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Diagnostic Methods and Techniques: Evaluating the Effectiveness and Accuracy of Diagnostic Tools and Procedures Commonly used in Rheumatology, Such as Blood Tests, Imaging Techniques (X-rays, MRI, Ultrasound), and Clinical Assessment Methods

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Abstract: This study compared the diagnostic accuracy of ultrasound and MRI methods for evaluating pathological changes in the luteal stage of rheumatic diseases. One hundred thirty patients from Iraq were enrolled in a randomized trial from 2023 to 2024. The study used expert-grade ultrasound scanners and MRI machines with a 1.5 Tesla magnetic field. The predictive value, sensitivity, and specificity of ultrasound structures were evaluated using MRI as a reference method. The results showed significant differences in data interpretation, with ultrasound showing no false positives and MRI showing the most common false negatives. Prompt identification and treatment of rheumatoid arthritis (RA) are essential for enhancing clinical results and the quality of life for patients. Nevertheless, the early identification of the condition is difficult because of the vague symptoms and the absence of precise diagnostic examinations. This article explores the potential application of MRI in accurately diagnosing, predicting the course of, and monitoring the long-term treatment of rheumatoid arthritis (RA). MRI is a sensitive, accurate, non-invasive tool for evaluating orbital joints in rheumatology patients, identifying abnormalities early, and preventing structural damage, thereby reducing long-term patient monitoring.

Keywords: MRI, (RA), Treatment, Patients, Us, Sensitive, Tool, Imaging techniques, Rheumatology, Diagnostic methods.

INTRODUCTION

Rheumatoid arthritis (RA) is a chronic inflammatory disease that affects individuals between the ages of 35 and 50 years. Without appropriate treatment, it can potentially lead to irreversible damage, disability, and a decreased quality of life. This disease has a variable clinical presentation and multiple risk factors, including genetic and environmental factors. In developing countries, the prevalence of this disease ranges between 0.1 and 0.5%. With regard to Colombia, in particular, there is a paucity of data regarding the prevalence and incidence of the disease. Studies conducted in this country have identified a higher prevalence in females, with a mean age of 50–54 years. It is also worth noting that comorbidities represent an additional risk factor for this population [Feldmann, M. *et al*., 2001; O'Dell, J. R. *et al*., 2001; McGonagle, D. *et al*., 2000; McGonagle, D. *et al*., 1999; Green, M. *et al*., 1999].

Patients with rheumatoid arthritis (RA) exhibit an elevated risk of infection in comparison to the general population, independent of the presence of the disease. This is largely attributed to the immunosuppressive effects of the illness, a chronic inflammatory state, the prevalence of comorbid conditions, disease activity, and the use of immunomodulatory medications. Nevertheless, the majority of infections associated with these patients are of bacterial etiology, primarily affecting the respiratory tract, integument, and musculoskeletal system [Wakefield, R. J. *et al*., 2000].

ESR is a diagnostic criterion for polymyalgia rheumatic and temporal arteritis. Each inflammatory process generates the production of proteins in plasma that cause a change in the surface charge of red blood cells, which tend to sediment more quickly. Thus, ESR is an indirect method to evaluate different acute-phase proteins. The protein that contributes most to increased ESR is fibrinogen (55%), followed by alpha-2 macroglobulin, immunoglobulin, and albumin. [McQueen, F. M. *et al*., 1998; Sugimoto, H. *et al*., 2000] Any disease that overexpresses these proteins can increase the erythrocyte sedimentation rate (e.g., pregnancy, diabetes, end-stage renal failure, coronary heart failure, macrocytic anemia, rheumatic diseases, and tumors) [Kainberger, F. *et al*., 1996].

There are discrepancies in medical practice when requesting laboratory and cabinet studies; in certain cases, they are essential, and in other times, they are not required. There is also no sequence for its use, which causes confusion in its interpretation and, often, unnecessary expenses. Sheldon and his

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collaborators,1 in their article "Laboratory testing in autoimmune rheumatic diseases," consider that there is a significant number of pathological conditions in which tissue damage can be detected through immunological tests by studying antibodies, some specific and others not present in various conditions other than rheumatic diseases. The same occurs with the detection of acute phase reactants directly related to the inflammatory process, which may also be present in various clinical conditions.2 Rheumatic diseases are a heterogeneous group of conditions that primarily affect the musculoskeletal system [Ostergaard, M. *et al*., 2001; Conaghan, P. *et al*., 2001]. The hallmarks of rheumatic diseases are pain, inflammation, and functional limitation; of these components, inflammation is the most susceptible to laboratory evaluation to determine disease activity.

