Evaluation of common carotid and vertebral arteries flow volumes in patients with ankylosing spondylitis

Arterial flow volume in ankylosing spondylitis

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Abstract

Aim: The aim of this study was to compare carotid intima-media thickness (IMT) and common carotid artery-vertebral artery flow volumes in ankylosing spondylitis patients with age and sex-matched healthy controls.

Materials and Methods: Fifty patients with ankylosing spondylitis (study group) and 50 healthy volunteers (control group) were included in the study. At first, carotid intima-media thickness (IMT) measurements were performed in supine-neutral position by B-mode ultrasonography (US). Afterwards, common carotid and vertebral artery flow volumes were calculated by Doppler US in the neutral, right rotational, and left rotational positions.

Results: Carotid IMT was significantly higher in the study group according to the control group (p=0.001). The common carotid artery (CCA) and vertebral artery (VA) flow volumes in the neutral position were similar between the two groups. There was no significant difference in CCA flow volumes between the groups in right and left rotational positions (p>0.05). Right vertebral artery and total vertebral artery flow volumes in the right rotational position were significantly lower in the study group (p=0.022 and p=0.005 respectively). In the left rotational position, left vertebral artery and total vertebral artery flow volumes were significantly lower in the study group when compared with the control group (p=0.001).

Discussion: In our study, carotid IMT was significantly higher in patients with AS compared to healthy controls. Besides, significant volume decreases in vertebral artery flow volumes were detected in the study group in rotational positions.

Keywords
Ankylosing Spondylitis; Doppler Ultrasonography; Flow Volume; Intima-media Thickness
Introduction

Ankylosing Spondylitis (AS) is a chronic inflammatory disease that primarily involves sacroiliac joints and axial skeleton. The main extraarticular structures affected in AS are the eyes, intestines, lungs, heart, skin, and kidneys [1]. Increased risk of cardiovascular disease and atherosclerosis has been reported in some chronic rheumatic diseases, especially in rheumatoid arthritis (RA) and systemic lupus erythematosus (SLE) due to a widespread systemic inflammatory response [2,3].

Measurement of intima-media thickness (IMT) of the common carotid artery is a useful marker in the diagnosis of early atherosclerosis, and the relationship between IMT and subclinical atherosclerosis in RA has been demonstrated [4]. However, in some studies on AS patients, carotid IMT values were higher than the control group, and in some other studies, it was reported that there was no significant difference compared to the control group [3,5-8].

In the literature, we did not find any studies examining the common carotid artery (CCA) and vertebral artery (VA) flow volumes in AS patients. As known, vertebral column involvement is prominent in AS and syndesmophytes and enthesopathic changes occur in joints and soft tissues. In particular, we thought that VA flow volume may be affected because of its course in the transverse foramina.

This study aimed to compare carotid IMT, a marker of subclinical atherosclerosis, in AS patients with healthy volunteers. In addition, we aimed to evaluate how CCA and VA flow volumes may change in AS patients compared to healthy controls.

Material and Methods

Subjects: The data of the patients who were diagnosed as AS in the physical medicine and rehabilitation clinic between September and November 2014 were collected retrospectively from the hospital database. All patients were questioned about previous neck trauma or surgical histories of the vascular structures in the neck region. Patients with comorbid conditions such as dyslipidemia, hypertension, diabetes mellitus, cerebrovascular disease, renal failure, peripheral vascular disease, and smoking were excluded from the study. In addition, a patient with vertebrobasilar insufficiency, a patient with 70% stenosis in the proximal left internal carotid artery, and a patient with severe cervical hernia were excluded. Fifty AS patients (25 male, 25 female) with appropriate conditions for the study were included in the study group, and 50 healthy volunteers (25 male, 25 female) mean age 32±9.8 years; range from 18 to 59 years) and 50 healthy volunteers (25 males, 25 females, mean age 32±9.8 years; range from 18 to 59 years) were included in the study. There was no statistically significant difference between the two groups in terms of mean age (P=0.287). The mean duration of the disease in AS patients was 6±3.8 years.

