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ASSESSMENT CORRELATION BETWEEN INCREASED BLOOD FLOW IN ANTERIOR HUMERAL CIRCUMFLEX ARTERY AND NIGHT PAIN IN PATIENT WITH ROTATOR CUFF TEAR

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ABSTRACT

Background and aim: Overnight pain is considered as one of the symptoms bothering patients with rotator cuff tear. This pain results in sleep disorders and thus reduces one's quality of life. Overnight pain in patients with rotator cuff tear has been attributed to various causes including shoulder impingement syndrome (which is the result of pressure increase in sub acromial bursa) and inflammatory changes. However, there hasn't been any agreement with regard to the causes of overnight pain in patients with rotator cuff tear. During arthroscopic surgery, vascularized synovium was seen in patients with rotator cuff injury. Thus, in this study, it has been hypothesized that synovitis is the main cause of overnight pain in such patients. Increase in synovial vessels' flow would probably result in increase in vessels' flow through the artery feeding joint capsule. Hence, this study aimed to examine the relationship between the blood flow in anterior humeral circumflex artery and overnight pain in patients with rotator cuff tear using pulse Doppler ultrasonography.
Method: 24 patients with rotator cuff's injury were investigated in this study. Peak systolic velocity and the resistance index of blood flow in anterior humeral circumflex artery's ascending branch were investigated using pulse Doppler ultrasonography. In addition, 12 healthy subjects (without any shoulder damage) volunteered and they were studied as the control group. Peak systolic velocity and the resistance index in the mentioned artery were compared between the affected and unaffected shoulders in patients' group and between the dominant and non-dominant sides within control group.
Results: A significant difference was observed between the peak systolic velocity and the resistance index for anterior humeral circumflex artery of affected and unaffected shoulders in patients with rotator cuff tear and overnight pain. However, no significant difference was found between the peak systolic velocity and the resistance index in anterior humeral circumflex artery in control group subjects as well as patients with rotator cuffs tear without overnight pain.
Conclusion: In the present study, it has been attempted to scrutinize the hemodynamics of anterior humeral circumflex artery in patients with injured rotator cuff and healthy subjects using sonographic Doppler data. Overnight pain in patients with rotator cuff tear might be the result of hemodynamic changes in this artery. An investigation involving patients with rotator cuff tear and overnight pain will help better understand the etiology of this symptom.

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Introduction

The Patients with shoulder injuries repeatedly complain about overnight pain [1, 2]. Overnight pain in patients with rotator cuff tear has been attributed to various reasons including shoulder impingement syndrome (which is the result of increase in sub-acromial pressure [3, 4, 5] and inflammatory changes (synovitis) [7, 8]. However, there hasn't been any agreement over what causes the overnight pain in patients with rotator cuff tear, so far. During arthroscopic surgery, vascularized synovium was observed around rotator cuff and joint capsule in patients with rotator cuff injury. Thus, it can be concluded that synovitis itself may result in overnight pain. Any increase in synovial vessels' flow may probably lead to increase in vessels' flow in the artery feeding joint capsule. [15] previously attempted to describe vascular anatomy around glenohumeral joint capsule. These arteries include anterior and posterior humeral circumflex arteries, suprascapular and circumflex scapular arteries. The major blood supply to the lateral portion of the capsule is provided by the anterior humeral circumflex artery (AHCA). To supply the anterior part of the lateral aspect of the capsule, the vessels from AHCA ascend along the anterior humeral insertion and arborize medially [15]. Previous studies have studied the blood flow through shoulder's joint in inflammatory disorders using power Doppler sonography as well as shoulder's dynamic MRI with Gadolinium injection [16-19]. The analysis of power Doppler results were semi-quantitative and unrepeatable. On the other hand, the results of MRI studies were quantitative but the study was undertaken using Gadolinium injection that was inconvenient and invasive. A special kind of artery (anterior humeral circumflex artery) was investigated in this study. This artery can be easily found using bone landmarks. On the contrary, the measurement of peak systolic velocity and resistance index were repeatable. However, a similar study concerning the investigation of hemodynamics of anterior humeral circumflex artery in patients with rotator cuff tear, using quantitative data and sonography Doppler results has been administered in 2014 in an orthopedic referral center in Japan [1].

