiac causes of chest pain being ignored.

Cervical angina (CA) is one potential cause of noncardiac chest pain being overlooked [6]. It is defined as chest pain resembling true cardiac angina but originating from disorders of the cervical spine [7]. Common manifestations associated with CA included arm and neck pain, upper arm radicular symptoms and fatigue, parasternal tenderness and occipital headache [8]. Patients should be well aware of this presentation in their clinical examinations. Unfortunately, a number of patients still appear to be diagnosed as coronary artery disease, and thus undergo unnecessary medications [8]. Generally, CA originates from a cervical discopathy with nerve root compression [9, 10]. The pathogenesis of CA 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 CA are more likely to have disease at the C6 and/or C7 level [10]. Some reports have indicated that anterior cervical surgery to correct nerve root or spinal cord compression might be a useful measure for CA [7]. However, the diagnosis of CA remains unresolved.

Here, a series of 38 patients affected by cervical vertebra disease were included. Of these, 19 CA patients were included as Group CA. As a matched control group (Group C), another 19

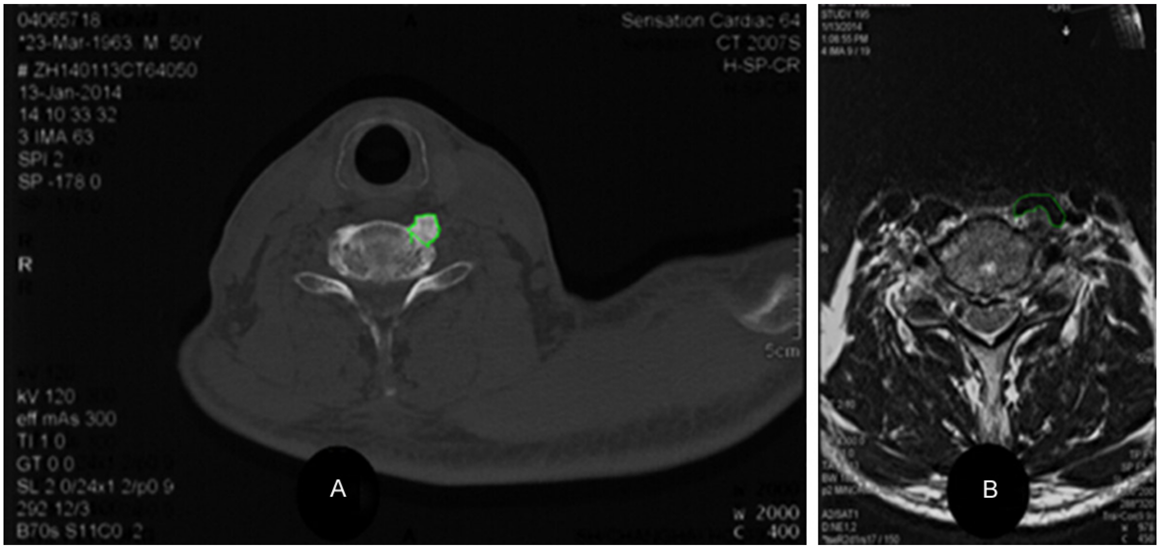

Figure 1. Area measuring of Luschka's joint hyperplasia and homolateral musculus longus colli atrophy. A. Targeting for biggest hyperplasia slice on CT axial; B. Area measuring of musculus longus colli according A.

patients were included. Then we evaluated the area of Luschka's joint osteophyte (LJO) and homolateral longus colli (LC) and studied the function scores of the patients after anterior cervical discectomy and interbody fusion (ACDF). The aim of the current study was to evaluate the degree of Luschka's joint hyperplasia and homolateral LC atrophy and explore their role in cervical angina (CA) pathogenesis.

Materials and methods

Subjects

This was a match-paired retrospective cohort study. Between June 2008 and June 2013, a total of 553 patients who underwent ACDF surgeries were enrolled in our hospital. Reviewing the clinical charts in retrospect, 489 patients had complete follow-up (more than 12 months) data. Of these, 19 CA patients were included as group CA (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 magnetic resonance imaging (MRI) high T2 signal and complications of Group CA.

The inclusion criteria were as follows: (i) have CA as their primary complaint and invalid in conservative treatment; (ii) chest pain patients without heart disease detecting using electrocardiogram or coronary angiography. The exclusion criteria were as follows: (i) cervical spine tumor; (ii) cervical infection (specific/non-specific); (iii) cervical spine trauma; (iv) severe osteoporosis; (v) combined with heart disease.

