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Article

A study of the effectiveness of ultrasound imaging in the early detection of cartilage degeneration in the knee joint of athletes

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Abstract: Knee injury is one of the common sports injuries, this paper aims to analyze the performance of ultrasound imaging technology in the assessment of early detection of athletes with knee pain, to provide a reliable assessment index for clinical diagnosis and treatment and an index for judging the efficacy. To analyze the causes of cartilage degeneration in athletes' knee joints, and to evaluate and compare the ultrasound imaging method with the commonly used clinical assessment (Visual Analogue Scale (VAS) score, Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) score) and imaging assessment (Digital Radiography(DR), Magnetic Resonance Imaging (MRI)) for knee osteoarthritis according to the advantageous performance of ultrasound imaging technology in the examination of knee joint diseases. The correlation between ultrasound assessment and VAS score and WOMAC score, as well as DR assessment and MRI assessment were obtained, respectively. To investigate the value of ultrasonography in the evaluation of patients with osteoarthritis of the knee. The ultrasound scores of the knee were positively correlated with the VAS scores and WOMAC scores, with correlation coefficients of 0.891 and 0.902, respectively. The correlation coefficients of ultrasound ratings with DR ratings and MRI ratings were 0.876 and 0.895, respectively (both > 0.75), which were good correlations.

Keywords: ultrasound imaging technique; knee joint; VAS score; MRI assessment; cartilage degeneration

1. Introduction

The knee is one of the most complex flexible large joints in the human body and one of the major load-bearing joints in the body. The main movements of the knee include extension, flexion, internal rotation, external rotation and buckling movements [1,2]. The knee joint is load-bearing not only from the body's own gravity, but also from the body's external load, i.e., extracorporeal weight-bearing, in addition to the forces generated by the muscle activity around the joint, which is one of the main sources of force on the knee joint [3,4]. The knee joint is located between the two longest bones of the human body, the femur and the tibia, which makes it an important hub for lower limb activities, and is linked to the hip and ankle joints, which allows the lower limbs to do more flexible movements, and is one of the important physiological features that differentiate human beings from animals. The anatomical structure of the knee joint mainly includes the bony structure of the joint, the knee joint capsule and the tensile band of the knee joint capsule [5–7].

Osteoarthritis has become the most common type of arthritis nowadays due to better quality of life and increased life expectancy of human beings [8,9]. OA is a degenerative change in which the main pathological change is erosion of articular cartilage tissue leading to pain and loss of joint function. Currently the only therapeutic endpoint remains joint replacement surgery. Because the knee is the largest weight-bearing joint in the body, it is most often involved [10,11]. Artificial total knee arthroplasty is the mainstay of treatment for severe knee disorders, relief of knee pain, and reconstruction of knee function, and a large number of patients undergo TKA every year worldwide. Postoperative patients show significant improvement in pain, joint function and mobility [12,13].

Ultrasonography is convenient, cost-effective, no obvious harm to the examination object, dynamic observation of bilateral contrast, with very good tissue contrast and image clarity, with the continuous improvement of ultrasound instrumentation, the emission frequency continues to increase, the imaging method is gradually improved, the image is becoming clearer and clearer, showing more and more subtle structures, high-frequency ultrasound in the superficial parts of the diagnosis of soft tissue diseases play an increasingly important role in the diagnosis of. In particular, it has become an irreplaceable imaging modality for the diagnosis of breast, thyroid, superficial lymph nodes, superficial masses and other diseases [14–16]. High-frequency ultrasound can clearly display the muscle firmus, joint capsule, articular cartilage, and bone surface around the knee joint, and it has obvious advantages for detail display, and it can be observed dynamically in real time, and it can also be applied with new technologies such as color Doppler imaging, ultrasound elastography, and 3D imaging, which can provide the blood supply situation of the knee soft tissues, the information of the biological elasticity, and the information of the local three-dimensional reconstruction, and the high-frequency ultrasound can also well display the intra-articular cavity fluid condition, and assess the condition of exudate effusion and intra-articular free body caused by joint inflammation, trauma and other reasons [17–19].