Method

Patients referred to Golestan Hospital's outpatient orthopedic clinic were clinically observed. These patients were also studied using radiography and sonography techniques. 24 patients with rotator cuff tear diagnosis were selected to be included in this study. Also 12 healthy volunteers without any previous compliant with regard to shoulder pain were selected as the control group's subjects. There wasn't any significant difference in terms of age within these three groups (p value>0.05). Subjects' demographic information is shown in Table 1.

Table 1. Subjects' demographic information (gender and age in study groups)

Gender (number)/mean age	Patients with rotator cuff tear(n=24)		Control group(n=12)
	With overnight pain (n=12)	Without overnight pain (n=12)	
Male	8	7	6
Female	4	5	6
Mean age(year)	50.3	49.91	49.25

Overnight pain definition

There are probably various causes of shoulder complaints. Some patients reported been awakened to aching pain that is relieved by sitting or heating. Although some complained of piercing pain when sleeping on their sides that get reduced by rolling while sleeping or moving from one side to the other. In this study, overnight pain was referred to as a kind of pain which disturbs a patient's sleep [1, 2] so the patient needs to sit or have a warm shower to decrease his/her symptoms. Accordingly, the patients were interviewed for these characteristics of night pain. Movement-related pains, such as when rolling over and compression pain on the affected side in the lateral position were excluded.

Ultrasonographic evaluation

Doppler sonography was applied from anterior humeral circumflex artery using GE sonography machine, Voluson E8 model and 7-13 MHz linear array transducer. The same Doppler settings was used for all examinations. The gain setting for color Doppler was just below noise level, and the system was adjusted to determine flow with higher sensitivity. At the beginning, the rotator cuff tendons were examined briefly for tendons' tear. After that, Doppler sonography was taken from anterior humeral circumflex artery. The patient remained in a sitting position with 90 degree elbow joint flexion and the hand resting on the palm up on the thigh. Then a transverse section was prepared from bicipital groove. Anterior humeral circumflex artery is located on the lateral side of biceps tendon. After finding the place of artery by color Doppler, the longitudinal section was obtained from AHCA. Pulse Doppler mode was used to measure the peak systolic velocity (PSV) and resistance index (RI= PSV-EDV/PSV) of the AHCA. The sample volume was set within the AHCA, and the incident angle between the artery and Doppler beam kept 60 degree or less (Figure 1). Measurement of all the parameters was repeated three times, and finally the mean result was considered as the final data. PSV and RI between the affected and unaffected sides in patient group and between dominant and non-dominant hands in control group were measured. Then, the patient was allowed to rest for 10 minutes lying on a bed, and Doppler sonography was repeated once more in sleeping position.