Results

Fifty patients with AS (25 males, 25 females, mean age 32±9.8 years; range from 18 to 59 years) and 50 healthy volunteers (25 males, 25 females, mean age 32±9.3 years; range from 21 to 58 years) were included in the study. There was no statistically significant difference between the two groups in terms of mean age (p=0.287). The mean duration of the disease in AS patients was 6±3.8 years.

Table 1. Arterial flow volume and carotid IMT values in the neutral position

|                  | Study Group |       |       |        | Control Group |       |       |        | p      |
|------------------|-------------|-------|-------|--------|---------------|-------|-------|--------|--------|
|                  | mean±SD     | Min.-Max. | mean±SD | Min.-Max. |               | mean±SD | Min.-Max. |        |        |
| Right CCA flow volume | 845±849     | 459-668 | 752±152 | 468-1271 | 0.445         |       |       |        |        |
| Left CCA flow volume  | 730±126     | 426-1030 | 745±165 | 455-1500 | 0.600         |       |       |        |        |
| Total CCA flow volume | 1575±864   | 1040-7455 | 1498±251 | 977-2232 | 0.541         |       |       |        |        |
| Right VA flow volume  | 123±42     | 34-229 | 138±61 | 22-299 | 0.147         |       |       |        |        |
| Left VA flow volume  | 129±45     | 43-273 | 124±55 | 44-320 | 0.679         |       |       |        |        |
| Total VA flow volume  | 252±46     | 176-385 | 263±67 | 88-471 | 0.332         |       |       |        |        |
| Total CCA+VA flow volume | 1827±884 | 1348-7840 | 1761±247 | 1215-2411 | 0.609        |       |       |        |        |
| Carotid IMT        | 0.60±0.07 | 0.48-0.82 | 0.55±0.06 | 0.44-0.82 | 0.001         |       |       |        |        |

CCA: common carotid artery, VA: vertebral artery, IMT: intima-media thickness.
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Table 2. Arterial flow volume values in the right rotational position

| Study Group | Control Group | P  |
|-------------|---------------|----|
|             | mean±SD | Min.-Max. | mean±SD | Min.-Max. |
| Right CCA flow volume | 742±145 | 435-1000 | 733±148 | 452-1271 | 0.763 |
| Left CCA flow volume | 780±119 | 541-995 | 779±175 | 412-1411 | 0.961 |
| Total CCA flow volume | 1525±231 | 1088-1951 | 1513±275 | 864-2682 | 0.839 |
| Right VA flow volume | 111±45 | 29-274 | 155±123 | 31-864 | 0.022 |
| Left VA flow volume | 133±46 | 25-242 | 150±56 | 29-264 | 0.089 |
| Total VA flow volume | 244±55 | 150-569 | 305±138 | 141-1093 | 0.005 |
| Total CCA+VA flow volume | 1768±255 | 1265-2247 | 1819±325 | 1181-3000 | 0.387 |

CCA: common carotid artery, VA: vertebral artery

Table 3. Arterial flow volume values in the left rotational position

| Study Group | Control Group | P  |
|-------------|---------------|----|
|             | mean±SD | Min.-Max. | mean±SD | Min.-Max. |
| Right CCA flow volume | 862±117 | 512-1050 | 778±174 | 493-1310 | 0.060 |
| Left CCA flow volume | 780±123 | 451-1030 | 779±176 | 463-1280 | 0.990 |
| Total CCA flow volume | 1642±213 | 963-1974 | 1558±266 | 1060-2255 | 0.083 |
| Right VA flow volume | 126±46 | 35-258 | 141±72 | 43-394 | 0.218 |
| Left VA flow volume | 87±20 | 45-142 | 142±80 | 32-553 | 0.001 |
| Total VA flow volume | 214±42 | 132-417 | 284±97 | 134-603 | 0.001 |
| Total CCA+VA flow volume | 1896±226 | 1205-2341 | 1854±313 | 1261-2554 | 0.449 |