In recent years, high-frequency ultrasound has become one of the important methods of bone and joint system examination, because of its convenience and low cost, and non-invasive, more easily accepted by the clinic and the majority of patients, so high-frequency ultrasound in the diagnosis of knee joint disease also has obvious advantages. However, due to the disadvantages of bone display, high-frequency ultrasound has become an important examination modality for soft tissue diseases of the locomotor system, such as tendon tensilage and other soft tissue diseases [20,21]. The application and study of articular cartilage is still less, especially the application of imaging diagnosis in OA patients, especially the early OA diagnostic study is less. Due to the important role of articular cartilage and high morbidity, research in this field is of great value [22,23].

This paper analyzes the etiology of knee cartilage injury in athletes, which is manifested as knee cartilage degeneration caused by knee overwork and overactivity as well as knee cartilage injury caused by acute knee violence. The advantages of using ultrasound imaging technology in knee joint diseases are proposed. Athletes with and without knee pain who met the experimental requirements were screened, and patients were tested using ultrasound imaging technology before and after treatment, respectively. Analyze the changes of each variable before and after the treatment of the observers, and test the feasibility of the experimental treatment plan in this paper. Technical comparison of ultrasound imaging with different clinical assessment techniques and imaging techniques was performed to analyze the correlation between ultrasound assessment and clinical assessment and imaging assessment.

2. Research base

2.1. Athlete's knee cartilage

With the continuous improvement of the competitive level and the increasing perfection of the technical level, sports injuries seriously disturb the normal life and training of athletes, how to get rid of sports injuries has become a major problem for coaches, athletes and scientific research workers.

The causes of knee cartilage injury are as follows:

(1) Lack of exercise

Lack of activity or insufficient exercise in the knee joint is often the cause of certain diseases directly or indirectly. Long-term immobilization or lack of activity of the knee joint leads to a decrease in blood supply. Nutrients and oxygen can not be supplied to the cartilage through diffusion. What's more, when the knee joint lacks activity, the cartilage loses its extrusion, and the cartilage loses its nutrition and undergoes degenerative changes. On the contrary, the knee joint activity, cartilage can be constantly subjected to mechanical stimulation, mutual extrusion, decompression, thereby accelerating the cartilage nutrient and metabolic material exchange. Therefore, knee joint activity is an important condition to maintain the physiological state of articular cartilage.

(2) Knee cartilage degeneration caused by overwork and excessive activity of knee joints

Unscientific sports training program or long-term large amount of exercise, strong load on the knee joint is easy to cause cartilage softening of the knee joint. This kind of injury often does not have acute injury history, is due to long-term gradual strain, wear and tear, as well as the accumulation of microscopic injuries.

(3) Knee joint cartilage injury caused by acute violence of knee joints

Acute violence injury to the joint is caused by the strong compression of the joint surfaces, after the injury, the cartilage tissue is crushed, and at the same time, the collagen fibers and chondrocytes in the tangential layer produce tears. Under extreme force, the cartilage surface of the knee joint develops linear cracks, gap tears or laceration defects. The most common acute violence during training activities in sports are twisting errors, tangential injuries, and impact injuries.

2.2. Ultrasound imaging in knee disorders

Ultrasound imaging is a new non-traumatic new technology of clinical medicine developed in the late 1950s. By using the physical properties of ultrasound, imaging principles, anatomical, physiological and pathological characteristics of human tissues and organs, as well as the basic knowledge of clinical medicine to show the changes in the morphology and function of human tissues and organs, and to provide a basis for clinical diagnosis [24–26].

2.2.1. Application of ultrasound imaging in knee joint and periarticular swelling

Compared with CT and MRI, ultrasound is the simplest and most convenient method for examining intra- and periarticular masses in the knee joint. Ultrasound can identify the cystic solidity of the mass, show its blood flow distribution, clarify the relationship between the lesion and the surrounding tissues, and guide the puncture for biopsy and interventional therapy.