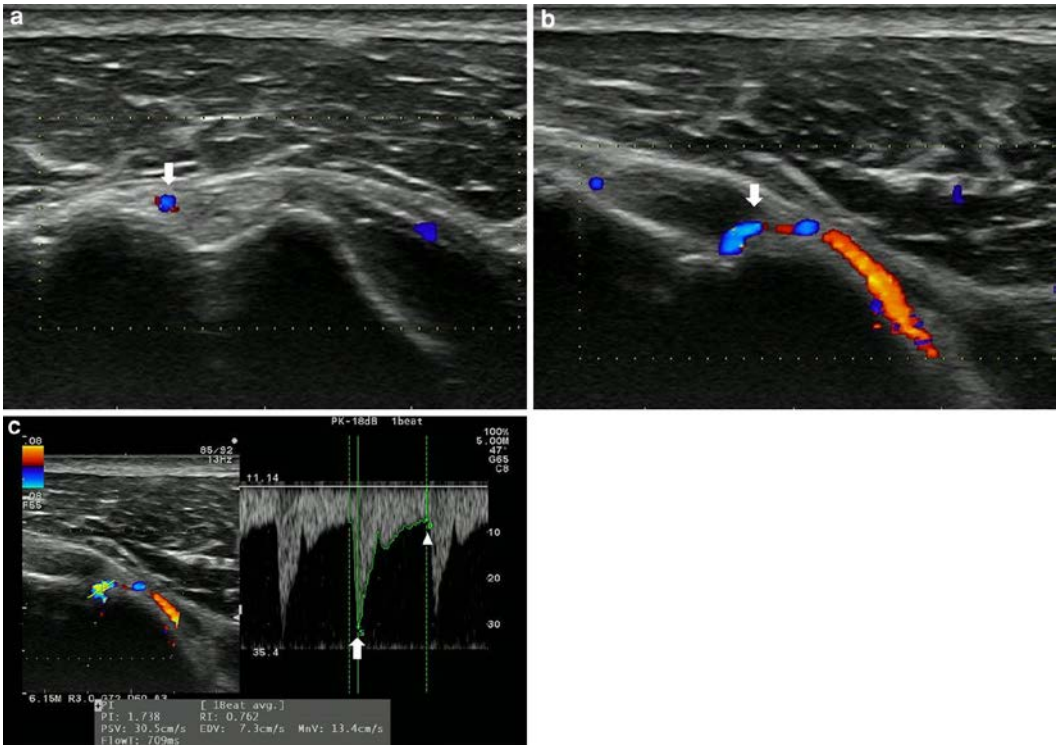

Figure 1: a) Transversal cross section on color Doppler sonography from bicipital groove.

(a)Ascending branch of anterior humeral circumflex artery (arrow) is located outside the groove (b) Longitudinal cross section in color Doppler sonography from the ascending branch of anterior humeral circumflex artery(arrow), (c) Pulses from Doppler sonography which show peak systolic velocity(arrow) and end diastolic velocity(arrowhead).

Ethics

The protocol in this study was approved by Ahvaz Medical University's ethical and research committee for studying human subjects, and all of the patients voluntarily signed written consent forms before entering this study.

Statistical analysis

The data for this study were analyzed using SPSS software package. In order to analyze the differences in mean variables of PSV and RI in three groups (control, patients with rotator cuff tear and overnight pain, and patients with rotator cuff tear without overnight pain), one-way ANOVA test (or its non-parametric equivalent, i.e. Kruskal Wallis test) was used. Paired T-test or its non-parametric equivalent, i.e. Wilcoxon Test was used to compare both affected and unaffected sides in patients with rotator cuff tear, with and without overnight pain as well as dominant and non-dominant hand in control group. The mean and standard deviation of PSV and RI parameters in anterior humeral circumflex artery were extracted based on the information made available by [1].

Results

Comparison of PSV between affected and unaffected sides

Patients with rotator cuff tear and overnight pain showed a significantly higher PSV in anterior humeral circumflex artery in affected shoulder as compared with those unaffected (affected side: 39.5∓16.4 cm/sec and non-affected shoulder: 16.08∓4.73 cm/sec, P value< 0.0001). However, no significant differences were found between affected and unaffected side on patients with rotator cuff and without night pain, as well as in control group between their dominant and non-dominant hands.

Table 2. A comparison of PSV (cm/sec) in anterior humeral circumflex artery in affected and non-affected shoulder (in sitting position**)**

Groups	Number	Affected shoulder	Non-affected shoulder	P value
Rotator cuff tear and overnight pain	12	39.5±16.4	16.08±4.73	<0.0001
Rotator cuff tear and without overnight pain	12	18.3±3.48	16.65±2.81	0.2146
Control	12	12.8±2.48	12.65±1.90	0.8694

Control: comparison between dominant and non-dominant sides

Comparison of RI between affected and unaffected sides

Those patients with rotator cuff tear and nightly pain showed a lower RI in anterior humeral circumflex artery in affected shoulder compared with non-affected one (affected side: 0.66±0.063 and non-affected side: 0.74±0.096, p value<0.0246).

However, the comparison of RI in both affected and unaffected sides didn't show any significant difference in subjects with rotator cuff tear and without nightly pain and dominant and non-dominant sides in control group subjects.

Table 3. A comparison of anterior humeral circumflex artery's RI in affected and unaffected shoulders (sitting position)

Groups	Number of subjects	Affected shoulder	unaffected shoulder	P value
Rotator cuff tear with overnight pain	12	0.66±0.063	0.74±0.096	<0.0246
Rotator cuff tear without overnight pain	12	0.68±0.091	0.68±0.076	1.000
control	12	0.62±0.075	0.67±0.093	0.1612

Control: comparison between dominant and nondominant sides

A comparison of PSV and RI variations in anterior humeral circumflex artery in sitting and supine positions

The results of PSV changes in control group from sitting position when compared to supine position were found to be statistically significant. It was observed that by changing position from sitting to rest, PSV increased (P value=0.02). However, RI changes weren't statistically significant with regard to sitting and supine positions. In the other two groups, patients with rotator cuff tear with or without overnight pain, PSV and RI changes were not statistically significant when the position changed from sitting to supine position.

