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Diagnostic Value of High Frequency Ultrasound in Rheumatoid Arthritis Shoulder Joint Pathologies

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Abstract: In order to explore the diagnostic value of high-frequency ultrasound (HFUS) in shoulder joint pathologies of rheumatoid arthritis (RA) patients, and the method used is high frequency ultrasound (HFUS) to scan the shoulder joints of 120 patients with RA who have shoulder pain, swelling and limited mobility. Inflammatory diseases include synovitis, tenosynovitis, tendonitis and bursitis, as well as structural pathologies including bone erosion, osteophyte, tendon damage, tendon atrophy and tendon dislocation, were statistically analyzed. The thickness of acromioclavicular joint cavity, glenohumeral joint cavity, subacromial-subdeltoid bursa and tendon and tendon sheath of long head of biceps brachii were also analyzed. The results showed that 10 pathological types were detected. Among them, synovitis in 33 cases (33/120, 27.5%), tenosynovitis in 61 cases (61/120, 50.8%), bursitis in 55 cases (55/120, 45.8%), bone erosion in 73 cases (73/120, 60.8%), tendinitis in 15 cases (15/120, 12.5%), tendon damage in 10 cases (10/120, 8.3%), calcified tendinitis in 7 cases (7/120, 5.8%), osteophyte in 44 cases (44/120, 36.7%), tendon atrophy and tendon dislocation occurred in 2 cases each(2/120,1.7%), glenohumeral joint cavity thickness (5.97±2.12)mm, acromioclavicular joint cavity thickness(3.91±0.37)mm, tendon of long head of biceps brachii thickness(6.27±1.48)mm, tendon sheath of biceps brachii long head thickness(3.49±1.88)mm, subacromial-subdeltoid bursa thickness(6.42±3.67)mm. We come to the conclusion that high-frequency ultrasound can effectively identify a variety of pathological changes caused by rheumatoid shoulder arthritis, which has high diagnostic value.

1. Introduction

Rheumatoid arthritis is an autoimmune disease characterized by chronic, destructive and polyarthritis mediated by T lymphocytes and driven by antigen[1-2]. The incidence rate ranges from0.25% to 1%, and can even reach 1-2% among people aged 20-50[3-4]. The incidence rate in women is 2-3 times higher than that in men[5]. There are more than 30 million RA patients in China, which is one of the main causes of labor loss and disability[6]. RA mainly involves small joints, but shoulder joint involvement is not uncommon. It is reported in the literature that over 90% patients with RA may involve shoulder in the course of disease, resulting in symptoms of shoulder arthritis,

but it has not been paid enough attention to, and it is often easy to be missed or misdiagnosed in the process of disease diagnosis[7]. Therefore, early diagnosis and treatment of rheumatoid shoulder arthritis can effectively prevent shoulder joint dysfunction and deformity. This study observed the ultrasound imaging manifestations of shoulder joint and surrounding soft tissue lesions in RA patients, explored the auxiliary diagnostic value of high-frequency ultrasound for RA shoulder joint pathologies.

2. Materials and methods

2.1 General information

Collect patients with rheumatoid arthritis who visited the Rheumatology and Immunology Department of Xi'an Fifth Hospital from September 2021 to September 2022 and experienced shoulder joint pain, swelling, or restricted mobility. RA conforms to the 1987 ACR classification standard or the 2010 ACR/EULAR classification standard. Except: there are other autoimmune diseases and tumor history that may cause shoulder joint lesions; congenital dysplasia of shoulder joint; shoulder joint surgery or prosthesis implantation; history of shoulder injury within half a year; received shoulder joint injection within 3 months; skin around the shoulder joint is broken or infected; mental disorders, low cognitive function, physical disability and severe dysfunction cannot cooperate with the examination. All subjects signed informed consent.