MRI is an essential diagnostic instrument for rheumatoid arthritis, as it detects alterations in bone marrow, identifies joint erosions cartilage tissue, and differentiates between soft tissue and fluid. The high sensitivity of the test enables precise tracking of symptom progression over time. Over the past decade, rheumatologists have increasingly used ultrasound as a clinical tool, a painless, harmless test that provides detailed images of internal body structures. Advances in probe technology have allowed ultrasound to examine joints and soft tissues, making it inexpensive and safe [Smolen, J. S. *et al*., 2010; Klareskog, L. *et al*., 2009; Breedveld, F. C. *et al*., 2006].

Synovitis and bone loss are the hallmarks of RA. They are crucial in the pathogenesis, diagnosis, and prognosis of the disease. It is traditionally believed that synovitis promotes the release of pro-inflammatory cytokines, which subsequently activate osteoclasts and enhance bone resorption at vulnerable anatomical sites, leading to bone loss and, thus, joint damage. [Genovese, M. C. *et al*., 2002]

This concept has been challenged by recent findings that bone changes or tendinitis could occur very early in the course of RA, even in the preclinical phases of the disease. All these abnormalities can now be detected by sensitive imaging techniques, namely, ultrasound (US), magnetic resonance imaging (MRI), and high-resolution peripheral quantitative CT (HR-pQCT). US can be regarded as an extension of the clinical examination in real-time, whereas the primary advantage of MRI is the possibility to visualize bone marrow abnormality. They both have no ionizing radiation and can be used during pregnancy. While MRI is limited by its long examination time and high cost, the main drawback of the US is its operator dependency. [Weinblatt, M. E. *et al*., 2003]

DATA COLLECTION

In this study, 130 patients with rheumatic diseases were collected and distributed into two groups according to the diagnostic method used in this study. The patients were collected from several different hospitals in Iraq during the period from 2023 to 2024.

Study design

The purpose of the study was to compare the diagnostic accuracy of the ultrasound method with the MRI method as a reference method in evaluating pathological changes in the luteal stage.

Rheumatic diseases. The current analysis included patients suffering from rheumatic diseases who underwent examination and treatment in medical institutions in Iraq within the framework of a randomized trial. This study was approved, which initially aims to compare the effectiveness of methods for diagnosing rheumatic diseases and to compare the different methods used by a committee. Ethics All patients signed a voluntary informed consent to participate in the study before the start of the study. Recruitment took place between January 2023 and March 2024.

Expert-grade ultrasound scanners were used, and the study was performed by experienced specialists in this field.

MRI was performed using machines with a 1.5 Tesla magnetic field in three mutually perpendicular planes.

The predictive value of positive and negative findings, as well as the sensitivity and specificity of the studied structures of ultrasound, were evaluated using MRI as a reference method. The analysis was performed by filling in simple tables of four fields with 95% confidence intervals for each indicator. Calculations were made using an online calculator.

When analyzing the diagnostic accuracy of the ultrasound method using MRI as a reference method, significant differences in data interpretation were found. There were no false positives, and the most common false negative

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results were observed according to ultrasound when evaluating the changes.

The ultrasound results were consistent with the results of magnetic resonance imaging in diagnosing rheumatic diseases.

Procedure

CRP, a classic acute-phase protein, increases with inflammation and is a marker of treatment effectiveness. It is a criterion for rheumatoid arthritis and cardiovascular risk assessment. CRP levels vary in joint and spine diseases, with more active inflammation in systemic vasculitis. Hemoglobin levels are crucial in clinical blood tests, as rheumatic diseases are characterized by iron deficiency anemia and chronic inflammation anemia. White blood cell and platelet levels are also important, with leukopenia and thrombocytopenia being diagnostic criteria. Drug-induced leukopenia should be considered in differential diagnosis.