2.2.2. Application of ultrasound in knee osteoarthritis

The knee is the joint with the richest synovium in the body, and the suprapatellar bursa is the largest synovial fluid sac in the body, which is connected to the knee joint. When the synovial membrane is physically, chemically or biologically stimulated, inflammatory changes will occur, synovial membrane congestion, edema, followed by exudation, resulting in fluid accumulation. If the cause of the disease persists for a long time, the synovial membrane is hyperplasia and hypertrophy. High-frequency ultrasound has good resolution of the joints and can clearly show the anatomical structures of the articular cartilage, interstitial space and surrounding soft tissues.

Rheumatoid arthritis (RA) is an autoimmune disease with symmetrical polyarthritis as the main clinical manifestation. It can cause progressive, irreversible joint damage. The knee joint is the most frequently involved large joint, and its basic pathological changes are synovitis invading the underlying cartilage and bone, resulting in progressive joint destruction, deformity and loss of function, etc. Therefore, early diagnosis of RA is important.

In the past, X-ray or MRI was used to observe knee joint lesions. With the continuous development of ultrasound instruments and the improvement of ultrasound diagnostic techniques for skeletal and muscular lesions, high-frequency ultrasound, color Doppler flow imaging (CDFI), and contrast-enhanced ultrasound (CEUS) are more and more frequently used in the diagnosis and efficacy determination of RA.

Ultrasound can directly visualize articular cartilage. Experiments in animal models of isolated cartilage degeneration have also shown that ultrasound is able to discriminate between normal cartilage and degenerative cartilage lesions with high sensitivity.

In summary, high-frequency ultrasound can clearly show the joint cavity, synovium, bursa, effusion, cartilage thickness and morphology. And color ultrasound can detect the distribution of blood flow in the joint tissues and show the state of synovial hyperplasia with high sensitivity. It can also make ultrasound grading diagnosis, which is helpful for guiding clinical and follow-up diagnosis.

2.2.3. Application of ultrasound in the diagnosis of traumatic lesions of knee joints

The knee joint has a complex structure, high activity, and a high chance of tendon and ligament injury. In recent years, the diagnostic accuracy of ultrasound for tendon and lateral collateral ligament lesions has been improving, and it has been applied to the examination of many diseases in orthopedics and Chinese orthopedics and traumatology.

3. Subject and methodology of the study

3.1. Types of research

This study was a prospective, observational cross-sectional study with randomized sampling. The target population of the study was knee pain athletes and athletes without knee pain who met all the inclusion criteria and patients who did not meet any of the exclusion criteria. Prior to the start of the trial, a clinical trial informed consent form was read to the subjects by the researcher, and the subjects agreed and signed to join.

The whole study of this experiment included a screening period and an experimental observation period. The screening period was mainly for pre-recruitment, communication, and explanation of the experimental process and related benefits. During the experimental observation period, all subjects received basic information collection, knee function assessment, myofascial trigger point palpation, musculoskeletal ultrasound testing, and infrared thermography testing.

3.2. Subjects

Sixty cases of volunteers were selected to be recruited through the Rehabilitation Medicine Center of Southwest University Hospital from July 2023 to November 2023, and the volunteers were all athletes. Athletes are those who have been recognized by the relevant national departments and issued athletic grade certificates. Among them, there were 54 cases of experimental subjects meeting the requirements of the experiment, and the screening criteria were the pre-determined inclusion exclusion criteria and the subjects voluntarily joined this experiment.

Through investigation 54, it is found that most of the subjects are track and field athletes. Due to the long-term high-load training of track and field athletes and the competitive requirements, this sport attaches great importance to the knee cartilage tissue of athletes.

3.2.1. Screening criteria for athletes with knee pain

I Inclusion criteria (All trial subjects need to meet the following criteria):

1) Patients with knee pain meet the criteria for chronic musculoskeletal knee pain of the International Classification of Diseases (ICD-11).

