"ULTRASONOGRAPHIC EVALUATION OF TENOSYNOVITIS OF WRIST, MCP JOINT'S IN RHEUMATOID ARTHRITIS WITH CLINICAL AND SEROLOGICAL CORRELATION- A ONE YEAR HOSPITAL BASED OBSERVATIONAL STUDY"

BY

REG. NO. BS0121010

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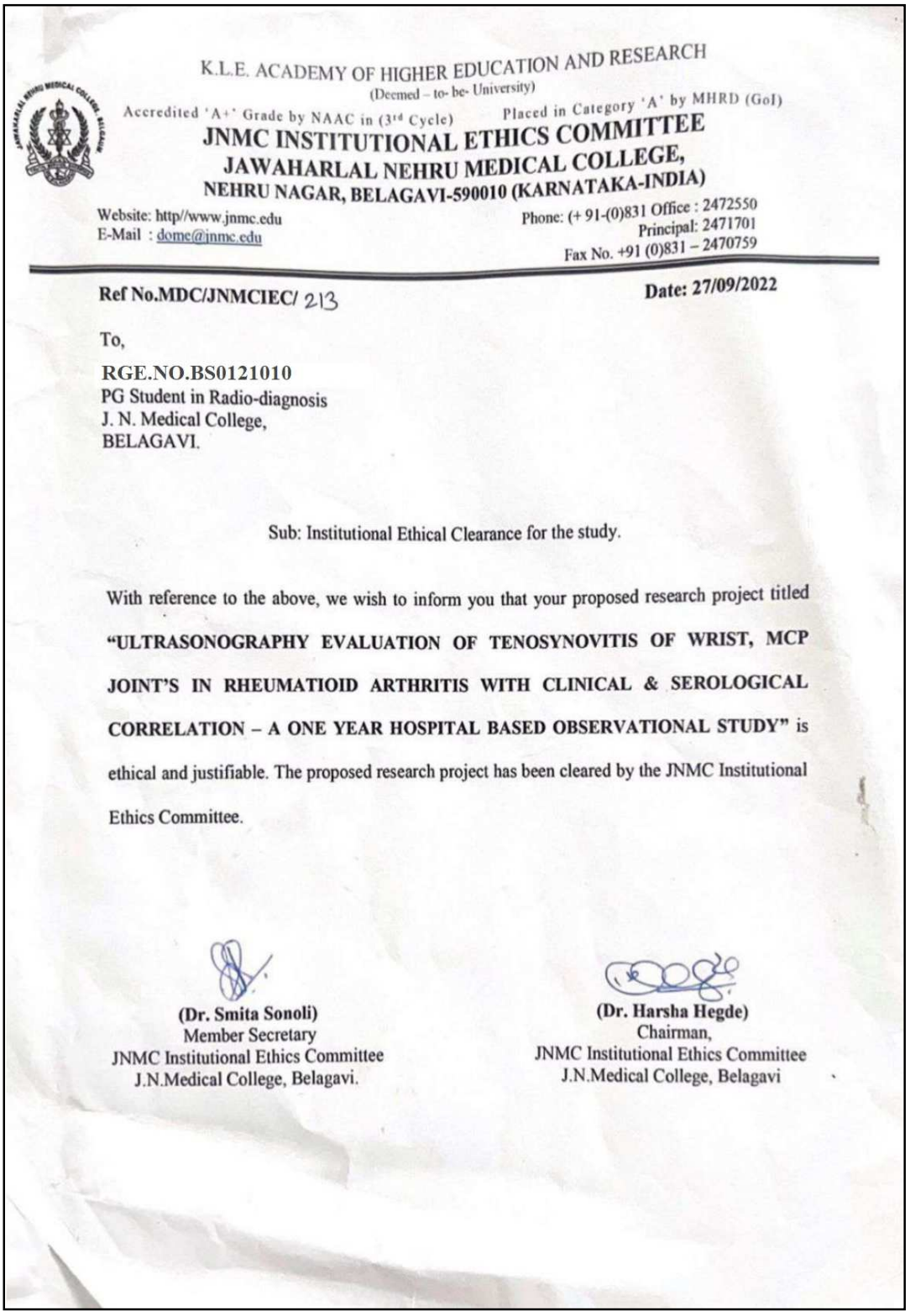

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Sub: Institutional Ethical Clearance for the study.

With reference to the above, we wish to inform you that your proposed research project titled **"ULTRASONOGRAPHY EVALUATION OF TENOSYNOVITIS OF WRIST, MCP JOINT'S IN RHEUMATOID ARTHRITIS WITH CLINICAL & SEROLOGICAL CORRELATION – A ONE YEAR HOSPITAL BASED OBSERVATIONAL STUDY"** is ethical and justifiable. The proposed research project has been cleared by the JNMC Institutional Ethics Committee.

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LIST OF ABBREVATIONS

GLOSSARY	ABBREVATIONS
US	Ultrasonography
RA	Rheumatoid arthritis
PIP	Proximal interphalangeal joint
MCP	Metacarpophalangeal joint
PD	Power doppler
GS	Gray scale
PCR	Proximal carpal row
DCR	Distal carpal row
FCR	Flexor carpi radialis
FCU	Flexor carpi ulnaris
PL	Palmaris longus
FDS	Flexor digitorum superficialis
EPL	Extensor pollicis longus
ECRL/ECRB	Extensor carpi radialis/brevis
APL/EPB	Abductor pollicis longus/ extensor pollicis brevis
ECU/EDM	Extensor carpi ulnaris/digiti minimi
ED/EI	Extensor digitorum/indices
RF	Rheumatoid factor
ACCP	Anti citrullinated peptide antibody
ESR	Erythrocyte sedimentation rate
CRP	C- Reactive protein

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ABSTRACT

BACKGROUND & OBJECTIVES: Rheumatoid arthritis (RA) is a chronic autoimmune disease that damages bone, cartilage, ligaments, and tendons, primarily through the inflammation of the synovium. The wrist and hand joints, particularly the metacarpophalangeal (MCP) joints, are among the most affected in early RA.

Ultrasound (US) has emerged as a valuable tool for tracking RA disease activity and joint destruction. Grayscale US and Power Doppler (PD) US are more sensitive than clinical examinations in detecting synovitis, tenosynovitis, and the degree of inflammation in RA. US can visualize soft tissues, detect blood flow signals in thickened synovium, and identify bone and cartilage erosions.

This study aims to evaluate tenosynovitis of the wrist and MCP joints in RA, correlating clinical and serological data. The main objective of the study is to develop and validate ultrasound (USG) as a diagnostic tool for RA.

MATERIALS AND METHODS: A one-yearcross sectional study was conducted in the department of radiodiagnosis at KLES Dr. PRABHAKAR KORE HOSPITAL & MRC, Belagavi, aimed to evaluate the prevalence and clinical correlates of tenosynovitis in patients with early rheumatoid arthritis (RA) using ultrasound (US). Over a 12-month period from January 2023 to December 2023, 36 eligible patients aged over 18 years with joint pain duration between 6 months to 1 year and positive rheumatoid factor (RF) or anti-cyclic citrullinated peptide (ACCP) were included.

Ultrasound examinations were performed using a Mindray ResonaI9 ultrasound machine with an L14-3WS linear array transducer. Longitudinal and transverse scans of wrists, metacarpophalangeal (MCP) joints were conducted to detect synovitis, tenosynovitis, and tendinitis.

RESULTS: The study analyzed 36 patients, finding that the majority were aged 51-60 years (36.1%) and predominantly female (55.6%). Pain was the most common symptom, affecting 52 joints, with more right-side involvement. Ultrasound (USG) findings revealed high incidences of probe tenderness, soft tissue swelling, and tenosynovitis, particularly in the flexor carpi radialis (FCR) tendon and extensor tenosynovitis was most prevalent in the extensor digiti minimi (EDM)/extensor carpi ulnaris (ECU) tendons. Clinical examination showed high diagnostic accuracy for detecting tenosynovitis when compared to USG, especially when at least one symptom was present. Diagnostic accuracy for detecting tenosynovitis was highest using specialist diagnostic criteria (86.59% for flexor tendons and 80.56% for extensor tendons). Serology Markers showed mean values of RF 43 U/mL, ACCP 20 EU/ml, ESR 27 mm/hr, and CRP 17.6 mg/dL.

INTERPRETATION & CONCLUSION: Musculoskeletal ultrasound (MSUS) is pivotal in the early diagnosis and assessment of RA disease activity, sometimes proving superior to clinical examination. MSUS assesses synovium, tendons, and cartilage directly. The reliability of MSUS depends on the operator's skill, making standardization of evaluations crucial.

Grayscale (GS) ultrasound, supplemented by power Doppler (PD) ultrasound was used to assess tenosynovitis comprehensively.

Early tendon and tendon sheath lesions are common in RA and contribute to functional disability. Ultrasound is crucial for identifying tendon lesions, which are often missed in clinical examinations. High-frequency ultrasound is effective for diagnosing tendon abnormalities, with good specificity and positive predictive value.

Ultrasound can detect increased blood flow in the synovium, indicating active inflammation. Power Doppler (PD) accurately determines the extent of the inflammatory process. In this study, abnormal vascularity was a primary finding in MCP joints, consistent with previous research indicating high sensitivity and specificity for detecting inflammatory activity.

Clinical examination alone showed limitations in detecting tenosynovitis, whereas USG demonstrated higher sensitivity and specificity. High-frequency ultrasonography is effective in identifying early indicators of RA in hand MCP and wrist joints, such as joint cavity fluid, synovial inflammation, and abnormal vascularity. It improves diagnostic accuracy and enables early intervention, reducing functional disability and joint damage. Tenosynovitis was prevalent among middle-aged adults, with a higher incidence in females.

KEYWORDS: Rheumatoid arthritis, metacarpophalangeal joints, gray scale, power doppler, ultrasonography, flexor carpi ulnaris, extensor digiti minimi, extensor carpi ulnaris.

INTRODUCTION

"*Rheumatoid arthritis*"(RA) is a chronic autoimmune disease that damages bone, cartilage, ligaments, and tendons when it causes synovitis, affects the main lining of the synovial joints. Physical tests carefully evaluate the wrist and hand joints (proximal interphalangeal PIPs and MCPs), the most afflicted joints in the early stages of RA, to guide therapy decisions[1].

"*Rheumatoid arthritis*" (RA)in the hands is characterized by abnormalities and decreased muscle strength and movement. It is accompanied by impairments and functional disabilities. "It is characterized by persistent inflammation of the synovium, which leads to inflammatory arthritis. Patients with early inflammatory arthritis and tenosynovitis have limitations on their functioning abilities[2,3].

Over the course of RA, the severity of the disease may vary greatly. Monitoring disease activity has become increasingly important in RA management. Mounting evidence underscores the importance of early diagnosis, suggesting that therapeutic intervention early in the course of RA leads to earlier disease management and less joint destruction[4].

Clinical signs are the main basis for diagnosing RA, and it can be difficult to distinguish early-stage RA from other joint conditions. Traditional radiography of the wrist and finger joints is important for the evaluation and diagnosis of RA patients. On X-rays, however, up to 70% of people with early RA show no discernibleabnormalities[4,5].

"Patients with RA have recently used ultrasound (US) for tracking the disease activity and joint destruction.

Grayscale quantifies disease activity, and studies have shown that Power Doppler (PD) synovitis and tenosynovitis are "more sensitive" than "clinical

examination" in detecting enthesitis and synovitis, as well as determining the degree of inflammation in RA[3,5].

When it comes to RA diagnosis and assessment, particularly in the smaller joints of the hands and feet, US have demonstrated its sensitivity in detecting bone deterioration. In fact, US is more sensitive than radiography at identifying erosions in the metacarpophalangeal joints (MCPs) in individuals with early-stage RA[6]. The US's best feature is that it can see more clearly through soft tissues. This means that it can detect blood flow signals in thickened synovium, as well as erosions in bones and cartilage. Furthermore, because of its time-saving, non-invasive, repeatable, and dynamic observation features, this technique has the potential to diagnose joint lesions in patients with RA[6,7].