Rheumatoid factor testing is used to diagnose rheumatoid arthritis and other autoimmune disorders, as well as to understand its severity and potential organ effects. However, it cannot diagnose other health problems. A negative result indicates little or no rheumatoid factor in the blood, but it doesn't rule out other health issues. Further tests may be ordered if symptoms persist.

RESULTS

Table 1: Demographic characteristics of patients

Variable	Blood test N=50	MRI N=60	Ultrasound, N=20
Age in years	47±4.4	51.2±3.9	39.9±2.6
Sex			
Male	40	24	11
Female	10	16	9
BMI, N			
25-28	11	15	4
29-31	29	25	12
32-34	10	20	4
Comorbidities, N			
Diabetes	17	14	5
arthritis	20	16	8
blood pressure	7	20	5
Kidney disease	6	10	2
Smoking, N			
Yes	20	15	5
No	30	45	15
Rheumatic, N diseases			
Degenerative arthritis	40	35	10
Rheumatoid arthritis	5	15	5
Systemic lupus erythematosus	---	5	3
Psoriatic arthritis	---	5	2
Time from disease onset to inclusion. mean (SD)	210 (151)	190 (170)	188 (161)
Causes, N			
age	5	4	2
Sex	3	6	1
overweight	1	10	1
Injuries	25	25	11
Muscle weakness	4	5	2
Genetic factors	4	7	2
Environmental factors	8	8	1

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Table 2: Biochemical outcomes of patients

Variable	Blood test N=50	MRI N=60	Ultrasound, N=20
HB	13.99±2.2	12.893±3.3	13.6±3.54
AEA(IU/ml)	148±39.8	150±40.6	149.2±3.5
Vitamin E (µg/ml)	13.3±4.1	14.1±5.2	14.5±4.77
ALT (UI/L)	70.3±40	72.3±47.7	74.9±50.8
AST (UI/L)	131.6±22.3	133±25.7	132.9±34.7
TB (mg/DL)	0.66±0.44	0.70±0.56	0.86±0.44
CRP mg/dl	5.99 ±8.99	6.6±7.7	6.98±8.1
Platelet count 1000/UL)	292±85.3	301.4±88.7	303.4±90.9

Table 3: Evaluating blood pressure results according to Systolic blood pressure, Diastolic blood pressure, Mean arterial pressure, Serum potassium level, And Systolic Blood Pressure

Variable	Blood test N=50	MRI N=60	Ultrasound, N=20
Systolic blood pressure (mm Hg)	181 ± 16.8	182.7±17.4	185.9±15.9
Diastolic blood pressure (mm Hg)	106 ± 12	108.9±13.7	110.99±16.6
Mean arterial pressure (mm Hg)	130 ± 12	133.4±16.6	132±15.5
Serum potassium level (mmol/L)	3.88 (1.99–4.38)	4.66 (2.1–7.7)	4.22 (2.4–7.8)
Plasma aldosterone concentration (ng/dl)	32.24 (11.88–76.53)	35.6 (12.77–80.8)	31.6 (12.2–69.87)
Systolic blood pressure (mm Hg)	180.9 ± 16	182.2±18.8	185.5±17.7