2) Athletes aged 18–35 years old.

3) Knee pain (VAS $\geq$ 1 point) for at least one month in quiet state.

4) Signed informed consent.

II Exclusion criteria:

1) Acute injury with obvious swelling, etc.

2) Knee fracture, meniscus and other related surgeries less than 3 months.

3) Myofascial trigger points were not diagnosed by palpation of quadriceps muscle.

4) Other diseases that make it impossible to cooperate.

III Shedding criteria: 1) Those who quit the experiment in the middle. 2) Those with incomplete data.

3.2.2. Screening criteria for athletes with non-knee pain

I Inclusion criteria (All test subjects need to meet the following criteria):

1) Athletes aged 18–35 years old.

2) No knee pain for at least 3 months in a quiet state.

3) Sign the informed consent form.

II Exclusion criteria (Subjects meeting any of the following criteria will be excluded from the study):

1) Knee pain or hip pain in the last 3 months.

2) Lower extremity trauma history less than 3 months.

3) Other diseases that make it impossible to cooperate.

III Shedding criteria: 1) Those who quit the experiment in the middle. 2) Those with incomplete data.

3.2.3. Treatment

All of them were given leflunomide (specification: 10 mg, Dalian Meiluo Pharmaceutical Factory) treatment, 20 mg/dose, 1 time/d. Oral methotrexate, 10 mg/dose, 1 time/week. Non-steroidal anti-inflammatory drugs (NSAIDs) could be used as appropriate according to the patient’s specific condition, with 4 weeks as 1 course of treatment and 8 courses of continuous treatment.

3.3. Research methodology

(1) Random sampling

Recruitment of volunteers with sports experience was carried out through the Internet, posters, etc., and random sampling of enrolled subjects was adopted to avoid sampling errors.

(2) Baseline survey

Collect the baseline data of all patients, including: basic personal information (age, gender, education level, type of exercise, level of exercise, years of exercise, etc.), Lysholm score, muscle strength assessment, VAS rating scale.

Analyze whether the two groups of patients were comparable. Knee function index: including pain assessment, muscle strength and knee function assessment. Baseline collection of patients was performed by one physician, including basic information, knee function assessment, and muscle strength. Knee function assessment included pain score using visual analog scale (VAS) and knee function assessment (Lysholm scale). The assessment was performed by a rehabilitation therapist with more than 5 years of experience using the VAS scale and the Lysholm scale.

1) VAS score: The Visual Analog Scale (VAS) for pain is a scale that asks the patient to describe the intensity of pain using 11 points from 0–10. 0 indicates no pain, and the number of points increases when the pain is stronger, in that order. 10 indicates severe pain that is intolerable.

2) Knee function score: The Lysholm score is an assessment scale for knee function.

The score includes 8 items, including limping, support, squatting, colic, stairs, joint instability, swelling and pain, with a score of 100 points. Scoring criteria: 100 points, completely normal. 91–99 points, excellent. 75–90 points, good. 50–74 points, fair. < 50 points, poor.

3) Muscle strength: Measured using portable muscle strength testing equipment, using torque to indicate the magnitude of muscle strength.

(3) Bias and control in experiments

Bias refers to the fact that the results of a scientific study may be interfered by non-treatment factors in addition to sampling errors, resulting in biased results. The source of bias runs through the whole experiment, so it is necessary to control bias as much as possible. The principle of controlling bias in this experiment is to plan before analyzing and collect data independently. That is, measurements were made by experienced assessors at each session for each subject, and standardized training was conducted before the experiment was implemented.

(4) Statistics and analysis

The statistical software SPSS 25.0 was applied to process and analyze the study data, and the measurements were expressed as mean ± standard deviation. The value of $\alpha$was taken as 0.05 as the test level and p-values were taken as two-sided probability.