When it comes to identifying synovitis in RA patients, US has comparable sensitivity and specificity to MRI. Furthermore, the revised ACR/EULAR classification criteria recommend using US in joint assessments due to its strong intra- and inter-rater reliability. Ultrasonography in grayscale (GS) and power Doppler (PD) modes offers valuable insights for the diagnosis and staging of RA[8].

Starting immunosuppressive treatment in the early stages of RA alters the disease's progression. It's still difficult, however, to separate patients presenting with clinical arthritis within 12 weeks of symptom onset from those whose condition will regress are at risk of developing RA.

In addition to "clinical and serological factors" a number of the predictive algorithms used today for the course of RA are based on clinical joint involvement. US, a non-invasive and well-tolerated imaging method, makes these kinds of algorithms more accurate because it can find synovitis that isn't yet showing any symptoms[9,10].

Hence the present study was designed with the aim to evaluate tenosynovitis of wrist, MCP joints in "*Rheumatoid arthritis*" (RA)with clinical and serological correlation.

AIMS & OBJECTIVES

AIM:

- To evaluate tenosynovitis of wrist, MCP joints in "*Rheumatoid arthritis*" (RA) with clinical and serological correlation.

OBJECTIVES:

- To develop and validate Ultra Sound (USG) as a tool for diagnosis of Rheumatoid arthritis.
- To develop and validate Ultra Sound to monitor and for treatment of tenosynovitis.

REVIEW OF LITERATURE

Anatomy of the Wrist Joint

Bones:

The eight different carpal bones that make up the wrist joint are synovial joints. They are situated between the five metacarpal bones and the forearm (radius and ulna). Two sets of carpal bones make up the wrist: the distal carpal row (DCR), which includes the trapezium, trapezoid, capitate, and hamate bones from radial to ulnar, and the proximal carpal row (PCR), which includes the "scaphoid, lunate, triquetrum, and pisiform" bones[11].

"The DCR bones are securely interconnected with robust ligaments, forming a cohesive and integrated functioning entity." DCR is functionaly seen as part of unit that moves in response to the muscle forces of the forearm because to its strong ligamentous connection to the foundation of the metacarpal bones. The wrist bones are firmly interconnected by a system of ligaments, which restricts the range of motion between the bones[11].

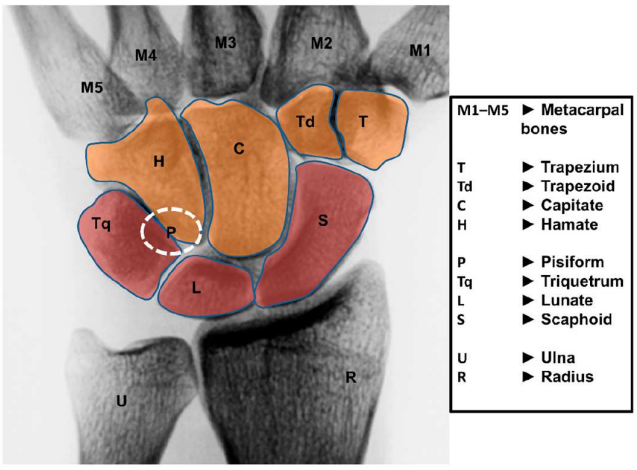
Comparing the Differential Chain Reaction (DCR) with the Polymerase Chain Reaction (PCR), several features are evident. Next to each other, bones move quite a little, and the row as a whole moves mostly in one direction. Wrist flexion and extension (FE) causes the PCR and DCR to move in tandem. "But even with wrist radial and ulnar deviation the PCR experiences FE". The PCR is an auxiliary segment that is placed in between the DCR and the radius[12].

The pisiform bone is unconnected to any of the wrist muscles. At the distal end are put all the tendons that influence wrist movement. The mechanical forces applied by the surrounding articulations are the only factors that affect the motion of

PCR. As a result, the Distal Carpal Row (DCR) is where all wrist movement must begin.

"After the tense extrinsic ligaments around the midcarpal joint and the force appled to the PCR exceeds the frictional forces between the articular segments and resistance from opposing muscle forces, the PCR begins to move. The wrist's unique bone form, its unique relationship to neighbouring bones, and the existence of both intrinsic and extrinsic ligaments are all necessary for its functionality.

As a structure, the triangular fibrocartilage complex (TFCC) carries loads and supports weight. The TFCC is located between the lunate, triquetrum, and ulnar head on the medial surface of the wrist. The structure is made up of "base of the extensor carpi ulnari sheath, the ulnolunate and ulnotriquetral" sections of the palmar ulnocarpal ligament, ulnomeniscal homologue, the UCL, dorsal and palmar RUL, and a triangular fibrocartilage articular disc. Its principal function is to stabilise the ulnar aspect. Furthermore, by dispersing and transferring the force imparted to the wrist, the triangular fibrocartilage complex (TFCC) helps to avoid the ulna and carpal bones from coming into contact. It improves the range of motion in the wrist[13].



Wrist bones from dorsal. "The orange-colored bones are the DCR and the red colored bones belong to the PCR". "The pisiform is just indicated because it is positioned on the palmar side"

Ligaments:

Extrinsic carpal ligaments[13]

The ligaments supporting the carpus prohibit the carpal segment from moving in a single direction. The radius or the metacarpals are located between the carpal bones and the extrinsic ligamentous system. It is still not well understood how the extrinsic wrist ligaments act in carpal kinematics.

"The dorsal intercarpal (DIC)", "dorsal radiocarpal (DRC)", "radio-scapho-capitate (RSC)", "long radio-lunate (LRL)", "short radio-lunate (SRL)", "ulno-lunate", and "ulno-capitate" ligaments are extrinsic wrist ligaments." A convergence of ligaments includes the extrinsic wrist ligaments. This suggests that depending on the direction of movement, different ligamentous regions undergo different degrees of strain.

Position	Ligament	Description and Characteristics
Volar radiocarpal ligaments	radial collateral ligament	
	radioscaphocapitate ligament	- creating a sling to support the waist of the scaphoid - preserve when doing PCR–ectomy - acts as the primary stabilizer of the wrist after PRC and prevents ulnar drift
	long radiolunate ligament	- counteracts ulnardistal translocation of the lunate
	radioscapho-lunate ligament	- only functions as a neurovascular conduit - does not add mechanical strength
	short radiolunate ligament	- stabilizes the lunate
Volar ulnocarpal ligaments	ulnotriquetral ligament	
	ulnolunate ligament	
	ulnocapitate ligament	
Dorsal ligaments	radiotriquetral ligament	- referred also as dorsal radiocarpal ligament (DRC) - must also be disrupted for VISI deformity to form (in combination with rupture of the luno-triquetral interosseous ligament)
	dorsal intercarpal (DIC) ligament	
	radiolunate ligament	
	radioscaphoid ligament	

The intrinsic carpal ligaments[14]

The intrinsic ligaments have their origin and insertion points within the carpus. "Majority carpal bones are directly connected to their adjacent bones by interosseous ligaments." No ligamentous connections between the lunate and capitate bones.

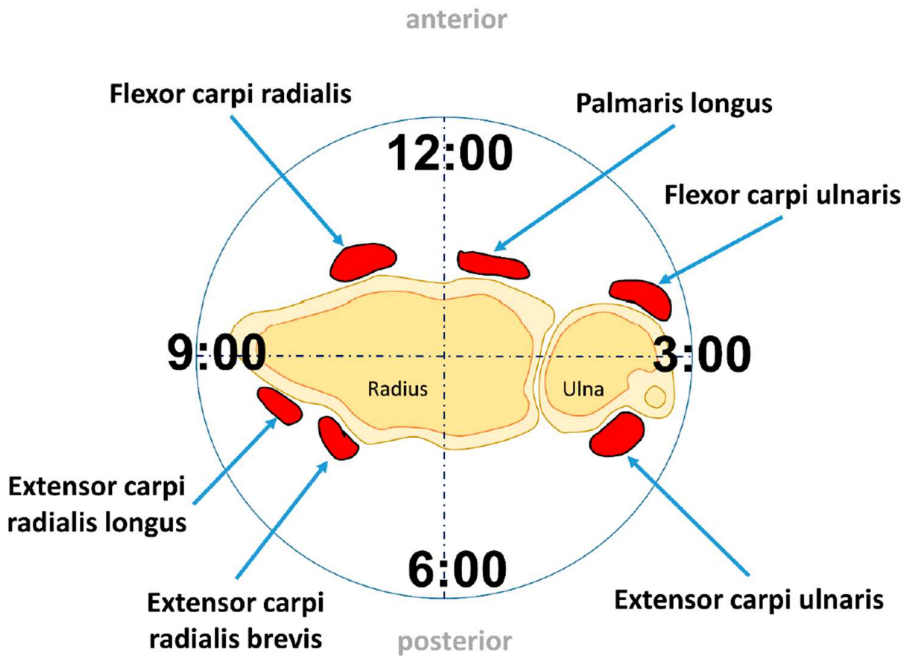
PCR's mobility, the emphasis is on the ligaments that link the bones of the PCR. PCR bones are connected by the "scapholunate interosseous ligament (SLIL)" and the "lunotriquetral interosseous ligament (LTIL)". 2 ligaments have a "C-shaped" structure, which allows the distal part of these bones to be available for articulation with the DCR. The two significant intrinsc ligaments are the scapholunate interosseous ligament and the lunotriquetral interosseous ligament.

Position	Ligament		Description and Characteristics
Proximal row	Scapholunate interosseous ligament	dorsal portion	- prevents translation - primary stabilizer of scapholunate joint
		volar portion	- prevents rotation
		proximal portion	
	Lunotriquetral interosseous ligament	dorsal portion	
		volar portion	- strongest part
		proximal portion	
Distal row	trapeziotrapezoid ligament		
	trapeziocapitate ligament		
	capitohamate ligament		
Palmar midcarpal	scaphotrapeziotrapezoid ligament		
	scaphocapitate ligament		
	triquetralcapitate ligament		
	triquetralhamate ligament		

"Muscles":

"Muscles that exert force on the wrist joint are located within the forearm". The muscles which pass across the wrist joint attach to the (hand or fingers). The carpus and PCR do not have any tendons directly linked to them. "The muscle located on the back side of the forearm are responsible for extending the wrist, whereas the muscle on the front side of the forearm are responsible for flexing the wrist. The movement of wrist bones is solely determined by mechanical forces exerted by the surrounding

joints. The biomechanics of the carpal bones depend on the way ligaments interact with their shape. The movement of the wrist bones is intricate and takes place in three dimensions. Several wrist issues arise from a modification in the movement between the bones of the wrist. At now, the movement between the carpal bones is not fully understood[15,16].



Six of the numerous forearm muscles are affixed to the base of the metacarpal bone or the carpal bones (at the distal carpal row). The flexion-extension (FE) and radial-ulnar (RU) axes are the rotational effects that these six muscles produce. These muscles, which include the (FCR), (FCU), and (PL) on the front side, are exclusively focused on the wrist.

“The extensor carpi radialis longus, extensor carpi radialis brevis, and extensor carpi ulnaris are the three primary muscles on the back side of the wrist that are involved in wrist extension. They have bigger moment arms around the wrist axes. The flexor carpi ulnaris , flexor carpi radialis , and palmaris longus are the main muscles involved in flexion. Support for the movement is provided by the flexor digitorum

superficialis muscle. ECRL, ECRB, and ECU are the main contributors to the extension. The muscle known as the extensor digitorum will aid them. The Extensor Carpi Ulnaris (ECU) and Flexor Carpi Ulnaris (FCU) muscles contract to produce the adduction[17,18].