CCA: common carotid artery, VA: vertebral artery

Comparative US results are summarized in Tables 1, 2, and 3. Carotid IMT was significantly higher in the study group (0.60±0.07 mm) compared with the control group (0.55±0.06 mm) (p=0.001). The CCA and VA flow volumes in the neutral position were similar between the two groups. There was no significant difference between CCA flow volumes in right and left rotational positions between the groups (p>0.05). The right vertebral artery and total vertebral artery flow volumes in the right rotational position were significantly lower in the study group (p=0.022 and p=0.005 respectively). In the left rotational position, the left vertebral artery and total vertebral artery flow volumes were significantly lower in the study group when compared with the control group (p=0.001). There was no statistical significance in other parameters.

Discussion

Ankylosing Spondylitis is a chronic inflammatory disease primarily involving the sacroiliac joints and spine. There are common extra-articular manifestations such as cardiovascular involvement in AS. The mortality rate in AS patients is 1.6-1.9 times higher than the normal population and cardiovascular involvement is estimated to account for 20-40% of this rate [5,10,11]. The mechanism of association between AS and cardiovascular involvement is not fully understood. However, it has been reported that systemic inflammation and autoimmune response play a primary role in the pathogenesis of atherosclerosis and chronic systemic inflammation contributes to increased mortality and morbidity [5,10].

Carotid IMT measurement with high resolution B-mode US is a non-invasive method and an important marker for the assessment of early subclinical atherosclerosis [12]. In our study, carotid IMT values measured in AS patients were significantly higher than healthy controls. We attribute this statistically significant difference to subclinical atherosclerosis described in the literature. In studies, carotid IMT values in AS were higher than in healthy controls and this finding was associated with subclinical atherosclerosis [5,6,10]. However, Choe et al. [7] and Sari et al. [8] found no significant difference in carotid IMT values between the AS patients and control groups. Yuan et al. [1] evaluated 24 articles in a meta-analysis study and found significantly increased carotid IMT in AS groups compared to healthy controls, and stated that this was related to subclinical atherosclerosis in AS.

To the best of our knowledge, there were no studies in the literature examining the flow volumes of CCA and VA in AS patients. In our study, we measured bilateral CCA and VA flow volumes and total arterial flow volumes in neutral, right and left rotational positions. We interpreted the absence of significant changes in CCA flow volumes to autoregulation mechanisms that further protect the anterior circulation and provide haemodynamic balance. We observed that the right VA flow volume in the right rotational position and the left VA flow volume in the left rotational position were significantly lower in AS patients compared to the control group. Likewise, we measured the total VA flow volume in the right and left rotational positions significantly lower in the study group than in the control group. The significant difference in VA flow volume between the two groups in the right and left rotational positions may be due to possible syndesmophytes and enthesopathic changes that cause partial compression of VA (due to the anatomical course of the vertebral artery in the cervical vertebral column) in AS patients. Because syndesmophyte formations are determinant in structural damage and sometimes they can lead to complete fusion of axial skeleton and even peripheral joints. In addition, changes such as vertebral erosions, sclerosis, inflammatory lesions, and fat tissue dysplasia can be seen in the spine [13,14]. Small sample size is the most important limitation of our study. Besides, the lack of correlation of the data obtained in our study with laboratory values such as erythrocyte sedimentation rate (ESR), C-reactive protein (CRP), and cholesterol can be considered as a limitation.

Conclusion: In this study, carotid IMT was significantly higher in AS patients compared to healthy controls. We did not find any significant difference in CCA flow volumes between study and control groups. However, significant volume decreases in VA flow volumes were detected in the study group in rotational positions. We attribute this finding to possible joint and soft tissue changes that may affect VA in AS patients. Further studies are needed to confirm our findings.
Scientific Responsibility Statement
The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.

Animal and human rights statement
All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. No animal or human studies were carried out by the authors for this article.

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Conflict of interest
None of the authors received any type of financial support that could be considered potential conflict of interest regarding the manuscript or its submission.

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