Each patient’s knee was evaluated ultrasonographically using the ultrasound scoring method and the total score was calculated. The VAS pain score and WOMAC visualization scale were also used for clinical assessment of each patient, and the correlation between the ultrasound score and the clinical score was analyzed.

Imaging assessment comparisons included ultrasonography and MRI.

4. Results

4.1. Clinical characteristics

Comparison of the results of effusion, synovial and cartilage thickness in the 2 groups is shown in **Table 1**. Comparison of the results of effusion, synovial, and cartilage thickness showed that the observation group showed more abundant blood flow before treatment, mostly in the form of dendrites or dots. While the control group showed no blood flow. The depth (thickness) of effusion and synovial thickness of knee and elbow joints in the observation group were significantly higher than those in the control group ($P < 0.05$), and cartilage thickness was significantly lower than those in the control group ($P < 0.05$).

Table 1. The results of the two groups were compared.

Group	Knee joint		
	Fluid thickness	**Synovial thickness**	**Cartilage thickness**
Observation group	26.23 ± 6.89	9.68 ± 2.15	1.32 ± 0.36
Control group	3.42 ± 0.25	0.71 ± 0.52	1.35 ± 0.64
T value	30.26	23.15	7.46
P value	0.00	0.00	0.00

Comparison of the variables before and after treatment in the observation group is shown in **Table 2**. Blood flow distribution, synovial thickness, CRP, anti-CCP antibody, and ESR were significantly lower than those before treatment in the observation group ($P < 0.05$), and RI was significantly higher than those before treatment ($P < 0.05$).

Table 2. The observation group was compared before and after the treatment.

Time	RI	Synovial thickness (mm)	CRP (mg/L)	Antisymmetric antibody (U/mL)	ESR (mm/1h)
Pretreatment	0.53 ± 0.25	1.57 ± 0.63	63.52 ± 11.21	156.89 ± 16.43	84.53 ± 6.59
After treatment	0.89 ± 0.33	0.89 ± 0.21	16.79 ±4.57	77.54 ± 8.96	45.23 ± 9.11
T value	5.23	26.43	31.05	35.26	10.75
P value	0.06	0.00	0.00	0.00	0.03

4.2. Analysis of the value of ultrasound in the assessment of joint mobility in RA

4.2.1. Comparison of musculoskeletal ultrasound semiquantitative scores in RA cases with different levels of activity

Comparison of musculoskeletal ultrasound semiquantitative scores of RA cases with different degrees of activity is shown in **Table 3**, which was analyzed by Spearman's rank correlation method and showed that the correlation coefficients of synovial hyperplasia, intra-synovial blood flow signals, bone erosion, and articular effusion in joint-unobstructed cases, mildly obstructed cases, moderately obstructed cases, and severely obstructed cases were 0.725, 0.769, 0.703, respectively. 0.593, all $P < 0.05$.

Table 3. Different activity degree RA case muscle bone ultrasonic semi-quantitative score.

Group	*n*	Synovial proliferation	The flow signal in the slide membrane	Bone erosion	Joint fluid
Cases of joint accessibility	54	1.53 ± 0.68	1.53 ± 0.59	1.26 ± 0.54	1.04 ±0.75
Cases of mild obstruction of the joint	10	4.02 ± 0.24	3.71 ± 0.52	2.55 ± 0.65	2.35 ± 0.47
Cases of moderate joint	26	7.96 ± 0.72	8.63 ± 0.89	6.58 ± 0.75	6.59 ± 0.75
Cases of severe joint	18	10.36 ± 0.89	12.25 ± 0.86	8.76 ± 0.83	8.97 ± 1.21
Correlation coefficient		0.725	0.769	0.703	0.593
P		< 0.05	< 0.05	< 0.05	< 0.05

4.2.2. Correlation of ultrasonography scores in cases of rheumatoid arthritis

The two-by-two correlation coefficients of the ultrasonography scores of the rheumatoid arthritis cases are shown in **Table 4**. The two-by-two comparisons of Spearman's rank correlation method showed a comparison of synovial hyperplasia, intra-synovial blood flow signals, bone erosions, and articular effusions on ultrasonography of the rheumatoid arthritis cases ($P < 0.05$).