Surgical technique

All patients were induced and maintained under general anesthesia. All surgeries were performed by one surgeonas described previously [11-13]. The right side of the neck was cut, and the natural gap between the vascular sheath and the visceral sheath was separated. Then, the prevertebral fascia was exposed and the anterior longitudinal ligament was incised. Then the bone of vertebral posterior and lateral hyperplasia was removed through high speed drill. After that, the posterior longitudinal ligament and fragments of the disk were removed to complete decompression of the spinal cord. The end plate of the adjacent vertebral body was scraped until the bone was exposed. For patients with hyperplasia of uncovertebral joint, subperiosteal collilongus was dissected, and osteophytes were exposed. Then, hypertrophic osteophyte was removed using bone rongeur. Intervertebral space was planted by bone fragments and cervical spine was locked using plate. Finally, a negative pressure drainage tube was placed, and the wound was closed layer by layer. The surgery was approved by local Ethical Committee and was performed in accordance with the ethical stan-

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	
CA	53.37 ± 8.95	6	13	11	8	4	12	3	38.42 ± 15.06
Control	53.53 ± 8.41	6	13	11	8	4	12	3	33.32 ± 12.69
P	0.68								0.30

CA, Cervical angina.

dards. All patients gave their informed consent prior to their inclusion.

Postoperative treatment

Postoperative patients were treated with broad-spectrum intravenous antibiotics for 3 days, and then replaced with oral antibiotics as anti-inflammatory therapy. The drainage tube was carefully monitored and pulled up 24 hours after operation. Dehydrating agent was used to relieve reactive edema 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 was scheduled for more than 12 months. Follow-up data were obtained from medical records, contact via telephone, and a questionnaire survey administered at the time of this study.

Detection index

CT (SIENMENS SOMATOM sensation cardiac 64, 120 kV, 300 mA, slice thickness: 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 angle, sum range of motion (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 [14]. Changes in patients with myelopathy were considered according to the Japanese Orthopedic Association (JOA) classification of disability in spondylotic myelopathy [15, 16]. The neck disability index (NDI) was measured one week preoperatively and on the first postoperative day. The pain Visual Analog Scale (VAS) score was self-completed by the respondent, which was measured by asking to place a line perpendicular to the VAS line at the point that standing for their pain intensity [17]. Briefly, the score was determined by measuring the he distance (mm) on the 10-cm line using as ruler between the "no pain" anchor and the patient's mark, providing a range of scores from 0-100.

Statistical analysis

Data were analyzed using SPSS 18.0 (SPSS Inc., Chicago, IL, USA). Continuous data were reported as means ± 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

There was no difference in age, gender, weight and the number of pathological cord segment between Group CA and Group C (**Table 1**). Total 11 patients suffered from severe progressive pain at C5/6 level, and 8 patients at C6/7 level in either Group CA or Group C. In addition, 4 cases in single segment, 12 cases in two segments, and 3 cases in three segments were found. The median follow-up was 38.42 ± 15.06 months and 33.32 ± 12.69 months in Group CA and Group C, respectively.

Clinical presentation before and after surgical treatment

As shown in **Table 2**, there were no significant differences in Cobb's angle, sum ROM and segment ROM between the two groups. The area of LJO in the left (11.14 ± 4.11 mm^2) and right (9.56 ± 3.49 mm^2) in Group CA was higher than that in the left (6.1 ± 2.19 mm^2, $P < 0.001$) and right (5.94 ± 2.59 mm^2, $P = 0.002$) in Group C, respectively. The area of LC was 51.56 ± 14.79 mm^2 and 58.58 ± 13.98 mm^2 in left and right, respectively in Group CA, which was lower than that in left (4.83 ± 13.43 mm^2) and right (77.14 ± 15.34 mm^2) in Group C ($P < 0.01$).

Table 2. Image examination of the study population

	Cobb's angle	Sum ROM	Segment ROM	Area of LJO		Area of LC	
				Left	Right	Left	Right
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	58.58 ± 13.98
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	77.14 ± 15.34
P	1.00	0.37	0.97	< 0.001	0.002	< 0.001	0.001

ROM, Sum range of motion; LJO, Luschka joint osteophyte; LC, Longus colli.