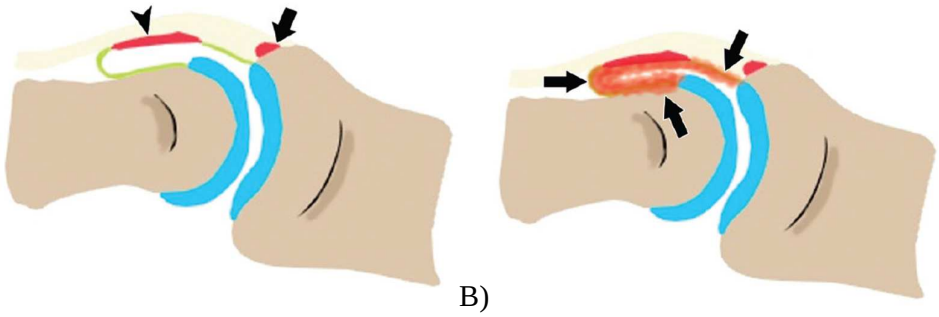
"The extensor carpi radialis longus (ECRL)", "extensor carpi radialis brevis (ECRB)", and "flexor carpi radialis (FCR) 'are the muscles that cause the abduction. The support for it comes from the abductor pollicis longus.

No.	Muscle		Origin	Insertion	Function on the Wrist
1	Flexor carpi radialis	(FCR)	Epicondylus medialis humeri	Os metacarpale II	Flexion, Radial Deviation
2	Palmaris longus	(PL)	Epicondylus medialis humeri	Ligamentum carpi transversum (Retinaculum flexorum), palmar aponeurosis	Flexion
3	Flexor carpi ulnaris	(FCU)	Epicondylus medialis humeri, Olecranon	Os hamatum (sesamoid: Os pisiforme)	Flexion, Ulnar Deviation
4	Extensor carpi ulnaris	(ECU)	Epicondylus lateralis humeri	Os metacarpale V	Extension, Ulnar Deviation
5	Extensor carpi radialis brevis	(ECRB)	Epicondylus lateralis humeri	Os metacarpale III	Extension, Radial Deviation
6	Extensor carpi radialis longus	(ECRL)	Crista supracondylaris lateralis	Os metacarpale II	Extension, Radial Deviation

Rheumatoid arthritis:

"RA is a chronic autoimmune disease that mostly affects the joints".

"*Rheumatoid arthritis*" (RA)is a condition where the body's immune system mistakenly attacks the joints, causing inflammation largely in the synovial membrane. It frequently impacts women between the ages of 30 and 50, with a prevalence rate of 1 in 150. It is accompanied by the presence of multi-organ illnesses, as well as the symptoms of pain, swelling, and stiffness in many joints. The process of joint destruction advances swiftly from its commencement, leading to permanent physical impairment and distortion of the impacted joints[19].



A) B)

A) Synovio-entheseal complex. The interphalangeal joint has fibrocartilage (red areas) that can be found in the extensor tendon not only at the tendon attachment site (arrow) but also at the friction site against the bone, which is known as functional enthesis (arrowhead). There is a close relationship between the fibrocartilage and the joint capsular synovium (green lines).

B) In RA, inflammation is localized in the synovium (arrows)

Pathology[20,21]:

The most significant gene linked to "*Rheumatoid arthritis*" (RA)susceptibility is the "human leukocyte antigen D-related B1 gene (HLA-DRB1)". This was discovered through analyses of single nucleotide polymorphisms throughout the entire genome in these patients. Furthermore, additional genes linked to the vulnerability to disease have also been identified. "TNF alpha induced protein 3 (TNFAIP3)", "cytotoxic T-lymphocyte antigen-4 (CTLA4)", "signal transducer and activator of transcription 4 (STAT4)", "protein tyrosine phosphatase non-receptor type 22 (PTPN22)", "C-C motif chemokine ligand 21 (CCL 21)", and "peptidyl arginine deiminase 4 (PADI4") are the genes that are included. In Japnese people, the PADI4 gene has been found to have two haplotypes: one that is disease-prone and the other that is not. It is known that the messenger RNA generated by the gene that is prone to illness is stable. People who test "positive" for "anticyclic citrullinated peptide" antibodies are more susceptible to the progression of bone or cartilage

degeneration. Anti-CCP antibodies have a high degree of specificity for a particular disease.

However, common environmental factors that can change the epigenome and eliminate methyl groups from histones and DNA include smoking, gingivitis, and gut bacterial ecology. As a result, proinflammatory cytokines become activated. The precise autoantigen causing "*Rheumatoid arthritis*" (RA)has not been found. On the other hand, epigenetic modifications are known to result from a confluence of environmental and genetic influences as well as the citrullinaton of specific "extracellular matrix" components (such fibrinogen and filaggrin). The immune system's tolerance to antigens is compromised by these alterations, which leads to the emergence of autoimmunity.

In patients with rheumatoid arthritis, autoreactive B and T lymphocytes congregate in the synovial tissue. Immunological tolerance to autoantigens is demonstrated by T lymphocytes. On the other hand, autoreactive T cells get activated when self-tolerance is compromised, which prompts B cells to start producing autoantibodies. Autoantibodies attach themselves to antigens to create immunological complexes, which are then stored in organs. Complement activation caused by these complexes results in histological damage and is categorised as a type III allergy. Angiogenesis or vasodilation, lymphocyte accumulation, and synoviocyte proliferation are all seen in synovitis tissues. In tissues that are undergoing extensive inflammation, memory T and B cell accumulation may result in the formation of structures that resemble germinal centres and lymphoid follicles. Proinflammatory cytokines and co-stimulators are highly expressed in these structures, and there is evidence of strong cellular relationships[21].

Excessive production of inflammatory cytokines by lymphocytes and synoviocytes, such as (TNF, IL-1, and IL-6) is a characteristic of synovitis lesions and causes the development of synovitis. In addition to general discomfort and mild fever, extraarticular organ involvement such as “sialadenitis”, “keratoconjunctivitis sicca”, and “interstitial pneumonia” are frequently observed. Moreover, matrix metalloproteinases (MMP) are produced by cytokines-stimulated synoviocytes and released in-to the synovial fluid. “Cartilage is broken down by the enzymes and is absorbed as a result. Moreover “receptor activator of nuclear factor kappa B ligand (RANKL)” is expressed by lymphocytes and synoviocytes to promote the growth and activation of osteoclasts. The stratified, quickly proliferating synoviocytes that make up inflammatory granulation tissues keep growing until they come into touch with the bones. Damage to joints is caused by multinucleated osteoclasts breaking down and absorbing bone, especially at the point of contact[23].

Clinical Manifestation:

“*Rheumatoid arthritis*” (RA)is characterized by pain and swelling in several joints, as well as stiffness in the morning. When the disease first starts, patients often have stiffness and difficulty moving their fingers when they wake up. This is sometimes referred to as having trouble creating a fist. Inflammation and limited range of motion are common companions of arthritis. These symptoms usually appear in the {knees, feet, hands, elbows, cervical spine}, and {joints of the fingers and toes}, including the ‘proximal interphalangeal’ ‘metacarpophalangeal’, and ‘metatarsophalangeal’ joints. However, symptoms seldom initially manifest at the distal interphalangeal joints. In addition, a lot of people report having general symptoms including fever, fatigue, and malaise.

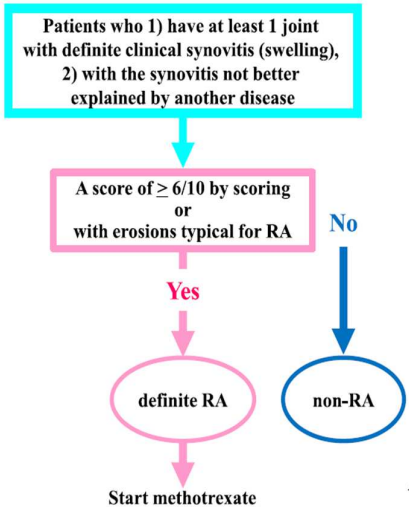
A number of symptoms are frequently reported, such as 45% of patients have dry eyes from keratoconjunctivitis sicca, 40% have dry mouth from sialadenitis, 35% have SC rheumatoid nodules on the outside of the forearm, 25% have numbnes in the hands and feet from compressive neuropathy, 15% have trouble breathing during physical activity, and 15% have a dry cough from interstitial pneumonia[19].

In reference to the findings of clinical investigations, it is frequently noted by visual inspection and palpation that the soft tissues around the joints are swollen and painful, and that synovial fluid has accumulated in these areas. Inflammatory signs and symptoms in the afflicted joints include redness, swelling, and warmth. Many joints are usually moveable and exhibit bilateral symmetry. Other forms of joint deformity, such as the "buttonhole and swan-neck deformities" of the finger joints, emerge as joint degeneration progresses. Numbness in the hands and occipital headache are two symptoms of atlantoaxial subluxation. When the inflammation spreads to the tendon, it causes 'carpal tunnel syndrome', which manifests as swelling in the wrist or trigger finger[19].

In terms of test results, more than 80 percent of patients show positive results for rheumatoid factors. However, it is important to remember that people with liver disease or those in excellent condition might equally test positive for these variables. 90% or more is the sensitivity and specificity of the anti-CCP antibodies. Before exhibiting any symptoms, patients with "*Rheumatoid arthritis*" (RA)have positive results for these antibodies. Joint degradation advances quickly in patients with high levels of rheumatoid factors or anti-CCP antibodies. Increased erythrocyte sedimentation rate and elevated C-reactive protein (CRP) levels are two findings associated with inflammation that are amplified in connection to disease activity. Moreover, elevated white blood cell counts and a particular kind of anaemia linked to

inflammation are present. This anaemia is marked by normal-sized red blood cells with decreased colour. Protease MMP-3 is synthesised by synovial tissues and is associated with the progression of joint degradation[21].

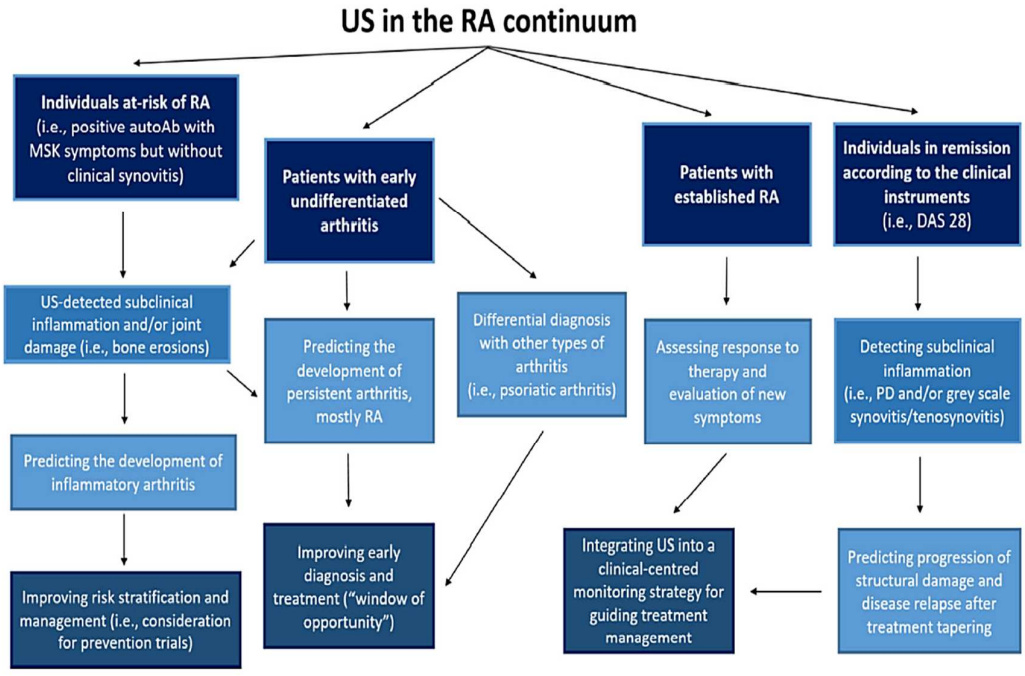
Diagnosis:



	score
Joint involvement	
=1 large joint	0
>1 large joint	1
1-3 small joints	2
4-10 small joints	3
>10 joints (small joint≧1)	5
Serology	
Negative RF and ACPA	0
Low positive RF or ACPA	2
High-positive RF or ACPA	3
Duration of symptoms	
<6 weeks	0
≧6 weeks	1
acute-phase reactants	
Normal CRP and ESR	0
Abnormal CRP or ESR	1