Table 4. The correlation coefficient of the two points.

	Synovial proliferation	The flow signal in the slide membrane	Bone erosion	Joint fluid
Synovial proliferation	/	/	/	/
The flow signal in the slide membrane	0.912*	/	/	/
Bone erosion	0.563*	0.589*	/	/
Joint fluid	0.642*	0.702*	0.724*	/

4.2.3. Correlation of ultrasonography scores with indicators of RA activity

The correlation coefficients between the ultrasound imaging scores and RA mobility indexes are shown in **Table 5**, which were analyzed by the Spearman rank correlation method, showing that the ultrasound imaging scores were positively correlated with the joint mobility assessment indexes (including the subjective scoring index, DAS28 score, and the objective serum indexes, ESR expression level and hs-CRP expression level).

Table 5. The correlation coefficient of ultrasonic imaging score and RA activity index.

	Ultrasonic grading	**DAS28**	**ESR**	**hs-CRP**
Ultrasonic imaging score	/	/	/	/
DAS28 score	0.801*	/	/	/
ESR	0.753*	0.911*	/	/
hs-CRP	0.706*	0.911*	0.816*	/

4.3. Correlation of ultrasound assessment with clinical assessment

4.3.1. Correlation between ultrasound score and VAS score

The correlation between ultrasound and VAS scores was analyzed as shown in **Table 6**, and the total number of knees with ultrasound scores ≤ 3 was 10, and all of them had mild VAS scores. The total number of knees with ultrasound scores of 4–6 was 26 cases, of which 10 cases had mild VAS, 14 cases had moderate VAS, and 2 cases had severe VAS. The total number of knees with ultrasound scores ≥ 7 was 18, with 7 moderate and 11 severe. The correlation coefficient between the VAS score and the ultrasound score of the knees was 0.891, which was statistically significant ($P < 0.05$).

Table 6. Correlation analysis of ultrasonic and vas scores.

VAS score	**Ultrasonic grading**									
	2	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Light	3	7	6	4						
Medium			5	6	3	5	2			
Severity					2	1	3	1	4	2

4.3.2. Correlation of ultrasound scores with WOMAC scores

The correlation analysis between ultrasound and WOMAC scores is shown in **Table 7**. Of the 10 knees with ultrasound scores ≤ 3, the WOMAC scores were mild in 9 cases and moderate in 1. Of the 26 knees with ultrasound scores of 4–6, the WOMAC scores were mild in 10 cases, moderate in 11 cases, and severe in 5. Of the 18 knees with ultrasound scores ≥ 7, the WOMAC scores were moderate in 3 cases and severe in 15 cases. The WOMAC score of knee osteoarthritis was positively correlated with the ultrasound score (correlation coefficient of 0.902, $P < 0.05$), which was statistically significant.

Table 7. Correlation analysis of ultrasonic and WOMAC scores.

WOMAC score	Ultrasonic grading									
	2	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Light	3	6	3	7						
Medium		1	2	4	5	1	2			
Severity				3	2	5	3	1	4	2

4.4. Correlation of ultrasound assessment with imaging assessment

4.4.1. Comparison of the value of ultrasound versus DR and MRI for the assessment of knee-related lesions

Comparison of the detection rates (*n*%) of ultrasound, X-ray, and MRI in nonosteochondral structures of knee osteoarthritis is shown in **Table 8**. The difference between ultrasound and MRI in nonosteochondral structural changes of OA, such as cartilage degeneration, effusion, synovial membrane hyperplasia, meniscus injury, ligamentous injury, and popliteal cysts, was not statistically significant, with $P > 0.05$ for all of them.

Table 8. The detection rate is compared to (*n*%).