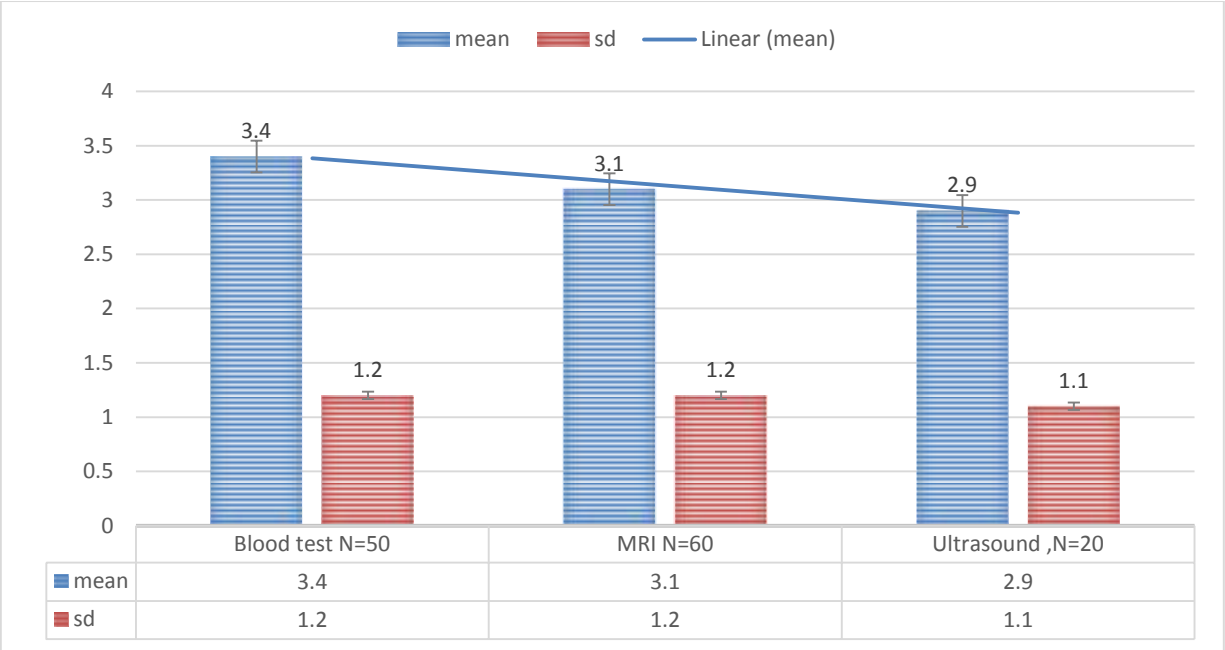

Fig 1: Disease Activity Score of patients according using clinical data

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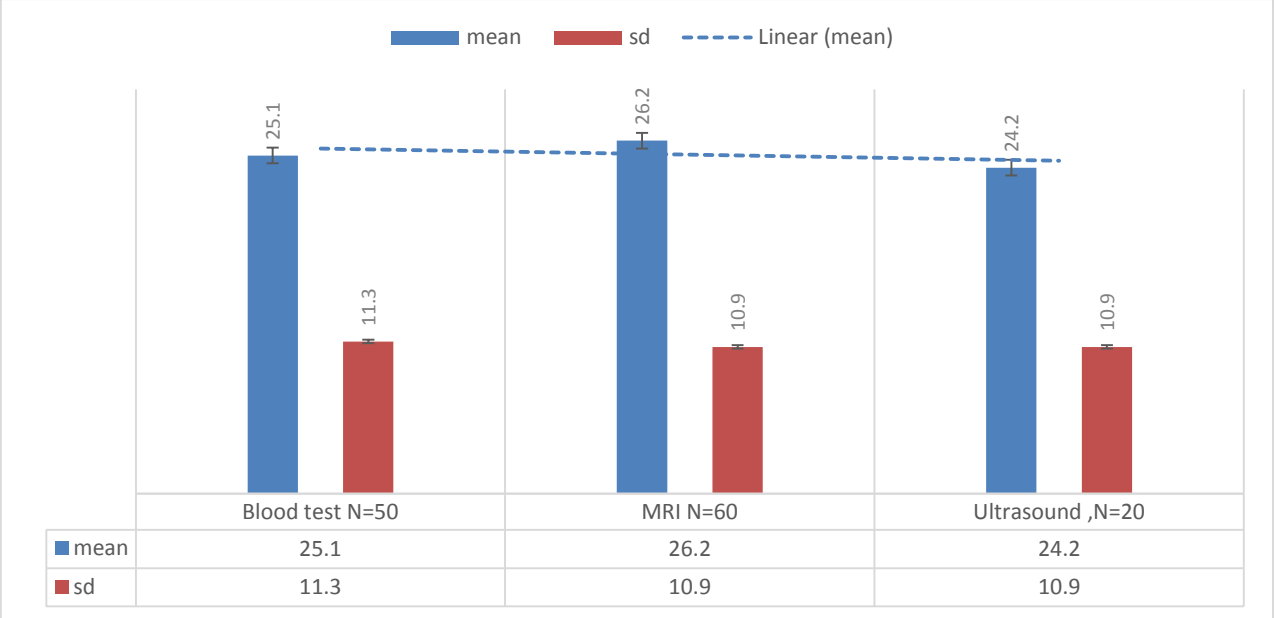