A score of ≥ 6/10 is needed for classification of a patient as having definite RA

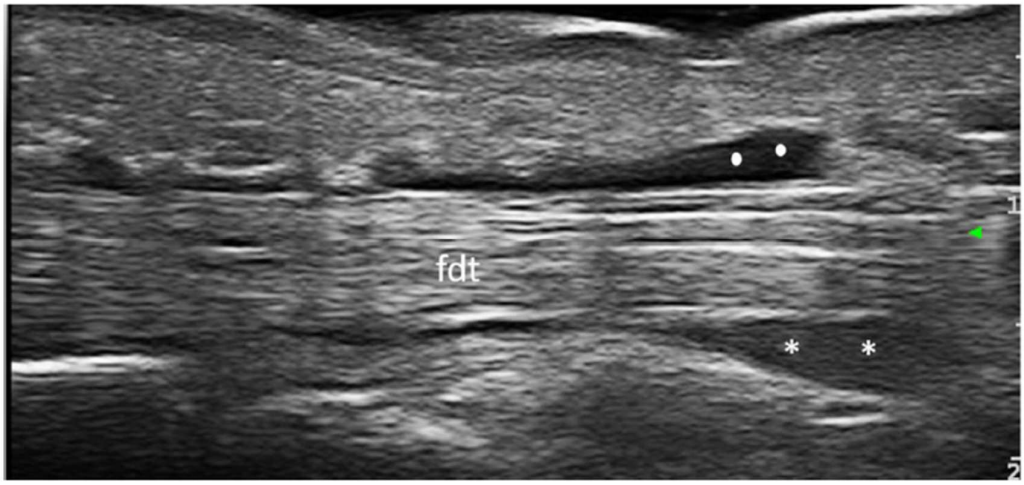
The Usefulness of Ultrasound in Managing People at Risk of "*Rheumatoid arthritis*" (RA)without Clinically detectable Synovitis



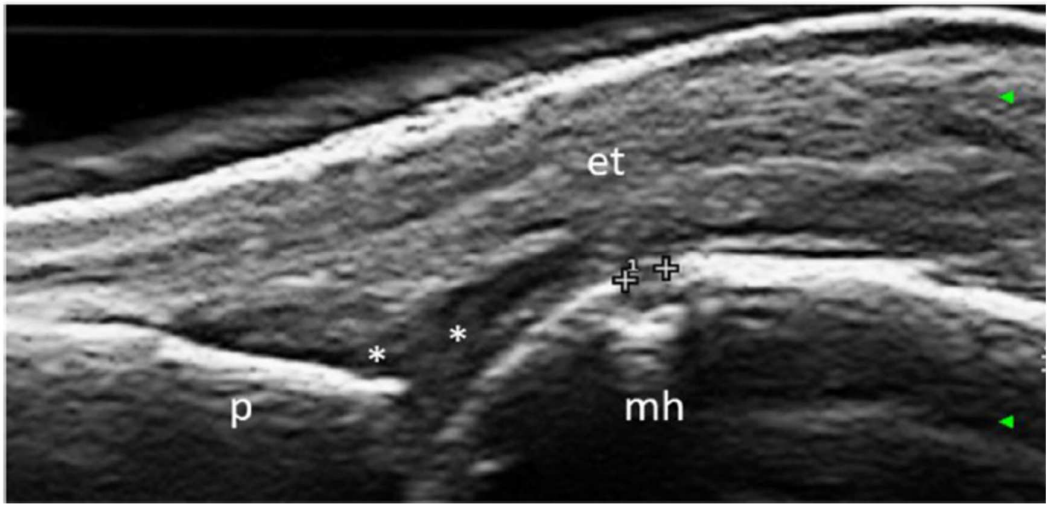
A noteworthy development in the study of rheumatology in recent times has been the improved understanding of the preclinical phase of "*Rheumatoid arthritis*" (RA), which is frequently referred to as "pre-RA." This concerns individuals who are classified as being "at-risk" for developing "*Rheumatoid arthritis*" (RA), but who do not yet display clinical synovitis or enough synovitis to make a firm diagnosis of the illness. At-risk" patients are individuals who, despite not showing any clinically detectable inflammation, have positive autoantibodies and experience symptoms like fatigue and clinically suspect arthralgia. It is possible to stop the progression of RA in patients who are susceptible to the disease in the future by identifying them[24].

Some people may have genetic and environmental factors that make them more likely to develop a condition, such as having a family member with the condition or being a smoker. However, this is not always true for all patients. Currently, individuals with autoantibodies and symptoms but without clinical synovitis are monitored as part of "at-risk" groups. However, it is crucial to identify which of these

individuals will eventually develop clinical synovitis on an individual basis. The therapy of these symptomatic at-risk individuals is difficult due to the lack of recommendations, resulting in a wide range of existing practices. As a result, both over-treatment and under-treatment are bound to happen, based on the rheumatologist's clinical judgment[24].



Tenosynovitis of the third flexor digitorum tendons in a patient with rheumatoid arthritis. The longitudinal scan of the flexor digitorum tendons reveals synovial hypertrophy (*) and synovial effusion within the synovial tendon sheath.



Bone erosion in the second metacarpophalangeal joint in a patient with rheumatoid arthritis. Longitudinal scan shows a small bone erosion (0.77 mm) within the head of metacarpal.

The understanding of people who are thought to be “at risk” of developing “*Rheumatoid arthritis*” (RA)has advanced recently. Thus, in order to investigate two primary areas, researchers have been examining biomarkers, such as ultrasound (US). In order to improve our understanding of how sickness develops, and in order to forecast and classify risks so that appropriate action can be taken.

Rheumatology textbooks typically characterise RA as a disease primarily affecting the synovial tissue. Nevertheless, two recent investigations have discovered that the flexor and interosseous tendons of finger might be implicated. An observational study by Stack et al., supports this assertion by demonstrating that inflammation associated with early "*Rheumatoid arthritis*" (RA) can appear extra-jointly. This is demonstrated by the skin's redness and swelling prior to the onset of RA. These extra-joint tissues may likely be involved, which could clarify the prodromal period of nonspecific pain and stiffness that can manifest prior to the beginning of clinical synovitis[25].

Ultrasound (US) has been utilised to detect joint deterioration, such as bone erosions, and subclinical inflammation in addition to clinical and serological markers. These results have been added to risk prediction models for individuals who have anti-cyclic citrullinated peptide (CCP) positivity and are susceptible to "*Rheumatoid arthritis*" (RA) These techniques make it possible to categorise people according to their risk level for developing inflammatory arthritis (IA). This strategy provides for the comfort and monitoring of those with a low likelihood of disease development, while also permitting the identification and closer monitoring of those at a high risk of developing arthritis in the near future, potentially for involvement in clinical trials[26].

Practically speaking, ultrasonography (US) can also be used to confirm that patients who are at risk and believe their condition has progressed to inflammatory arthritis (IA) indeed have clinical synovitis (and tenosynovitis). Early-stage clinical disease patients can be difficult to assess, and clinical findings might not be very noticeable.

Because of this, clinical research aimed at preventing "*Rheumatoid arthritis*" (RA) in patients at risk for the disease is increasingly requiring proof of

clinical synovitis in the US. While there are many advantages as previously discussed, there are several important considerations that must be made in order to use ultrasonography (US) as effectively as possible in individuals who are at risk of developing "*Rheumatoid arthritis*" (RA)but do not yet show symptoms of synovitis. The following justifications support the use of the US in vulnerable populations but urge caution and thoughtfulness instead of a haphazard approach.

Initially, it is important to note that the subclinical inflammation that may be identified using ultrasound (US) is typically observed in the later stages of the progression of inflammatory arthritis (IA). Furthermore, when this inflammation is present, it may indicate an increased likelihood of experiencing clinical synovitis in the near future. Sequential evaluations conducted in a group of persons at risk for developing "*Rheumatoid arthritis*" (RA)and who tested positive for anti-CCP antibodies indicate that subclinical inflammation emerges just prior to the onset of clinical synovitis. Consequently, the United States may not provide as much useful information for persons with a lower probability of developing clinical arthritis in the near future[27].

Furthermore, because of the widespread availability of ultrasounds (US) in early arthritis diagnostic centres, it is commonly utilized to aid in diagnosis and guide the treatment of the patients who may have inflammatory arthritis (IA). Rheumatologist algorithms suggest utilising ultrasonography (US) to direct treatment in patients who exhibit symptoms of inflammatory joint but lack observable synovitis during clinical examination, yet test positive for anti-citrullinated protein antibodies (ACPA). It is unclear what the optimal course of action is for managing these patients in the absence of trial evidence. However, ultrasonography (US) is already used spontaneously by rheumatologists in guiding the treatment in these patients; in fact,

when US identifies synovitis, doctors often opt to initiate treatment instead of waiting for improvement. This technique carries a high risk of needless therapy because a large number of individuals who are at risk of symptoms may not actually develop clinical synovitis, especially not in the near term.[28]

Furthermore, insufficient attention to the therapeutic regimen may result in patients being prescribed long-term drugs that may not be essential if treatment is initiated based only on the ultrasound findings.

Furthermore, there is ambiguity regarding the specific joints and the optimal number of joints that should be photographed to achieve the highest level of prediction accuracy.

Ultrasound for Confirming Diagnosis:

Rheumatoid arthritis[29]

"*Rheumatoid arthritis*" (RA) is primarily diagnosed clinically, with many practitioners verifying the diagnosis with the 2010 ACR/EULAR diagnostic criteria for RA. Important components of this criterion are synovitis and bone erosions linked to rheumatoid arthritis. The potential benefits of employing imaging modalities, such as ultrasonography (US), in addition to X-rays to establish the presence of inflammation are recognised by both the criteria of EULAR/ACR and the recommendations given by EULAR for treating early RA. However, based on the criteria of ACR/EULAR for RA, the information gathered through ultrasonography can be applied only in cases with confirmed clinical synovitis in atleast single joint. The 'pre-RA' group who have no clinical indicators has a problem because of this.

The diagnostic significance of ultrasonography for "*Rheumatoid arthritis*" (RA)stems from its ability in definitively verifying the existence and scope of the

inflammation and its consequences, as well as to identify alternative causes for symptoms by means of differential diagnoses. Undifferentiated arthritis (UA), particularly in seronegative patients, is a prevalent and difficult subset of patients.

Identifying individuals with undifferentiated arthritis (UA) who will progress to "*Rheumatoid arthritis*" (RA) is crucial in the treat-to-target (T2T) strategy.

This allows for early and vigorous medication to be initiated during the critical 'window of opportunity'. Several studies have shown that joint or tendon inflammation, may play a crucial role in predicting chronic disease among patients with early undifferentiated arthritis (EUA), when a definitive diagnosis is uncertain.
In 49 patients with early inflammatory symptoms (e.g., morning stiffness in the hands lasting at least an hour, with or without clinical synovitis, lasting less than three months), Freeston et al. assessed the role of power doppler signal in addition to standard clinical assessment in predicting persistent arthritis. After a year, patients who developed "*Rheumatoid arthritis*" (RA)were 47%, 31% developed connective tissue disease or reactive arthritis, and 22% did not develop chronic arthritis. Grey scale or Power Doppler synovitis significantly elevated the risk of developing chronic arthritis from 30% to 94% among patients who tested negative for rheumatoid factor (RF) and anti-CCP antibodies but showed elevated levels of C-reactive protein (CRP), a high count of swollen joints, or erosion of bone on traditional radiography. Sixty patients who had recently developed undifferentiated arthritis (UA) but did not fit the criteria 2010 criteria for "*Rheumatoid arthritis*" (RA) as defined by the European League Against Rheumatism (EULAR) and the American College of Rheumatology (ACR) undertook a prospective observational study.