2.2 Research method

All patients underwent bilateral shoulder joint ultrasound examination.①Equipment: Siemens ACUSON P50 color ultrasonic instrument and high-frequency linear probe with the center frequency of 7.5~18 MHz are adopted.②A physician with over 5 years of experience in musculoskeletal ultrasound examination will conduct ultrasound examinations on enrolled patients and record the type and location of lesions.③Ultrasonic examination was carried out according to the standard scanning specification[8] formulated by OMERACT. This study focuses on the statistical analysis of inflammatory lesions in the shoulder joint, including synovitis, tenosynovitis, tendinitis, and bursitis, as well as structural lesions such as bone erosion, osteophyte formation, tendon damage, tendon atrophy, and tendon dislocation. The thickness of acromioclavicular joint cavity, glenohumeral joint cavity, subacromial-subdeltoid bursa and tendon and tendon sheath of long head of biceps brachii were measured, and the thickest point was taken to avoid probe pressure. The above pathological changes all follow the accepted definition in the literature[9-10]. Synovitis[11] and tenosynovitis[12] were scored according to OMERACT ultrasonic grading. Bone erosion was graded according to Ala Saarela standard[13].

3. Results

3.1 General situation

A total of 120 patients with RA were included, including 28 males and 92 females, aged from 22 to 77 years, with an average of (52.2±11.9) years. The course of disease ranged from February to 13.75 years, with an average of (4.86±3.86) years. 240 shoulder joints were examined by ultrasound, among which 35 cases (35/120, 29.2%) were left shoulder pathologies, 41 cases (41/120, 34.2%) were right shoulder pathologies, 37 cases (37/120, 30.8%) were shoulders pathologies, and 7 cases (7/120, 5.8%) were normal. The detection rate of shoulder joint pathologies by ultrasound was 94.2%, and all the undetected cases were further improved by magnetic resonance imaging of shoulder joint.

3.2 Types of shoulder joint pathologies

Synovitis: 33 cases (33/120, 27.5%) with 42 shoulder joints (42/240, 17.5%) were detected, 27 cases (27/120, 22.5%) of glenohumeral synovitis, totaling 34 shoulder joints (34/240, 14.2%), and 6 cases (6/120, 5%) of acromioclavicular synovitis, totaling 8 shoulder joints (8/240, 3.3%). Thickness of the glenohumeral joint cavity (5.97 ±2.12) mm, and thickness of the acromioclavicular joint cavity (3.91 ±0.37) mm. The scoring results of synovitis are detailed in Table 1.

Table 1: Scoring of shoulder synovitis in RA patients

Synovitis	SH (greyscale)	Doppler (PD)	Combined score* (greyscale SH + PD)
Grade0 (normal)	0	11	0
Grade1(minimal)	11	11	8
Grade2(moderate)	23	15	23
Grade 3 (severe)	8	5	11

Tenosynovitis: 61 cases (61/120, 50.8%) with a total of 84 shoulder joints (84/240, 35%) were detected as tenosynovitis of the long head of the biceps tendon. The tendon thickness of the long head tendon of biceps brachii was (6.27 ±1.48) mm, and the tendon sheath thickness was (3.49 ±1.88) mm. See Table 2 for tenosynovitis score results.

Table 2: Shoulder tenosynovitis score in RA patients

Tenosynovitis	GS-mode	PD-mode
Grade0	0	12
Grade1	18	41
Grade2	49	23
Grade 3	17	8

Bursitis: A total of 73 shoulder joints (73/240, 30.4%) were found in 55 cases (55/120, 45.8%), which were subacromial-subdeltoid bursitis. The thickness of subacromial-subdeltoid bursa was (6.42 ±3.67) mm.

Bone erosion: 73 cases (73/120, 60.8%) with a total of 106 shoulder joints (106/240, 44.2%) were detected, which can be seen in any part of the joints. Nodules of the humeral head, the groove of the long head tendon of the biceps brachii, and the vicinity of the glenohumeral joint are commonly seen. Among them, there were 32 cases (32/120, 26.7%) of grade I erosion, totaling 46 shoulder joints (46/240, 19.2%), 23 cases (23/120, 19.2%) of grade II erosion, totaling 37 shoulder joints (37/240, 15.4%), and 18 cases (18/120, 15%) of grade III erosion, totaling 23 shoulder joints (23/240, 9.6%).

Tendinitis: 15 cases (15/120, 12.5%) with a total of 16 shoulder joints (16/240, 6.7%) were detected. Among them, there were 8 cases (8/120, 6.7%) of supraspinatus tendon with 9 shoulder joints (9/240, 3.8%), 4 cases (4/120, 3.3%) of biceps longus tendon with 4 shoulder joints (4/240, 1.7%), 2 cases (2/120, 1.7%) of infraspinatus tendon with 2 shoulder joints (2/240, 0.8%), and 1 case (1/120, 0.8%) of subscapularis tendon with 1 shoulder joint (1/240, 0.4%).