Fig 2: Simplified Disease Activity of Patient Index

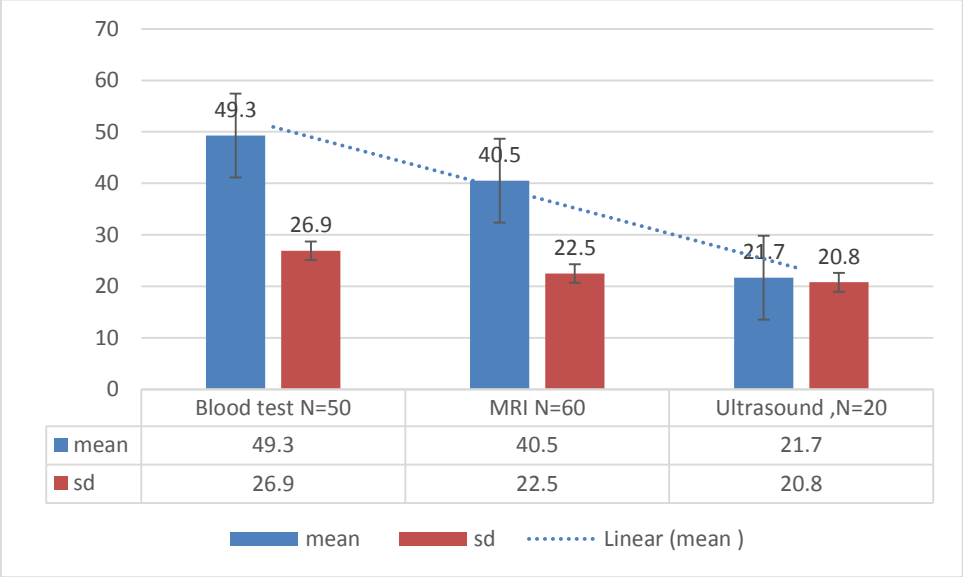

Fig 3: Patient global assessment

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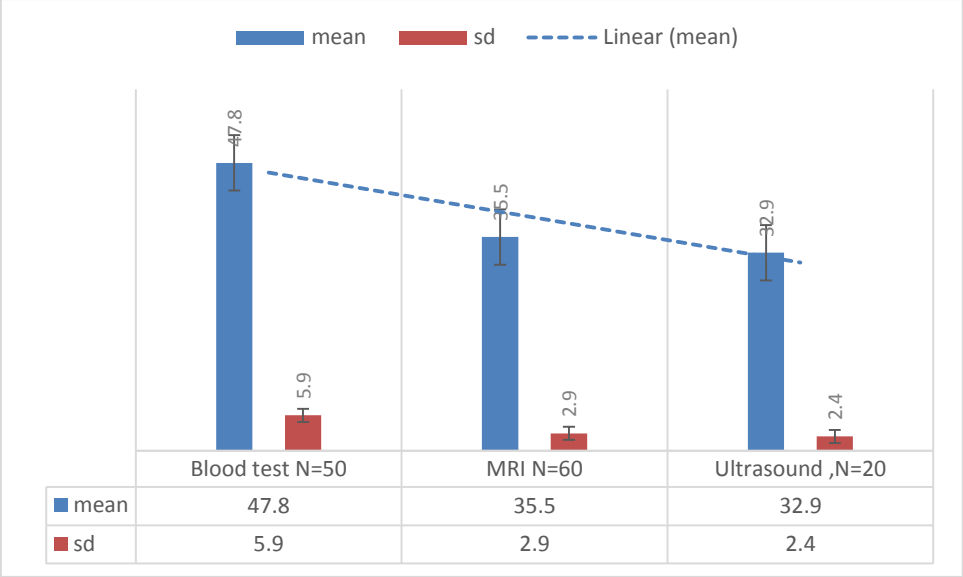

Fig 4: Assessment outcomes of patients according to Physician global assessment (VAS 0–100 mm)