Table 4. A comparison of PSV and RI changes in anterior humeral circumflex artery in control group subjects, on dominant hand from sitting to supine position.

	Sitting position (12)	Supine position (12)	P value
PSV	12.651.90	14.31.5	0.0275
RI	0.610.08	0.580.075	0.3536

Table 5. A comparison of PSV and RI changes in anterior humeral circumflex artery in control group subjects, on non-dominant hand from sitting to supine position.

	Sitting position (12)	Rest position (12)	P value
PSV	12.651.90	14.31.5	0.0275
RI	0.610.08	0.580.075	0.3536

Other tables weren't included in this paper because they weren't statistically significant.

Discussion

Anterior humeral circumflex artery's blood flow changed a lot in patients with rotator cuff tear and nightly pain and a higher PSV, and the lower RI were observed in anterior humeral circumflex artery in affected side compared with unaffected one (tables 2 and 3). These changes were illustrative of hemodynamic changes of blood flow. Among the advantages of measurements in this specific artery, compared to the other arteries, the anatomical features of AHCA can be referred. Despite being a small artery, the AHCA passes through the lateral side of bicipital groove and under the transverse ligament. Gray-scale ultrasound can easily show bicipital groove, so, the longitudinal image of AHCA can be detected. Besides, PSV of this artery because of its location under the transverse ligament may be insusceptible (Figure 1). The relationship between synovial blood flow and shoulder pain has been found in several studies. These studies have used power of Doppler sonography and dynamic enhanced MRI methods for their investigations [16-19]. In [17], the intensity dynamic MRI signal and arthroscopic and histologic results from sub-acromion were investigated. They found that the signal intensity was positively correlated with arthroscopic results with regard to redness and formation of villous. In addition such findings also correlate with pathologic results such as proliferation and capillary hyperplasia in patients with rotator cuff tear [17]. Also, several studies have attempted to investigate changes in shoulder joint in rheumatoid Arthritis and power Doppler sonography. These studies have shown an increase in synovial blood flow around rotator cuff and bicipital groove [19, 20]. [20] reported that the power of Doppler sonography showed vascularization increase along biceps tendon sheath in patients with RA (rheumatoid arthritis). Overall, these results suggested that blood flow may increase because of synovitis in symptomatic shoulders, however, these studies couldn't show any particular relationship with vessels' flow and shoulder's pain at night. Patients with night pain sometimes take hot shower or attempt to sleep in sitting position to relieve pain [2]. These symptoms are not solely justified by physical stimuli such as rolling over or the lateral decubitus position. Particularly, changing the sleep position will decrease the subacromial pressure [4,22] which explain the resultant pain relief. Being in a warm place may increase the blood flow as well as the chance for sweating, and therefore it will increase heat dissipation with consequential decrease in central blood flow [24]. In healthy people, blood flow is affected by any change in position, and it is expected that blood flow in anterior humeral circumflex artery would be decreased by change in position from rest to sitting one and vice versa. Decrease in blood flow by just changing position from sleeping to rest one can somehow justify the behavior of patients with rotator cuff tear and overnight pain in order to relieve their own pain. These patients try to sit when they feel pain at night. When they sit, the blood flow in shoulder's joint capsule is decreased, and this will result in decrease of pain. This issue was studied in the present investigation as well. It was found that in control group, PSV was lower in sitting position when compared with experimental group. However, RI changes by changing position in this group weren't statistically significant, and in the other two groups,

i.e. the patients with rotator cuff tear, with and without night pain, changes in PSV and RI variables weren't statistically significant by changing position. The reason for this phenomenon may lie in the small sample population or other intervening variables.

Thus, those patients with rotator cuff tear and overnight pain showed higher PSV and lower RI in anterior humeral circumflex artery in affected side compared with unaffected one. This shows that any increase in intraarticular flow is a background factor in pathogenesis of overnight pain in patients with rotator cuff tear. In addition, PSV investigation may be helpful in controlling their pain. Furthermore, this study suggests the use of proper medical and physiotherapy methods based on the etiology of blood flow increase in patients with overnight pain and rotator cuff tear. It is possible that these patients wouldn't respond to common physiotherapy methods that attempt to reduce sub-acromion pressure, while there is another etiology for the night pain.

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