Tendon damage: 10 cases (10/120, 8.3%) with 10 shoulder joints (10/240, 4.2%) were detected. 6 cases (6/120, 5%) of supraspinatus tendon, totaling 6 shoulder joints (6/240, 2.5%), including 4 cases (4/120, 3.3%) of partial tear, totaling 4 shoulder joints (4/240, 1.7%), and 2 cases (2/120, 1.7%) of full-thickness tear, totaling 2 shoulder joints (2/240, 0.8%). There were 2 cases of infraspinatus tendon (2/120, 1.7%) with 2 shoulder joints (2/240, 0.8%), 1 case of biceps brachii tendon and 1 case of subscapularis tendon (1/120, 0.8%), each involving 1 shoulder joint (1/240, 0.4%), all of which were partial tears.

Calcified tendinitis: 7 cases (7/120, 5.8%) with 8 shoulder joints (8/240, 3.3%) were detected.

Among them, there were 4 cases (4/120, 3.3%) of supraspinatus tendon with a total of 5 shoulder joints (5/240, 2.1%), 2 cases (2/120, 1.7%) of infraspinatus tendon with a total of 2 shoulder joints (2/240, 0.8%), and 1 case (1/120, 0.8%) of subscapularis tendon with a total of 1 shoulder joint (1/240, 0.4%).

Osteophyte: 44 cases (44/120, 36.7%) with a total of 78 shoulder joints (78/240, 32.5%) were detected, which can be seen in any part of the joints. Nodules of the humeral head, glenoid joint, and acromioclavicular joint are more common.

Tendon atrophy: Detected 2 cases (2/120, 1.7%) with a total of 2 shoulder joints (2/240, 0.8%), occurring in the supraspinatus tendon.

Tendon dislocation: 2cases (2/120, 1.7%) with 2 shoulder joints (2/240, 0.8%) were found, which were incomplete dislocation of the long head tendon of biceps brachii.

4. Discussion

During the course of RA, shoulder involvement is not uncommon, but due to its complex structure, it is difficult to locate the painful area. In the early stages of the disease, it is often difficult to attract the attention of patients and clinical physicians, resulting in patients missing the best treatment opportunity and ultimately leading to joint deformities and functional disorders. Early detection of shoulder joint pathological changes, staged diagnosis and treatment according to specific pathological types and severity can effectively control the patient's condition and delay the development of the disease.

At present, the commonly used imaging methods are X-ray, ultrasound, MRI and CT [14]. X-ray can show the structural diseases of shoulder joint such as bone hyperplasia, bone erosion and space stenosis, but it is not sensitive to the synovium and surrounding soft tissue diseases of shoulder joint, and its ability to find early RA shoulder joint diseases is limited. MRI can show RA synovitis, bone marrow edema, bone erosion and other diseases with high sensitivity, and can effectively evaluate RA shoulder joint diseases. It is an internationally recognized “gold standard” for diagnosis, but it is expensive, time-consuming and difficult to popularize and apply in primary hospitals, which limits its clinical application[15-16]. CT can detect early lesions in synovium and cartilage, and display fine structures of the rotator cuff, with a higher detection rate for osteoporosis than X-ray[17], but there is ionizing radiation present. High frequency ultrasound can clearly detect various pathological changes such as shoulder joint effusion, synovitis, bone erosion, bursitis, tenosynovitis, rotator cuff injury, etc., and has good consistency compared with MRI examination[18-19]. At the same time, ultrasound can be converted into color images related to blood vessels to analyze the speed and direction of blood flow, analyze local blood flow conditions[20], it has good diagnostic value for RA, especially early RA. Many clinicians and researchers believe that ultrasound examination is superior to physical examination, X-ray plain film and magnetic resonance imaging in rheumatic diseases[21]. The application of ultrasound in the clinical practice of rheumatism is increasing gradually, and ultrasound is linked with the diagnosis, treatment and condition evaluation of RA[22-23].