According to the study, the presence of synovitis identified by grayscale (GS) imaging at the start of the trial was a strong predictor of the development of RA and

the need for methotrexate (MTX) later on. This was especially true if the synovitis was grade 2 or higher. Other clinical signs, such as the number of swollen joints or grades of disease activity, had no effect on the prediction value. Strangely, there was no association found between the PD signal and any of the evaluated outcomes, including the use of MTX or the progression to RA. This is probably because there weren't many joints with PD at the start of the trial.

In order to determine whether early arthritis patients with clinical synovitis and symptoms lasting three months or less fulfill the 2010 ACR/EULAR classification criteria for rheumatoid arthritis.

Sahbudin et al. carried out a study to assess the predictive usefulness of tenosynovitis and synovitis found using ultrasound. The research comprised a group of 107 individuals. According to this study, "*Rheumatoid arthritis*" (RA) can be predicted independently by using ultrasonography (US) to detect tenosynovitis of the finger flexor tendons. This prognosis is in addition to the synovitis and anti-CCP antibody levels seen on US.

Utilisingultrasound for monitoring "*Rheumatoid arthritis*" (RA) patients:

Numerous investigations have shown that the United States is capable of tracking and assessing changes in tenosynovitis and synovitis over time in "*Rheumatoid arthritis*" (RA)patient. In the research by Naredo et al[31]., 42 patients diagnosed with early "*Rheumatoid arthritis*" (RA)who were treated with traditional disease-modifying and anti-rheumatic medications were studied. After a year of follow-up, the study discovered that synovitis, or inflammation of the joints, improved based on patients' clinical variables as assessed by ultrasound (US) utilising both gray-scale (GS) and power Doppler signals. Similar to this, Filippucci et al[32]. evaluated the alterations in the wrists of 24 RA patients who were taking adalimumab

(ADA) for their condition. After 12 weeks of treatment, the study showed a marked improvement in both clinical as well as ultrasound (US) data. It is important to note that the PD signal significantly decreased at week 2, week 6, and week 12 of all the following examinations.

D'Agostino et al[33]. studied "*Rheumatoid arthritis*" (RA) patients who were not responding to methotrexate (MTX) and were given intravenous abatacept during the course of a 24-week study. The research had a single-arm, multicenter, open-label design. By 24th week, discernible progress in the ultrasonography results and indices measuring disease activity as shown by the decline in the PD signal was observed.

Ultrasound (US) can detect changes brought on by local therapy in addition to those brought on by systemic treatments. A study by Gutierrez et al[34]. included 114 people with a diagnosis of tenosynovitis and "*Rheumatoid arthritis*" (RA). Local injections of corticosteroids under ultrasound guidance or conventional "blind" injections were given to these patients at random. During the 4-week follow-up period, there was a significant decrease observed in the PD scores and clinical measurements (Health Evaluarion Questionnaire and VAS for pain for both global and local) among the 60 patients who underwent US-guided injections.

Considering the US's capability to identify alterations in inflammatory levels, which individuals would derive the greatest advantage from undergoing a scan, taking into account the constraints of resources such as time and cost? Currently, we are examining three different scenarios:

Individuals with chronic illnesses who experience the onset of additional symptoms. Do these symptoms pertain to the presence of an ongoing illness, the potential problems arising from the illness, or a separate and distinct issue?

Patients who are not responding well to the recommended course of therapy. Is it necessary to verify the validity of the primary diagnosis before considering modifying or stepping up the treatment? For example, in the event that the United States finds no signs of "*Rheumatoid arthritis*" (RA), the physician may be able to consider a different diagnosis. Whereas osteophytosis may suggest osteoarthritis (OA), the lack of any anomalies may point to the existence of a chronic pain syndrome. It is noteworthy that the ACR/EULAR "*Rheumatoid arthritis*" (RA)categorization criteria (2010) might lead to erroneous outcomes, particularly false positives. It has been observed that about 10% of the patients diagnosed with RA using these criteria may not in fact have the condition, based on our own unpublished data.

Patients presenting with notable subclinical pathology at the initial assessment, revealing a considerable discrepancy between clinical findings and ultrasound testing. In this situation, depending solely on clinical assessment may underestimate the amount of inflammation present.

REVIEW OF PREVIOUS LITERATURE:

1.In their 2018 study, W. M. Hetta, S. M. Sharara, and G. A. Gouda examined the diagnostic efficacy of ultrasonography and MRI in identifying synovitis in the wrist and hand joint of patient's with Rheumatoid arthritis. A total of fifty patients diagnosed with "*Rheumatoid arthritis*" (RA)affecting the wrist underwent hand and wrist ultrasonography Doppler and MRI scans, and the findings were subsequently compared and analysed for correlation. Synovial hypertrophy (pannus) was identified in 42 wrist joints using ultrasound, while MRI revealed it in 46 joints. Power Doppler

identified elevated blood flow within 30 wrist joints (60%), whereas MRI revealed enhanced blood flow within 38 joints (76%). Power Doppler identified synovial activity (vascularity) in the metacarpophalangeal (MCP) joints of 13 patients, while MRI showed synovial activity (enhancement) in the MCP joints of 9 patients. Ultrasound identified erosions in 35 wrist and 27 metacarpophalangeal (MCP) joints, while MRI identified erosions in 37 wrist and 25 MCP joints. Tendinitis was identified in 9 extensor tendons using ultrasound, while MRI revealed tendinitis in 8 tendons. The authors discovered a strong correlation between power Doppler ultrasonography and MRI in identifying signs of inflammation and bone damage in the wrist and hand joints of individuals with rheumatoid arthritis. This highlights the potential significance of power Doppler study as a dependable non-invasive method for assessing and monitoring disease activity[35].

2.Sundeep Malla et al. (2020)[36] set out to determine how well power Doppler ultrasonography (USG) performed in detecting early signs of rheumatoidarthritis (RA)-related changes in hand and wrist joints. The study also attempted to evaluate the results from MRI and ultrasound (USG). After, receiving informed consent and ethical authorization from the institution, thirty-four people who-were diagnosed with "*Rheumatoid arthritis*" (RA)based' on the 2010 ACR/EULAR criteria and had symptoms during the previous year were chosen for the study.

The hands of these individuals that were most affected by the disease underwent contrast-enhanced 'magnetic resonance imaging (MRI)' and ultrasonography (USG). A total of nine joints, comprising the second to 5th metacarpophalangeal joints, 2nd to fifth proximal interphalangeal (PIP) joints, and wrist joints, were examined for synovitis, erosions, and tenosynovitis. The agreement between the two imaging modalities, as well as the sensitivity, specificity, NPV, PPV,

and diagnostic accuracy of ultrasonography in comparison to MRI (regarded as the gold standard) were calculated. The features of the USG and MRI were compared. A total of 306 joints were analysed, including 136 “metacarpophalangeal joints”, 136 “proximal interphalangeal joints”, and 34 wrist joints. Additionally, 136 flexor tendons were investigated. Ultrasound (USG) has the following characteristics: sensitivity (SN), specificity (SP), negative predictive value (NPV), positive predictive value (PPV), anddiagnostic accuracy for identifying synovitis: 91.1%, 86.1%, 85.8%, and 86.3%, respectively. The numbers for erosions were, in order, 67.2%, 97.5%, 84.8%, 90.5%, and 91.5%. The readings for tenosynovitis were, in order, 86.5%, 100%, 100%, 92.3%, and 94.8%. In 83% of joints, USG and MRI agreed to identify synovitis, and in 89.5% of joints, erosions were identified. During the early stages of rhumatoid arthritis (RA), ultrasound (USG) was found to be almost as successful as other diagnostic methods in identifying signs of joint and tendon sheath involvement. However, USG showed considerably superior performance in detecting tenosynovitis.

3.The study conducted by G. S. Seifeldein et al (2020)[37] assessed the use of musculoskeletal ultrasound in determining the severity of “*Rheumatoid arthritis*” (RA)in the wrist and hand joints, and examined its relationship with clinical, laboratory, and radiographic data. ‘This study conducted a cross-sectional analysis and enrolled 50 patients in a hospital that provides specialised medical care.

“*Rheumatoid arthritis*” (RA) ‘activity was evaluated using the ‘Disease Activity Score 28 (DAS28)’. A dorsal longitudinal scan was conducted on the wrists, MCPs, and PIPS joints using a high-frequency (18 MHZ) linear transducer during the MSUS examination. A total of 100 wrists were assessed using grayscale ultrasound and power Doppler ultrasound in three different angles. The evaluation included 500 metacarpophalangeal joints (MCPs) and 500 proximal interphalangeal joints (PIPs).

The semiquantitative scale included scores ranging from 0 to 3. The results were compared and analysed in relation to clinical, laboratory, and radiographic data. 'The Larsen score' was used to examine the 'X-rays' of the wrist and hand joints of all patients. The average age of the patients (49 females and one male) was 44.58 ± 10.07 years and their average-disease 'duration' was 16.26 ± 1.07 years. The average DAS28 score was 5.19 ± 0.95. 97.5% of the joints had a grade I Larsen score, 11.07% of the joints exhibited erosions, 9.2% of the joints had effusions, 23.8% of the joints demonstrated synovial thickening, 11.9% of the joints revealed PD signs, and 3.5% of the joints were accompanied by tenosynovitis. There are notable connections discovered between DAS28 and many factors including PD signals, synovial thickness, tenosynovitis, effusion, and Larsen score. There is no significant correlation ($p > 0.05$) between DAS28 and erosions observed by MSUS and X-ray. The study determined that MSUS is highly effective in identifying early RA by detecting synovitis, joint effusion, tenosynovitis, and bone erosions. These findings were found to be closely associated with 'clinical and laboratory data'.

4.In another study, Aya Hamed Safar et al (2020)[38] examined the use of musculoskeletal ultrasound(MSUS) to assess the function of the hands in individuals with rheumatoid arthritis. this goal was to determine if this imaging technique may provide a more effective means of evaluating functional defects and disabilities in this population. Hand grip weakness was strongly correlated with synovitis in the metacarpophalangeal joints of the fourth and fifth fingers, synovitis in the wrist joint, and tenosynovitis of the flexor tendons in the fourth and fifth fingers.

The grip ability test revealed a strong correlation between hand function impairment and synovitis in the metacarpophalangeal joints of the ulnar 4 fingers,

synovitis in the wrist joint, and tenosynovitis of the flexor tendons in the ulnar 4 fingers. The results of the multiple linear regression analysis indicated that ulnar 4 Flexor tendons tenosynovitis had the greatest impact on both the grip ability test and hand grip strength. Musculoskeletal ultrasound can be utilised as an evaluation method for hand function in "*Rheumatoid arthritis*" (RA)by detecting joint synovitis and tenosynovitis. These conditions are linked to decreased hand grip strength and impaired hand ability.

5.Ahmed Ramadan et colleagues (2021)[39] evaluated the utility of ultrasonography (US) in distinguishing between 'rheumatoid arthritis' (RA) and 'psoriatic arthritis' (PsA) in the wrist, hand joints, and tendons. A total of thirty-five patients, consisting of twenty with "*Rheumatoid arthritis*" (RA) and fifteen with psoriatic arthritis (PsA), were included in the study. All patients had symptoms affecting at least one joint in the hand and/or wrist for a duration of more than six weeks. Sonographic examination was conducted on the bilateral wrists, including the distal radioulnar, radiocarpal, and midcarpal joints. Additionally, the hands were examined, specifically the 1st–5th metacarpophalangeal (MCP), 2nd–5th proximal interphalangeal (PIP), and 1st–5th distal interphalangeal (DIP) joints. The flexor tendons and extensor compartments at the level of the wrist joint were also examined. The presence of synovial hypertrophy, joint effusion, erosions, and tenosynovitis were identified based on the definitions provided by Outcome Measures in Rheumatology. The results were associated with clinical, laboratory, and disease activity measures. Out of the 680 joints investigated in patients with RA and the 510 joints studied in patients with PsA, specific ultrasound characteristics including synovitis and erosions at the distal interphalangeal (DIP) joint were only found in patients with PsA. Synovitis was more commonly observed in the distal radioulnar joints (DRUJ) in patients with rhematoid

arthritis (RA) compared to those with psoriatic arthritis (PsA), with a prevalence of 52.5% and 26.7% respectively.