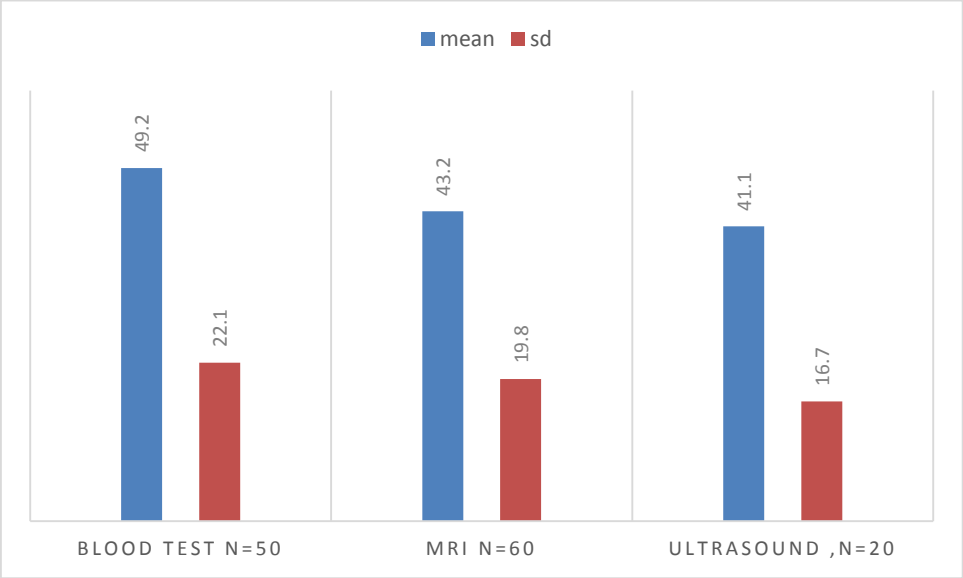

Fig 5: Joint pain outcomes of Iraqi patients (VAS 0–100 mm)

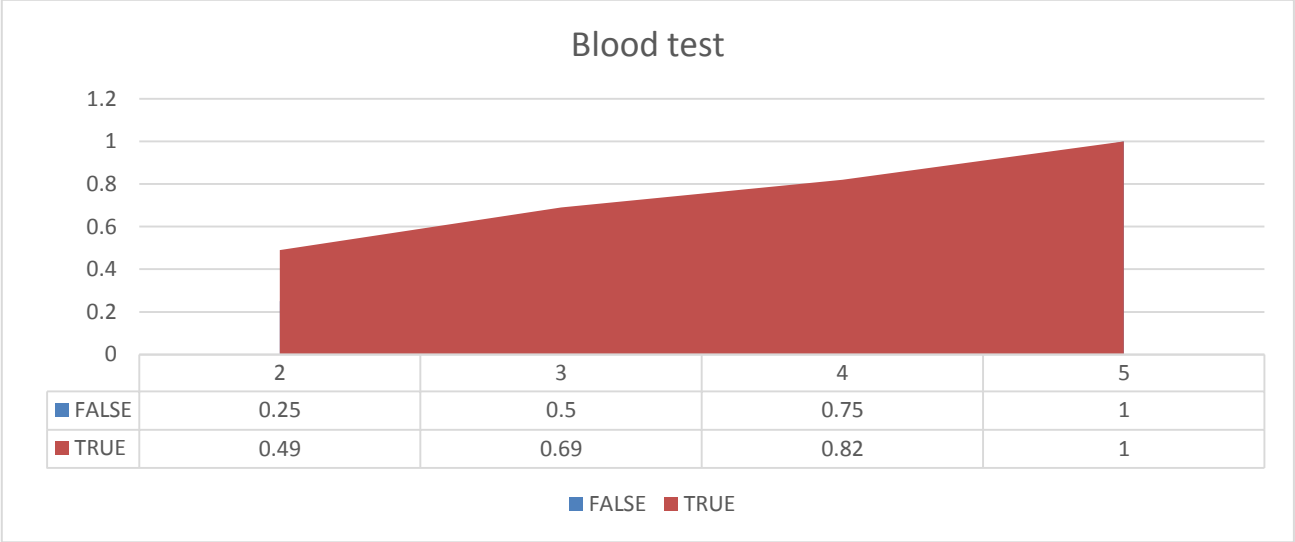

Fig 6: Final outcomes according to false positive and true of blood test, MRI, ultrasound