In this study, the detection rate of ultrasound in rheumatoid arthritis was as high as 94.2%, and 10 types of shoulder joint pathologies were detected, among which the most common inflammatory diseases were tenosynovitis of biceps brachii (50.8%), subacromial-subdeltoid bursitis (45.8%) and synovitis of joint cavity (27.5%). Essentially, these three types of pathologies appear as fluid accumulation and synovial hypertrophy under ultrasound, with differences in the location and mechanism of the pathologies[24-25]. In 2019, OMERACT[8] had independent definitions for synovitis and tenosynovitis, but did not have an independent definition for bursitis, which essentially still belongs to synovitis. This study suggests that tenosynovitis of biceps brachii, subacromial-subdeltoid bursitis and synovitis of joint cavity are the most common causes of shoulder pain and shoulder joint

dysfunction in rheumatoid arthritis,similar to previous research results[24,26]. It is further verified that synovitis and tenosynovitis are the most common pathological manifestations of rheumatoid arthritis shoulder joint, and it is suggested that ultrasound is very sensitive to detect synovitis and tenosynovitis of RA shoulder joint, which is helpful for early diagnosis of RA. Ultrasound can accurately measure the thickness of the pathologies. In this study, the thickness of acromioclavicular joint cavity, glenohumeral joint cavity, subacromial-subdeltoid bursa and tendon and tendon sheath of long head of biceps brachii were measured. The more obvious the thickening of synovium, the easier it is to observe blood flow signals,the grading of pathologies based on ultrasound detection results has important clinical significance for the diagnosis and subsequent treatment evaluation of rheumatoid arthritis shoulder joint pathologies.

This study suggests that the most common structural pathologies are bone erosion (60.8%) and osteophyte (36.7%). Previous studies have shown that ultrasound is easier to detect bone erosion early than X-ray[27], and the diagnostic coincidence rate is higher, and its detection efficiency is equivalent to that of MR[28]. In this study, the detection rate of bone erosion is high, especially in the large and small nodules of humeral head, the tendon groove of long head of biceps brachii and the vicinity of glenohumeral joint. The most common sites are all obvious inflammatory pathologies, and the positive rate of superficial erosion is significantly higher than that of the other two, suggesting that ultrasound has high sensitivity in detecting bone erosion and can accurately distinguish early tiny bone erosion. At the same time, the detection rate of osteophyte is high, which may be because some patients are older and have joint degenerative changes. On the other hand, it suggests that the progression of RA exacerbates shoulder joint strain.

There were 15 cases of tendinitis (12.5%), 10 cases of tendon damage (8.3%), 7 cases of calcified tendinitis (5.8%), 2 cases of tendon atrophy and 2 cases of tendon dislocation (1.7%), totaling 36 cases of tendon pathologies (36/120, 30%), indicating that tendon lesions are another serious consequence of chronic damage in RA. As is well known, synovitis is the basic pathological manifestation of RA, and bone erosion is the basic structural lesion of RA, previous studies have focused more on these lesions. This study found that tendon pathologies are also common clinical pathologies in rheumatoid arthritis shoulder joint pathologies and need to be taken seriously. A study[29] found that in 60 cases of RA shoulder ultrasound examination, the most common shoulder pathology was supraspinatus tendon lesions (n=33,55%), and similar conclusions were drawn. Tendon lesions, especially tendon tears, can be treated conservatively when the early damage is mild and only partially torn. If tendon rupture occurs, surgical treatment is necessary. The degree of tendon injury determines the choice of clinical treatment plan. Ultrasound can detect tendon injury early and accurately evaluate the degree of injury, which has good clinical value[30].

In this study, 7 patients (7/120,5.8%) with RA shoulder pain were diagnosed through MRI after complete ultrasound examination without detecting any pathologies. The main reasons for missed diagnosis analysis are as follows: (1) Ultrasound is easily affected by various factors, such as the performance of ultrasound equipment, the level of operation of the examining doctor, the degree of fat or thinness of the examinee, and the appropriate position during examination. (2) Due to the strong echogenicity of bones, ultrasound can only display cartilage and cortical bone, and cannot display bone marrow. (3) The ultrasound field of view is limited, making it difficult to comprehensively observe the anatomical structures of cartilage, rotator cuff, and deep areas.

5. Conclusion

In summary, high-frequency ultrasound has good tissue resolution and can clearly display tissues such as the surface of the shoulder joint bone, tendons, tendon sheaths, and bursae. It can accurately detect different pathological abnormalities of the shoulder joint in RA patients from all directions,

multiple angles, and accurately measure or implement semi quantitative grading of the pathologies range, objectively judge the severity of the disease, and have great potential and development space for the diagnosis and follow-up of RA shoulder joint pathologies.

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