"Rheumatoid arthritis" (RA) patient's showed a 'higher frequency' of joint effusion at the radiocarpal and midcarpal joints compared to patients with psoriatic arthritis (PsA). On the other hand, erosions were significantly more frequently detected at the radiocarpal joints in RA patients-compared to PsA patient's (45% vs. 20% respectively). Additionally, tenosynovitis was significantly more frequently detected at the extensor tendons in RA patients and at the flexor tendons in PsA patients. The musculoskeletal ultrasound findings of the hand and wrist revealed notable distinctions that aid in distinguishing between Rheumatoid arthriti's and psoriatic arthriti's

6.The study conducted by Hamed Rezaei et al (2014)[40] aims to examine the usefulness of musculoskeletal ultrasonography (MSUS) in detecting joint problems utilising a probabilistic methodology. One hundred and three people who had not had a rheumatologic diagnosis before were referred to the clinic have their inflammatory type arthritis evaluated. A clinical assessment was performed on the patients, which included a joint examination, rheumatoid-factor, anti-CPA, and laboratory tests to evaluate acute-phase reactants. In addition, radiograph's of the hands and feet were taken if the clinical results indicated it was essential. The competent rheumatologist did a diagnostic examination, in which the chances of inflammatory or "*Rheumatoid arthritis*" (RA)were rated using a 5-point measurement scale, ranging from a 0% to 20% probability to an 80% to 100% probability. Afterwards, a wrist ultrasound was undertaken, along with exams of second to fifth Metacarpo-phalangeal and Proximal-

interphalangeal joints inboth hands, and 2nd to 5thmetatarso-phalangeal (MTP) joints in both the feet, as well as joints that were causing problems.

The rheumatologist was then given the results. The latter then used the same measurement system to review the diagnosis probabilities. After performing ultrasonography exams, the rheumatologists' confidence in determining the absence or presence of inflammatory as well as "*Rheumatoid arthritis*" (RA)was significantly raised. 33.0% of patients had the greatest level of diagnostic confidence for inflammatory arthritis prior to musculoskeletal ultrasonography, while 71.8% did so following the procedure.

Before the test, the proportions for the diagnosis of RA were 31.1%, and after the test, they were 61.2%. In 95% of cases, the results of MSUS mathced with the final diagnosis. The level of certainty in diagnosing inflammatory arthritis in referred patients was greatly improved by the addition of musculoskeletal ultrasonography to the normal rheumatologic evaluation.

7.Ilfita Sahbudin et al (2018)[41] evaluated the predictive effectiveness of US-defined TS in conjunction with other variables.An investigation was conducted on a group of early arthritis patients to examine the relationship between synovitis as defined by the United States and various clinical and serological factors. A total of 107 patient's with clinicaly evident synovit'is in one /more joints with symptoms lasting three months or less underwent initial evaluation, including clinical examination, laboratory tests, and ultrasound assessment of 19 joint sites on both sides of the body and 16 tendon compartments on both sides. The diagnostic outcome for "*Rheumatoid arthritis*" (RA) was determined 18 months later using the 2010 ACR/EULAR classification criteria for RA. The study evaluated the predictive values of US-defined tenosynovitis for persistent "*Rheumatoid arthritis*" (RA)with those of US-defined synovitis,

clinical factors, and serological variables. The investigation encompassed a total of 4066 joint sites and 3424 tendon compartments in the United States. Out of the total number of patients, 46 individuals experienced ongoing "*Rheumatoid arthritis*" (RA), 17 individuals experienced ongoing non-RA chronic disease, and 44 individuals had a condition that was resolving at the time of follow-up. The presence of US-defined tendon sheath inflammation in at least one compartment was observed in a high proportion of individuals in all groups, with rates of 85% in those with rheumatoid arthritis, 71% in those with non-RA persisting disease, and 70% in those with resolving disease. In the context of statistics and mathematics, "multivariate" refers to the analysis or study of multiple variables simultaneously.

The study revealed that the US defined digit flexor tendon sheath (TS) offered additional predictive information that was independent of the presence of anti-citrullinated protein antibodies (ACPA) and US-defined joint synovitis. The US defined digit flexor tendon sheath gave autonomous prognostic information for the development of persistent rheumatoid arthritis in patients with early arthritis. It is necessary to evaluate the predictve value of this tendon location in a broader group of people. Researchers who are creating algorithms to predict the development of "*Rheumatoid arthritis*" (RA)using imaging techniques may consider include this tendon component as a potential variable.

8.Ilfita Sahbudin et al (2023)[42] evaluated the significance of US defined tenosynoviti's, along with US defined synoviti's and clinical and serological factors, inpredicting the development of persistent arthriti's in a group of patients with early arthriti's who had not received DMARD treatment before. A Total of 150 patient's who had not previously received '(DMARD-naïve)' and had clinically evident inflammation of one or more joints, along with a symptom duration of 3 months,

completed initial evaluations that included clinical, laboratory, and ultrasound examinations of 19 joints on both sides of the body and 16 tendon compartments on both sides. The results were categorised as either chronic or resolving arthriti's after 18 months of follow-up. A comparison was made between the predictive value of US-defined tenosynovitis and that of US-defined synovitis, as well as clinical and serological factors, for chronic arthritis. By the age of 18 months, 99 individuals (66%) had experienced the onset of chronic arthritis, while 51 patients (34%) had shown signs of their disease resolving. The results of the multivariate logistic regression analysis indicated that the existence of US-detected finger flexor tenosynovitis was independently-associated witha 6.6 times higher chances of persistence, even after accounting for the presence of US-detected joint synovitis and RF antibodies.

Within the RF/ACPA-negative subcohort, the presence of US defined digit flexor tenosynovits continued to be a significant prognostic factor (OR: 4.7, 95%), even after accounting for the presence of US-defined joint synoviti's. This study determined that tenosynovitis, as defined by US criteria, was a significant predictor for the development of persistent arthriti's.

9.In Jie Yang and colleagues looked at the relationship between "anti-cyclic citrullinated peptide (CCP)" antibody levels and high frequency US in patients diagnosed with early rheumatoid arthritis. The wrists, 2nd to 5th metacarpal phalangeal (MCP) joints, and first to fifth proximal interphalangeal (PIP) joints of thirty healthy people and fifty patients with early "*Rheumatoid arthritis*" (RA) were evaluated using high-frequency US. The thicknesses of the flexor, extensor of ulnar wrist, and first to fifth extensor tendon sheaths, as well as the synovial membrane, were measured. Pathological changes that corresponded to these were observed. There was

a substantial difference in the thickness of the sheaths covering the synovium, extensor, and flexor tendon between the RA and control groups. Of the joints in the RA group, 14.15% had fluid in the cavity, 5.23% had cartilage deterioration, and 2.32% had effusion in the bone cortices tendon sheath. Tendon adhesion and tendon sheath effusion were found in 19.81% and 16.30% of cases, respectively[43].

In comparison to the group that tested negative for anti-CCP antibodies, the group that tested positive for the antibodies exhibited substantial differences in DAS28, scores of Health Assessment Questionnaire, and positive rheumatoid factor rate. The results were strongly positively correlated with bony erosion, effusion in the tendon sheath, joint effusion, cartilage degradation, and synovitis. Additionally, blood flow signs indicating synovial thickening were observed in 8.92% of the joints. Out of these joints, 4.37% exhibited active phase signals. The synovial artery resistance index was found to be 0.58±0.07. However, as low as 0.94% of the total joints examined showed signals of synovial blood flow during the inactive period, and the resistance index of synovial artery was found to be 0.67±0.03.

When compared to the group with negative antibodies, the group with positive Anti-CCP antibodies showed a significantly higher sensitivity to erosion in the bone. In the presence of anti-CCP antibody, high-frequency ultrasonography improved the chance of identifying alterations in articular cartilage degradation and bone erosion in patients with early "*Rheumatoid arthritis*" (RA). When combined with ultrasonography, anti-CCP antibody testing can offer important information for formulating therapeutic treatment plans.

10.In Wang et al.'s study from 2022, they evaluated the utility of high-frequency ultrasound (HFUS) in detecting osteoarthritis (OA) and seronegative "*Rheumatoid arthritis*" (SNRA). Retrospective analysis was performed on 83 patients (referred to

as the SNRA group) and 40 patients (referred to as the OA group) who underwent HFUS. To find the cumulative scores of US factors, the power Doppler (PD), BE, and grayscale (GS) ratings were recorded and combined. The 28-joint disease activity score (DAS28), erythrocyte sedimentation rate (ESR), and C-reactive protein (CRP) in the US population were compared to the overall scores of US variables through analysis. An assessment was conducted on the diagnostic accuracy of the total scores of US factors for SNRA[44].

When utilising GS, PD, and BE to detect abnormal ultrasound findings in the joints and tendons, the SNRA group outperformed the OA group in this regard. The two groups demonstrated considerable discrepancies in GS scores, PD scores of joints and tendons, and BE ratings of joints. The total scores of major US variables and CRP, ESR, and DAS28 were positively correlated in the SNRA group. In contrast, no such connections ($P > 0.05$) were discovered in the OA group. The diagnostic value of the joint PD (Parkinson's Disease) total scores was shown to be highest elevated for SNRA (Sensory Nerve Root Ablation) among a number of variables in the United States. Through assessment of the joint and tendon synovial sheath, HFUS can be used to differentiate SNRA from OA and make an accurate diagnosis of SNRA[44].

11.K R Luza et al (2016)[45] assessed a new ultrasound scoring system called US10 for the evaluation of hand and wrist joints in patients with early "*Rheumatoid arthritis*" (RA). The study aimed to determine the correlation between US10 and clinical, laboratory, and functional factor s. A total of forty-eight patients with early "*Rheumatoid arthritis*" (RA) were subjected to clinical and laboratory assessments, along with blinded ultrasonography (US) examinations, at four different time points: baseline, three months, six months, and twelve months. The US10 system proposed the evaluation of the wrist, second and third metacarpo-phalangeal, and proximal

interphalangeal joints. The score included measures of inflammation, such as synovial proliferation (SP), power Doppler (PD), and tenosynovitis (TN), as well as measures of joint injury, including bone erosion (BE) and cartilage destruction (CD). The scoring of SP, PD, BE, and CD was done using both qualitative (0-1) and semi-quantitative (grades 0-3) methods. The presence or absence of tenosynovitis was assessed and recorded. The assessment also included the 28-Joint Disease Activity Score (DAS28), Health Assessment Questionnaire (HAQ), and C-reactive protein level (CRP). The average duration of symptoms was 7.58 ± 3.59 months. Strong correlations were seen between inflammatory parameters and CRP levels at the beginning of the investigation, as well as between the changes in these variables over the course of the study. Strong correlations were seen between the DAS28 score and both PD and TN at the beginning of the study, as well as between the changes in DAS28 score and both SP and TN during the entire follow-up period. Furthermore, there were notable connections observed between the alterations in inflammatory parameter scores and HAQ score during the course of the follow-up period.