Table 3. Function scores of the study population

	Group CA			Group C		
	JOA	NDI	VAS	JOA	NDI	VAS
Pre-operation	9.42 ± 1.84	35 ± 5.15	5.89 ± 1.24	8.32 ± 1.42	36.21 ± 5.79	6.11 ± 1.56
Post-operation	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	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01

JOA, Japanese orthopedic association score; NDI, Neck disability index score; VAS, Visual analog scale score.

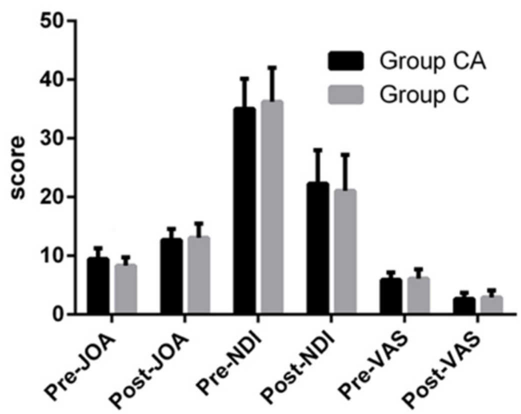

Figure 2. Comparisons between two groups in subjective scores. *Statistically significant.

All symptoms were relieved in patients of Group CA and Group C after operation, and there was no recurrence in follow-up period. JOA score increased from 9.42 ± 1.84 to 12.68 ± 1.89 (P < 0.01) after operation in Group CA and increased from 8.32 ± 1.42 to 13.05 ± 2.41 (P < 0.01) after operation in Group C (**Table 3**). NDI score decreased from 35 ± 5.15 to 22.26 ± 5.71 (P < 0.01) after operation in Group CA and decreased from 36.21 ± 5.79 to 21.05 ± 6.15 (P < 0.01) after operation in Group C. VAS score decreased from 5.89 ± 1.24 to 2.63 ± 1.07 (P < 0.01) after operation in Group CA and decreased from 6.11 ± 5.56 to 2.89 ± 1.20 after operation in Group C (P < 0.01, **Table 3**). There were no significant differences in JOA score, NDI and VAS between the two groups either pre-operation or post-operation (**Figure 2**). In addition, there were 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.

A case report

There was a 51 year old male patient who was accompanied by precordial pain. MRI examination showed three segments (C4/5-C6/7) of cervical degeneration, and osteophyma in C5/6 left uncovertebral joint. During the operation with ACDF and internal fixation, C5/6 osteophyma at the left side of the uncovertebral joint hyperplasia was found. Then musculus LC was jacked up with the shape changed like bowstring. After osteophyma was removed by operation, the LC was back to the normal position and the symptoms of CA improved (**Figure 3**).

Discussion

The current match-paired retrospective cohort study evaluated the degree of Luschka's joint hyperplasia and homolateral musculus LC atrophy in 38 patients with cervical spine disease using JOA Scores, NDI, Vass cores and radiological parameters. The results showed that there was no significant difference in Cobb's angle, 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.