Method		Degeneration of cartilage	Patellar fluid	Synovial proliferation	Meniscus injury	Cruciate ligament injury	Accessory ligament injury	Popliteal sac
X ray		0	0	0	0	0	0	0
MRI		47 (0.870)	47 (0.870)	36 (0.667)	21 (0.389)	6 (0.111)	5 (0.093)	18 (0.333)
Ultrasonic		49 (0.907)	49 (0.907)	36 (0.667)	33 (0.611)	4 (0.074)	5 (0.093)	18 (0.333)
X ray	X^2	113.52	113.52	142.36	72.14	31.25	13.69	41.01
MRI	P	0	0	0	0	0	0	0
Ultrasonic	X^2	0.38	0	0	0.03	1.12	0	0
MRI	P	0.67	1.00	1.00	0.56	0.34	1.00	1.00

Although there is no difference between the diagnostic results of ultrasound and MRI, compared with MRI, ultrasound imaging technology is more conducive to observing the morphology and structure of articular cartilage tissue of the knee and its relationship with surrounding tissues, and more effectively improves the sensitivity and accuracy of early diagnosis of knee cartilage degeneration.

4.4.2. Correlation of ultrasound ratings with DR/MRI ratings

The correlation analysis between musculoskeletal ultrasound ratings and DR ratings is shown in **Table 9**, and the correlation coefficient between ultrasound ratings and DR ratings was 0.876 (> 0.75), with a $P < 0.05$, indicating that the two correlate well. However, the diagnostic ability of DR was not as good as that of ultrasound in the milder samples, and the two were equivalent in the more severe samples.

Table 9. The correlation analysis of the ultrasound rating and DR ratings.

DR Score	Ultrasonic grading				
	0	**1**	**2**	**3**	**4**
0	3	2	4		
1		6	11		
2			4	5	
3				10	3
4					6
Correlation coefficient	0.876				
P value	0.000				

Similarly, it can be obtained that the correlation coefficient between ultrasound ratings and MRI ratings was 0.895 (> 0.75) slightly higher than the correlation with DR, $P < 0.05$, which is a good correlation between the two.

5. Discussion

Currently, the diagnosis of RA is mostly based on clinical symptoms and combined with laboratory and imaging examinations. However, laboratory examination lacks specificity, and X-ray examination cannot effectively display cartilage, synovium and other tissue structures, and has low resolution.

Ultrasonography can clearly show the fluid in the joint cavity, articular soft tissue, synovial membrane, bone surface, etc., and has high resolution for joints and soft tissues. In addition, it can also clearly show the pathologic changes of tissues, especially synovial changes. An important indication of RA is joint effusion, which is manifested by the presence of a clear anechoic area on ultrasound. Raised, irregularly thickened synovial surfaces with low echogenicity can be recognized as synovitis, and thus ultrasound can accurately detect synovitis before the margins are eroded. Ultrasound imaging is able to detect the presence of vascular opacities, which show blood flow signals in the form of dots, short lines, and dendrites, and are rich in blood flow signals, whereas in normal individuals they do not show blood flow signals. In severe cases, the thickness of the damaged articular cartilage is thinned and ultrasound is more sensitive to its detection.

The results of this study showed that the depth of joint effusion and synovial thickness observed before treatment was higher than that of the control group ($P < 0.05$), and the cartilage thickness was lower than that of the control group ($P < 0.05$), suggesting that ultrasonography can accurately diagnose early RA.