12.In their study, Xiaoying Sun et colleagues (2019)[46] sought to examine the concordance between joint inflammation detected by ultrasound and clinical indicators such as joint swelling and discomfort. This study used a cross-sectional design to analyse the wrists and hands of patients with "*Rheumatoid arthritis*"

(RA). A total of 22 joints were assessed using both physical examination (PE) and ultrasound. The synovitis found by ultrasound was assessed using semi-quantitative scoring methods (ranging from 0 to 3) for both grey scale (GS) and power Doppler (PD). The presence of tenosynovitis and peritendinitis was evaluated using a qualitative scoring system (0/1). A cohort of 258 consecutive "*Rheumatoid arthritis*" (RA)patients were included, with a median disease duration of 57 months

and average Disease Activity Score based on 28 joints (DAS28)-ESR/DAS28-CRP of 4.47/3.99. The concordance rate between positive clinical symptoms and ultrasound-determined joint inflammation was fair, based on the assessment of a total of 5676 joints. Joint discomfort in the wrists exhibited a larger κ coefficient in relation to ultrasound-detected joint inflammation compared to swelling. Conversely, swelling demonstrated a higher κ coefficient in relation to ultrasound-detected joint inflammation compared to tenderness. This κ coefficient was observed in the metacarpophalangeal (MCP) and proximal interphalangeal (PIP) joints. Synovitis regularly exhibited greater concurrence with discomfort and swelling compared to tenosynovitis/peritendinitis. The variables of tenderness and swelling showed the strongest correlation (κ coefficient) with synovial hyperplasia of grade 1 or higher in most MCP and PIP joints. However, in the case of synovial hyperplasia of grade 2 or higher, this correlation was observed mostly in the wrists. The κ coefficient showed the strongest association between PD ≥ 1 synovitis and clinical soreness and edoema across all 22 joints. Synovitis shown superior concordance with clinical manifestations compared to tenosynovitis/peritendinitis. There was more correlation between joint edoema and inflammation measured by ultrasound (US) for the "metacarpophalangeal (MCP)" and "proximal interphalangeal (PIP)" joints, whereas opposite was observed for the wrists. Both the presence of soreness and swelling are more likely to be associated with a grade of 2 or higher for wrists, a grade of 1 or higher for MCP and PIP joints, and a power Doppler grade of 1 or higher for any joint.

MATERIALS AND METHODS

STUDY DESIGN: A Hospital based observational cross sectional study

STUDY PERIOD: 12months (January 2023 to Dec 2023)

STUDY PLACE: Department of radio-diagnosis at KLES Dr. PRABHAKAR KORE HOSPITAL & MRC, Belagavi.

SAMPLE SIZE: 36 patients

INCLUSION CRITERIA:

- Patients with the age group of > 18 yrs. are included in the study'
- Patients having joint pain duration from 6months to 1year
- Patients with positive RF or ACCP
- Patients willing to give informed consent**.**

EXCLUSION CRITERIA:

- Patients of age less than 18 years
- Patients with duration of joint pain for more than one year
- Patients not willing to give informed consent.

METHODOLOGY

Procedure

Following the acquisition of ethical committee clearance from the "institutional review board and informed consent" from the patients, a total of 36 patients who were sent for ultrasonography based on clinical symptoms were included in the study conducted at THE KLES Dr. PRABHAKAR KORE HOSPITAL & MRC, Belagavi, specifically in the department of radio-diagnosis.

Tools for collecting data: A structured study proforma was utilised to document all relevant parameters.

The following ultrasonic examination approaches were employed to assess arthritic joint processes:

1. Perform longitudinal and transverse scans of the wrist, examining the dorsal, ulnar, and palmar aspects, to detect any indications of tenosynovitis.

Perform longitudinal and transverse scans of the MCP joints to detect any indications of synovitis, tenosynovitis, or tendinitis.

The grayscale & power doppler scans were conducted using a Mindray ResonaI9 ultrasound instrument that was outfitted with an L14-3WS linear array transducer. A gel was used to construct an acoustic interface. Each patient was scanned by a solitary sonographer (RB) in a consecutive and independent fashion. The joint was scanned in both longitudinal and transverse planes along its dorsal and volar aspects to ensure comprehensive coverage of the joint and prevent any distortions or abnormalities.

The transverse scans clearly detected the synovial sheath of the flexor tendon as a slightly less reflective area located towards the edge of the tendon. The presence of a clearly defined area with increased echogenicity within the tendon sheath

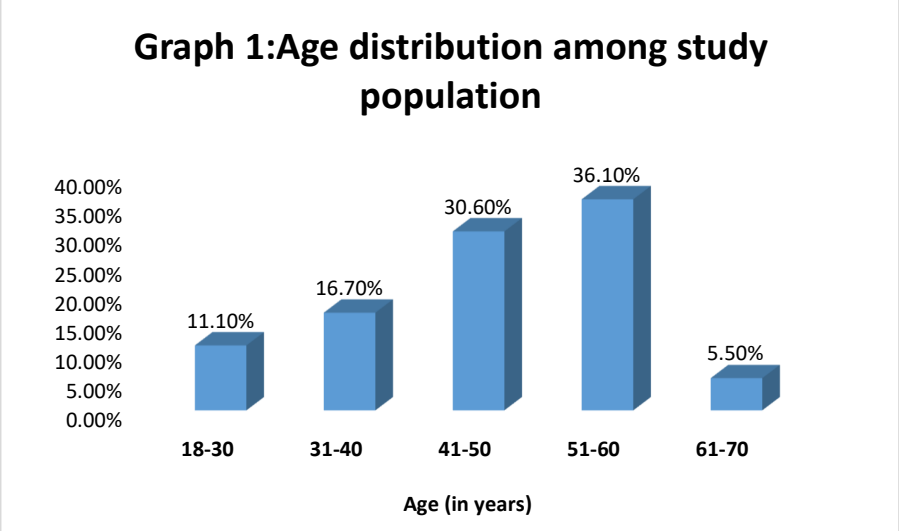
indicated the thickening of the synovial membrane. The documentation recorded whether flexor tenosynovitis was present (1) or absent (0).

Statistical analysis: The data analyses were conducted using IBM SPSS Statistics for Windows (Version 20.0.; IBM Corp., Armonk, NY, USA). The initial investigation focused on determining the prevalence of flexor tenosynovitis in early arthritis. A multivariate analysis wasconducted to identify the 'parameters' that are corelated with the presence of tenosynovtis. The variables considered in the analysis included the tender joint count, swollen joint count, and the presence of erosions. The agreement statistics were employed to compute the "sensitivity(SN), specificity(SP), positive predictive value(PPV), and negative predictive value(NPV) for the clinical examination, with ultrasound (US) being considered as the gold standard. P value less than 0.05 was deemed to be statisticaly significant.

RESULTS

Table 1. 'Age distribution among study population

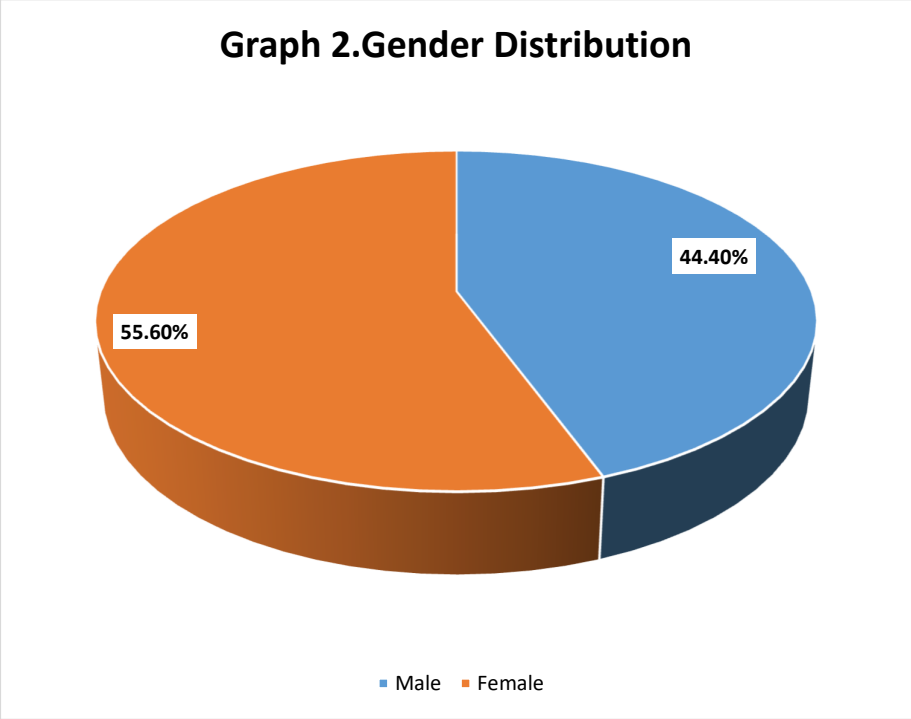
Age (in years)	N	%
18-30	4	11.1%
31-40	6	16.7%
41-50	11	30.6%
51-60	13	36.1%
61-70	2	5.5%
Total	36	100%



In the present study, majority of the patients (36.1%) where in "age group of 51-60 years", followed by 30.6% patients in 41-50 years age group.Patientsin 31-40 year age range comprised 16.7%.

Table 2. Gender Distribution

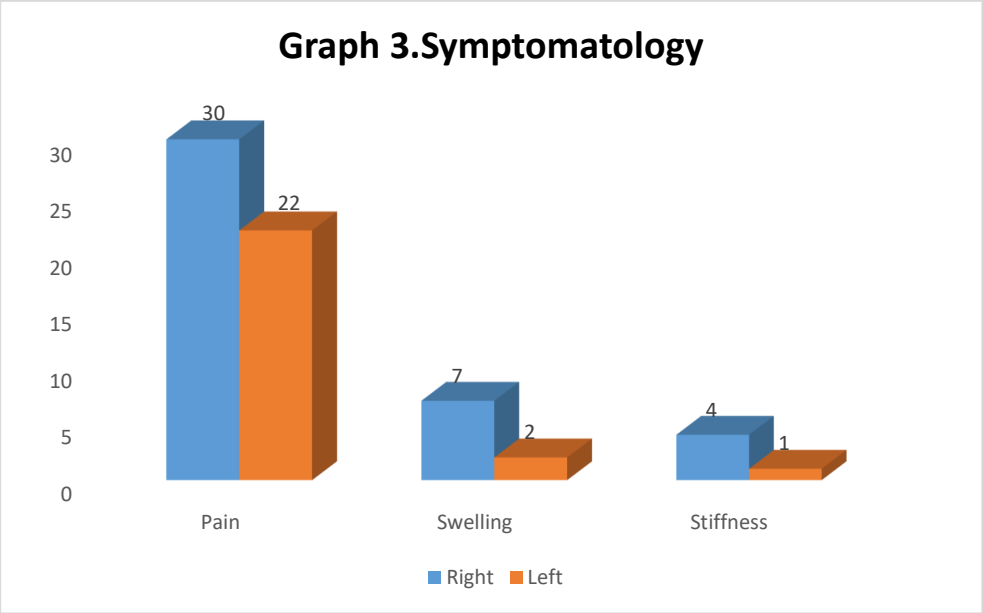
Gender	N	%
Male	16	44.4%
Female	20	55.6%



Out of a total of 36 patients, 20 (55.5%) were female and 16 (44.4%)weremales

Table 3. Symptomatology

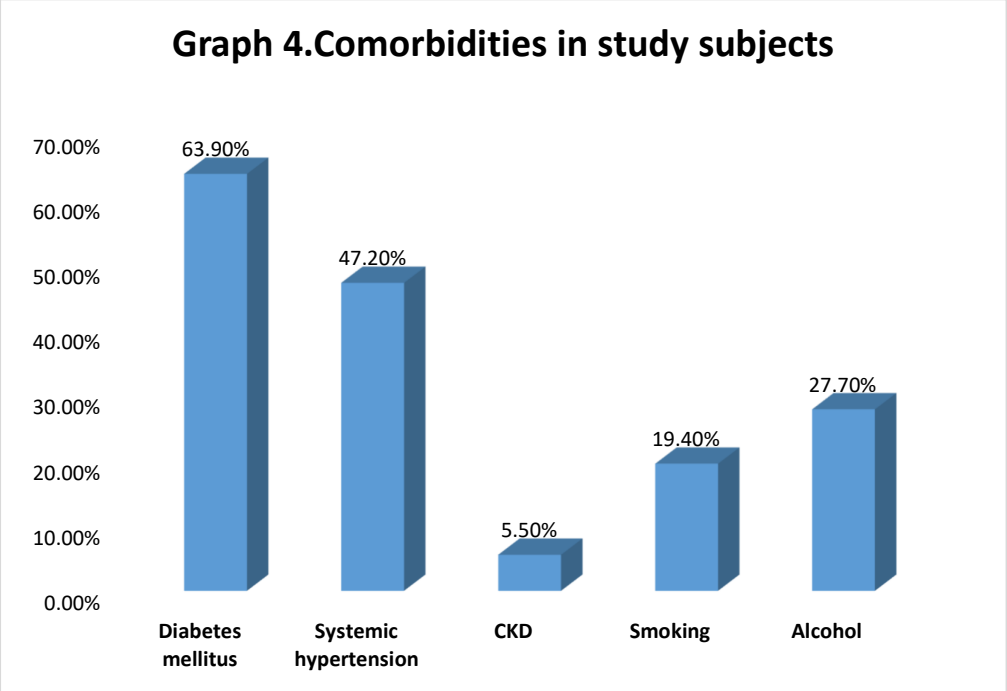
Symptom	Side	
	Right	**Left**
Pain	30	22
Swelling	7	2
Stiffness	4	1



Pain was present in 52 joints out of which, 30 were right side joints and 22 joints were left side. Swelling of joints was observed in 9 joints, out of which 7 were on the right side. Stiffness was mostly observed in right side joints compared to left side.