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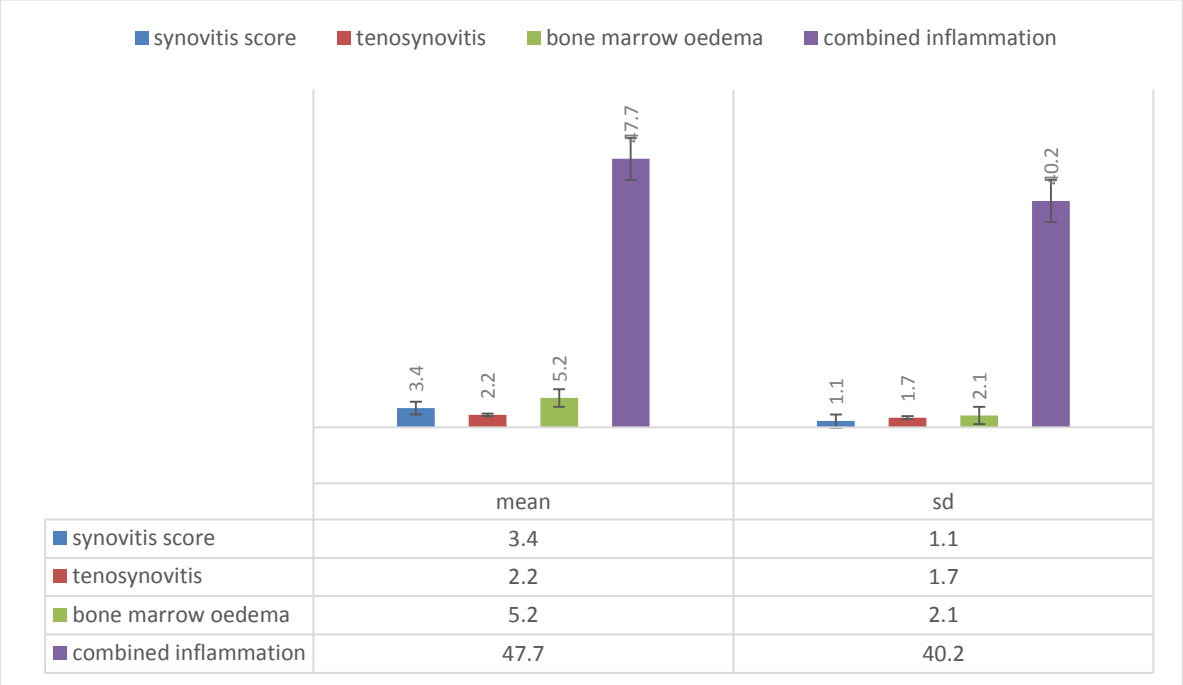
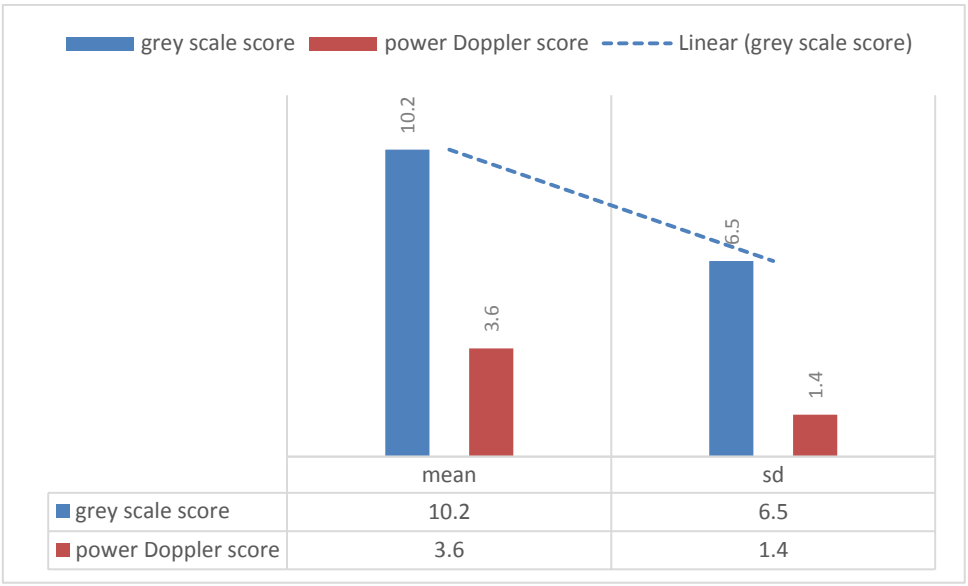


	mean	sd
synovitis score	3.4	1.1
tenosynovitis	2.2	1.7
bone marrow oedema	5.2	2.1
combined inflammation	47.7	40.2

Fig 7: MRI outcomes patients in clinical remission after ten months



	mean	sd
grey scale score	10.2	6.5
power Doppler score	3.6	1.4

Fig 8: US outcomes patients in clinical remission after ten months

DISCUSSION

Our current study discussed the feasibility of diagnostic tools used in rheumatic diseases in order to know the treatment method used, and this represents a crucial role in this process, as the techniques used at the present time, according to According to each method used in this study.