Initial symptoms of RA are mainly mild manifestations such as morning stiffness and joint pain in the affected joints, and after the disease progresses, it can be manifested as difficulty in joint movement or even loss of joint mobility, so joint mobility disorder is its main clinical manifestation. Early clinical diagnosis and assessment of the degree of joint mobility impairment are of great significance to the development of RA treatment programs. Imaging data is one of the most important auxiliary diagnostic or condition assessment tools, including X-ray, ultrasound and MRI are commonly used in the early clinical diagnosis of RA and assessment of the degree of joint mobility disorders, which is non-invasive, convenient, rapid and other advantages have been recognized by the clinic. However, X-ray and conventional ultrasound have their limitations, i.e., they are mainly focused on the diagnosis and assessment of solid lesions in bone tissue, but have limitations in the application of joint effusion, cartilage invasion, and blood rheology, etc. MRI has the advantage in RA joint effusion and cartilage invasion, but is expensive, so it is very important to choose a diagnostic tool that is economical and suitable for the diagnosis and assessment of RA joint effusion, cartilage invasion, and blood rheology. It is important to choose a diagnostic tool that is economical and suitable for the diagnosis and evaluation of RA joint effusion, cartilage tissue invasion, hemorheology and other lesions. Ultrasound is a high-frequency ultrasound technology that breaks through the blind spots of conventional ultrasound soft tissue examination, but the application of ultrasound in the diagnosis of RA lesions and the assessment of the degree of impaired joint mobility still requires in-depth research.

From the results of this study, musculoskeletal ultrasound can clearly show the structure, echoes, layers and blood flow signals of bursal tissue, synovial tissue, tendon tissue, etc. in the joint, and although it is not as sensitive as MRI in the diagnosis of cartilage tissue invasion and bone marrow edema, its sensitivity in clarifying whether it is combined with cartilage tissue invasion as a preliminary examination is also clinically significant. Musculoskeletal ultrasound has some clinical prospects in terms of imaging performance for the following reasons:

(1) The synovial lesions in RA are usually irregularly thickened, and musculoskeletal ultrasound, as a high-frequency ultrasound technique, has a patchy hypoechoic or nearly echo-less imaging performance, which generally has a tendency to project toward the bursa.

(2) Inflammatory reaction stimulation and other factors produce vascular opacities is a common pathological manifestation of RA, musculoskeletal ultrasound can clearly show the signal of intra-articular blood flow, so for synovial tissue lesions can be clearly displayed.

(3) Musculoskeletal ultrasound scanning can be observed in multiple sections, and usually the cross-sectional scanning is more effective.

(4) For irregular thickening of the synovial membrane in patches, musculoskeletal ultrasound images can be used for differential diagnosis by measuring synovial blood rheology and blood flow resistance index.

(5) Myofibular ultrasound enables real-time dynamic observation, which is better for identifying peripheral tissue adhesions and joint effusion.

6. Conclusion

This paper evaluates the performance of ultrasonography in the early detection of cartilage degeneration in the knee joint of athletes in terms of both clinical assessment modalities and imaging assessment. The inclusion/exclusion/dislodgement criteria of the experimental subjects were set, the treatment sessions were arranged and the clinical assessment tests were performed.

(1) Blood flow distribution, synovial thickness, CRP, anti-CCP antibody, and ESR were significantly lower and RI was significantly higher than before treatment in the observation group. The intervention treatment conducted in this experiment

was clinically shown to be effective and acted on the recovery of cartilage in the knee joints of the athletes.

(2) There was a good correlation between the scoring of pathological changes in the knee cartilage and surrounding tissues of the patients using ultrasound imaging and the clinical assessment. Ultrasound is comparable to MRI in detection rates and has unique advantages over X-ray in examining early athlete knee pathology.

(3) Ultrasonography showed good correlation with both clinical assessment modalities and imaging assessment modalities, and its simple, easy-to-operate, inexpensive, and repeatable multiple dynamic examinations can be the preferred method of imaging for patients with knee joints and continue to be promoted.

In summary, the 54 ultrasonic diagnostic coincidence rates in this group showed that the diagnostic coincidence rate was more than 80%, suggesting that ultrasonic imaging technology has high clinical value in the early diagnosis of knee cartilage degeneration. However, ultrasonic imaging technology also has certain limitations. For example, the author found that compared with X-ray, CT and other imaging technologies, ultrasonic imaging technology has problems such as high dependence on operator skills, high resolution of equipment, and high cost.

Ethical approval: Not applicable.

Conflict of interest: The author declares no conflict of interest.

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