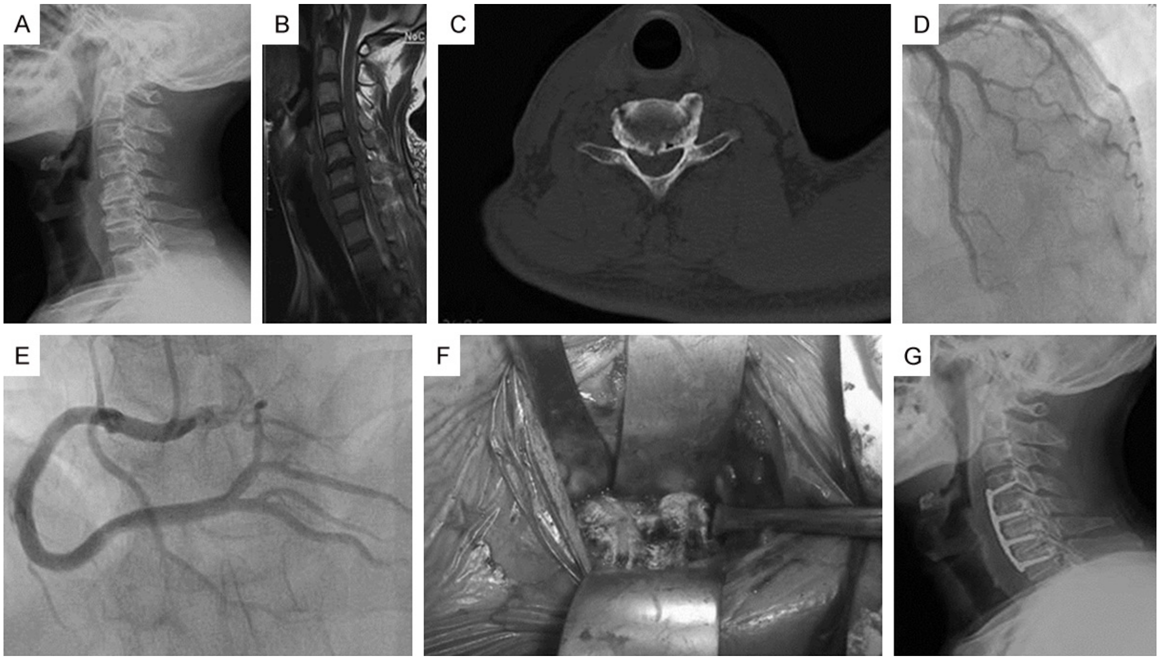

Figure 3. A case of a patient with 50 years old. (A) The cervical degeneration and osteophyte formation; (B) Magnetic resonance imaging (MRI) showed three segments (C4/5-C6/7) of cervical degeneration; (C) CT axial slices indicated that C5/6 osteophyma at the left side of the uncovertebral joint; (D) Coronary artery angiography showed no left coronary artery stenosis and (E) no right coronary artery stenosis; (F) Osteophyma in C5/6 left uncovertebral joint; (G) Surgery with anterior cervical discectomy and fusion.

The musculus LC area of the pathological cord segment in both left and right of Group CA were lower than those in Group C. All symptoms were relieved in patients of Group CA and Group C after operation, and there was no recurrence in follow-up period. JOA score increased, NDI score and VAS score decreased after operation in both Group CA and Group C (P < 0.05). The present data suggested that evaluating the degree of Luschka's joint hyperplasia and homolateral musculus LC atrophy might assist in the diagnosis of CA. Luschka's joint hyperplasia could result in homolateral musculus LC 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 [8]. The mechanisms of pain production in CA have been a matter of considerable speculation [18]. Cervical spine disorders may often be present with pain in the upper anterior chest and scapular areas, resembling true angina pectoris [19]. A previous study has 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 [20]. While other studies have speculated that the referred pain may be caused by painful foci in the neck caused by factors such as disk degeneration, facet syndrome, or anterior or posterior longitudinal ligaments [21]. Besides, some CA patients are present with myelopathic pain [22]. In these cases, the mechanism of pain is controversial. Sympathetic-mediated pain and myelopathic pain have been considered as potential mechanisms [23]. Although the exact mechanism is unclear, cervical neural roots from C4 to C8 may contribute to the sensory and motor innervations associated with anterior chest pain, and patients with CA are more likely to have disease at the C6 and/or C7 level [10].

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 [8]. 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 CA, 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. In many cases, the neurological symptoms are often overlooked. Prompt diagnosis of this under recognized syndrome needs an awareness of the common presenting features and clinical findings of CA and 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 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 difficult to diagnose CA according to the completely same criteria. Besides, although the population was highly selected according to the standards of match-paired retrospective cohort study, the sample size was small, and 19 cases likely underestimated the overall patients in our hospital with CA. Furthermore, the area of LJO and musculus LC were detected on MRI and CT respectively, and it was difficult to insure the same plane. Therefore, larger randomized studies are needed to evaluate the role of Luschka's joint hyperplasia and homolateral musculus LC 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 LC atrophy might assist in diagnosis of CA. Luschka's joint hyperplasia could result in homolateral musculus LC 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.

Acknowledgements

This study was supported by "1255" Fund of Changhai Hospital and Yangfan Project (Project number: 15YF140030).

Disclosure of conflict of interest

None.

Address correspondence to: Hong-Xing Shen, Department of Orthopedics, Changhai Hospital, The Second Military Medical University, 168 Changhai Rd, Shanghai 200433, China. Tel: +86-021-31161698; Fax: +86-021-31161698; E-mail: shenhxgk@126.com

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