The study demonstrates that the presence of joint inflammation on MRI and ultrasound is linked to both the intensification of treatment and the advancement of radiographic changes in patients with rheumatoid arthritis who are in clinical remission after one year of treat-to-target medication.

Methotrexate monotherapy and glucocorticoids are effective in 50%-60% of early RA cases, but disease relapse and joint damage may persist. Supplementing clinical assessments with ultrasound or MRI could improve the prediction of adverse developments [St Clair, E. W. *et al*., 2004; Aga, A. B. *et al*., 2015].

The study revealed that the presence of inflammation detected through imaging at the beginning of the trial was a reliable indicator of the

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development of erosive damage in patients with rheumatoid arthritis. Additionally, the study demonstrated that the presence of subclinical tenosynovitis detected using MRI was a reliable predictor of the need for more intensive therapy in the future. Nevertheless, the utilization of MRI or ultrasound data in prediction models did not demonstrate superiority over models that relied on regular metrics. The findings indicate that the use of MRI and ultrasound imaging does not significantly enhance treatment decision-making in current treat-to-target techniques. [Smolen, J. S. *et al*., 2016; Dougados, M. *et al*., 2010]

Subsequent investigations should conduct thorough cost-benefit evaluations.

In our current study, through identifying the sensitivity and validity of predicting results, it was found that ultrasound imaging, in addition to the magnetic resonance imaging technique used in diagnosing rheumatic diseases, has ideal results in detecting joint abnormalities as a sensitivity of up to 91% was found, in addition to accuracy in diagnosis up to 89%As for the qualitative results, it is clear.

HRUS Similar results reach 94%, also this leads to reaching decisive results in detecting the extent of subsequent damage in patients [Filer, A. *et al*., 2011; Saleem, B. *et al*., 2012].

The American College of Rheumatology (ACR) suggests using radiographic analysis as a diagnostic method for rheumatoid arthritis. However, its sensitivity is restricted. Radiography has a limited ability to detect joint erosions, only identifying them in 15% of patients. On the other hand, MRI is far more effective, detecting abnormalities in 70% of patients, including 35% of their joints. Magnetic resonance imaging (MRI) has been employed to distinguish between anchorage-based and primary intrasynovial illness, as well as to ascertain if recent knee synovitis exhibits variations in individuals with rheumatoid arthritis as opposed to those with spondyloarthropathy. Patients that have a favorable prognosis exhibit distinct pathology, which is a significant clinical factor to take into account. Nevertheless, discerning these distinctions among disorders proves challenging during regular clinical assessments, hence highlighting the significance of MRI as a powerful diagnostic instrument for this specific subset of patients.

A study verified the presence of a lesion on ultrasound that was previously identified on MRI, and collected tissue from the specific erosion site validated by the MRI. Five biopsies were collected, all of which included bone, and three of them were accompanied by cellular material. MRI accurately assesses genuine anomalies, and its ability to identify bone deterioration has been compared to radiography. 15% of patients with rheumatoid arthritis (RA) were found to have bone erosions through radiographic analysis, but an MRI study revealed erosions in 45% of patients. Longitudinal studies have verified that MRI lesions later manifest as radiographic erosions. Radiographs are unable to identify first bone erosions because they lack the ability to capture images from several angles [Wakefield, R. J. *et al*., 2012].

CONCLUSION

Ultrasound is included in the standard diagnosis of rheumatology, but in practice, it is used much more widely: on the basis of this study, rheumatology is often diagnosed.

By MRI and ultrasound, this method is considered very useful, and the reliability of the data obtained depends not only on the qualifications of the specialist but also on the capabilities of the equipment used. The effectiveness of ultrasound increases when the information obtained is compared with data derived from clinical examination, patient records, and other research methods.

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