Table 4. Comorbidities among study population

Comorbidity	N	%
Diabetes mellitus	23	63.9%
Systemic hypertension	17	47.2%
CKD	2	5.5%
Smoking	7	19.4%
Alcohol	10	27.7%



Most common comorbidity in the study patients was DM (63.9%), followed by Hypertension, present in 47.2% patients. Prevalence of smoking and alcohol habits was 19.4% and 27.7% respectively.

Table 5. USG findings in wrist joint

USG	Present		Absent
	Right	Left	
Probe tenderness	28	22	22
Soft tissue swelling	16	10	46
Joint effusion	14	12	46
Synovitis	26	17	29
Tenosynovitis	32	30	10
Bursitis	14	10	48

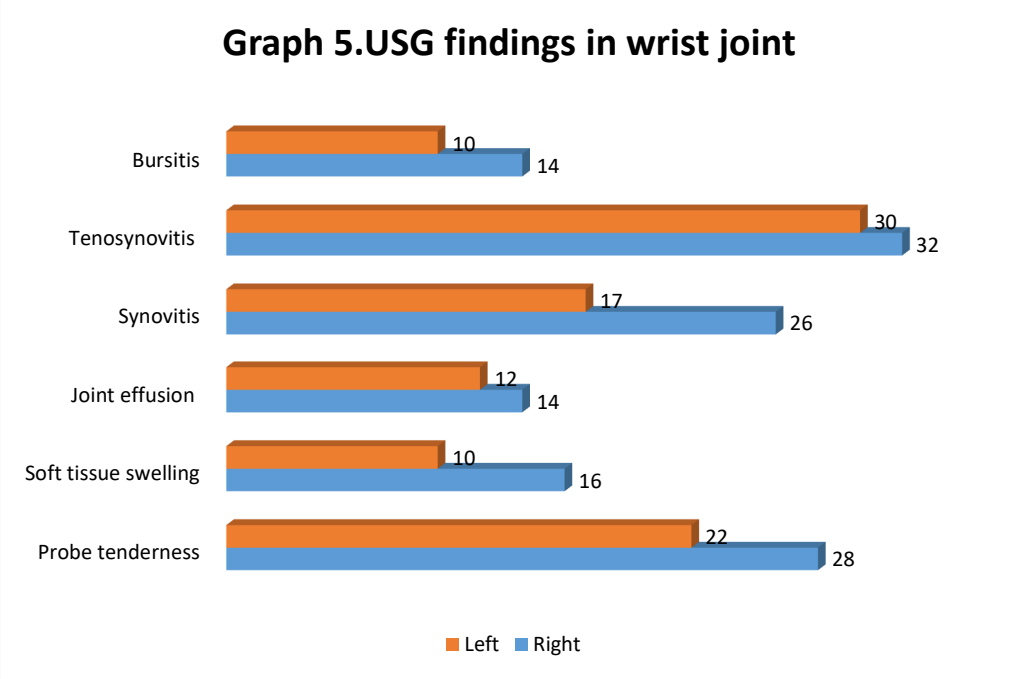
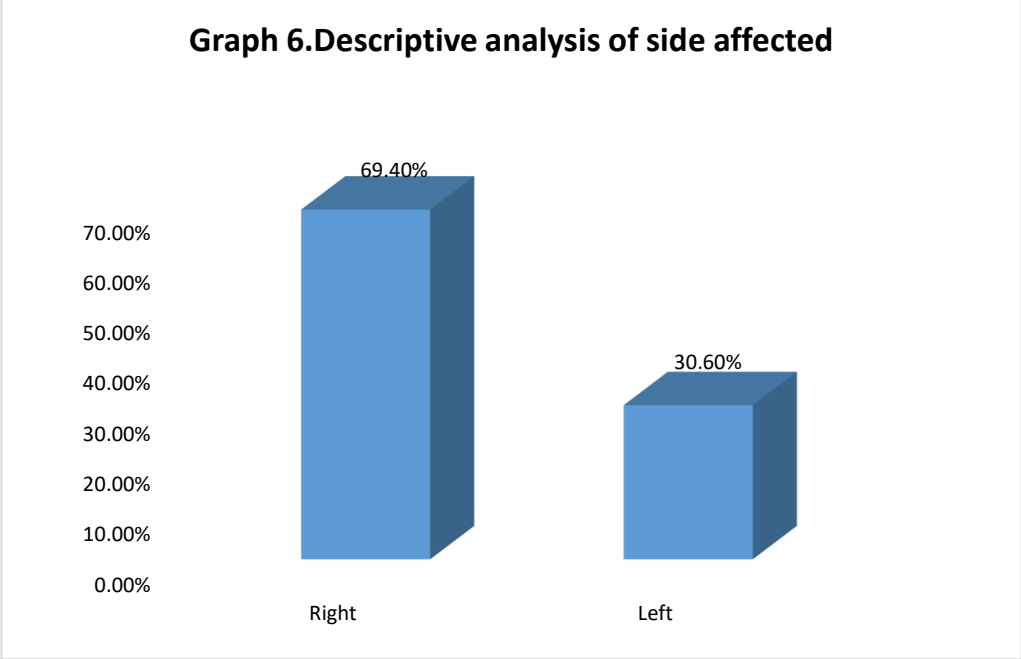


Table 6. Descriptive analysis of side affected

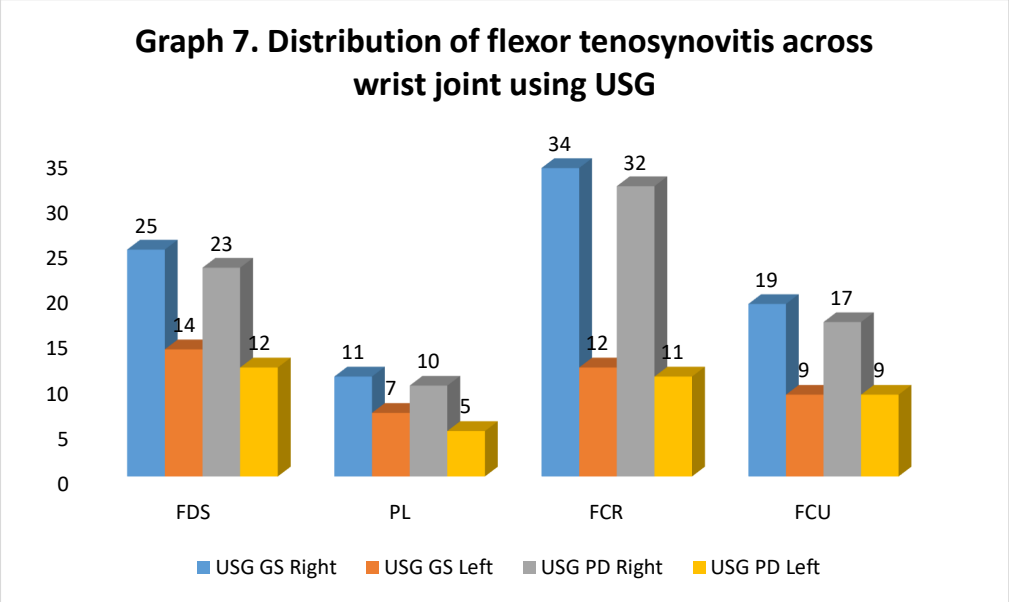
Side	N	%
Right	25	69.4%
Left	11	30.6%



The most affected side was right side (69.4%) and left side joints were affected in 30.6% patients

Table 7. Distribution of flexor tenosynovitis across wrist joint using USG

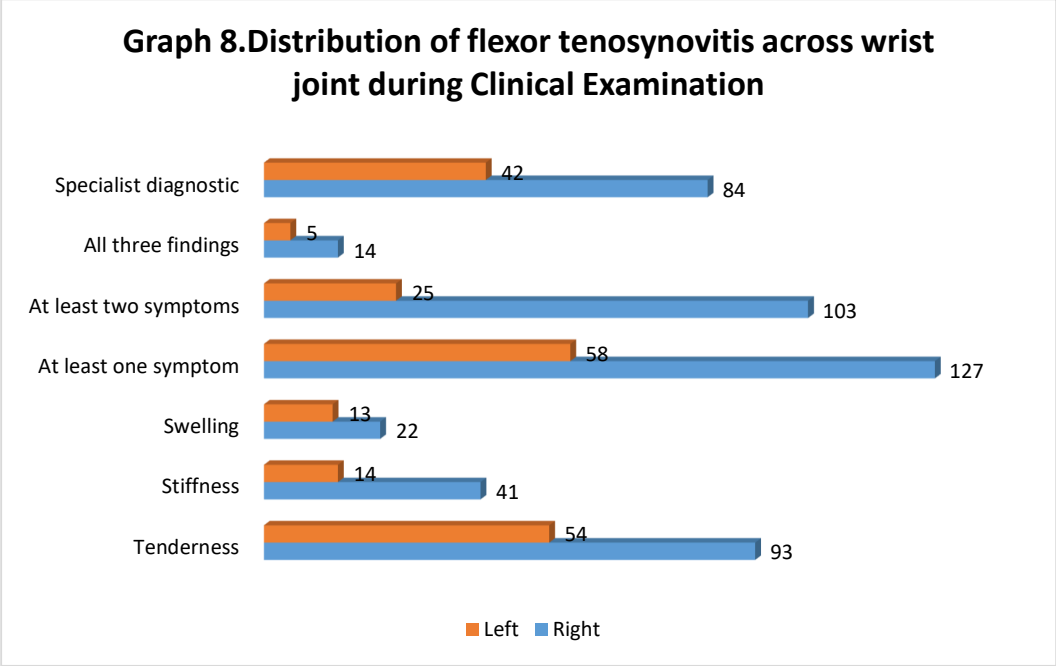
Flexor tendons	Tenosynovitis Present in USG Gray scale		Absent in GS	Tenosynovitis Present in USG PD		Tenosynovitis Absent in PD
	Right	Left		Right	Left	
Flexor digitorum superficialis (FDS)	25	14	33	23	12	37
Palmaris longus (PL)	11	7	54	10	5	57
Flexor carpi radialis (FCR)	34	12	26	32	11	29
Flexor carpi ulnaris (FCU)	19	9	44	17	9	46
Total	89	42	157	82	37	169



Out of the 288 flexor tendon sheaths examined, tenosynovitiswas detected in 131 tendons on ultrasonography gray scale, while power doppler detected tenosynovitis in 119 joints.Tenosynovitis was most prevalent in FCR tendon followed by FDS tendon. Least affected was PL tendon.

Table 8. Distribution of flexor tenosynovitis across wrist jointduring Clinical Examination

Findings	Positive		Negative
	Right	Left	
Tenderness	93	54	141
Stiffness	41	14	233
Swelling	22	13	253
At least one symptom	127	58	185
At least two symptoms	103	25	128
All three findings	14	5	67
Specialist diagnostic	84	42	53



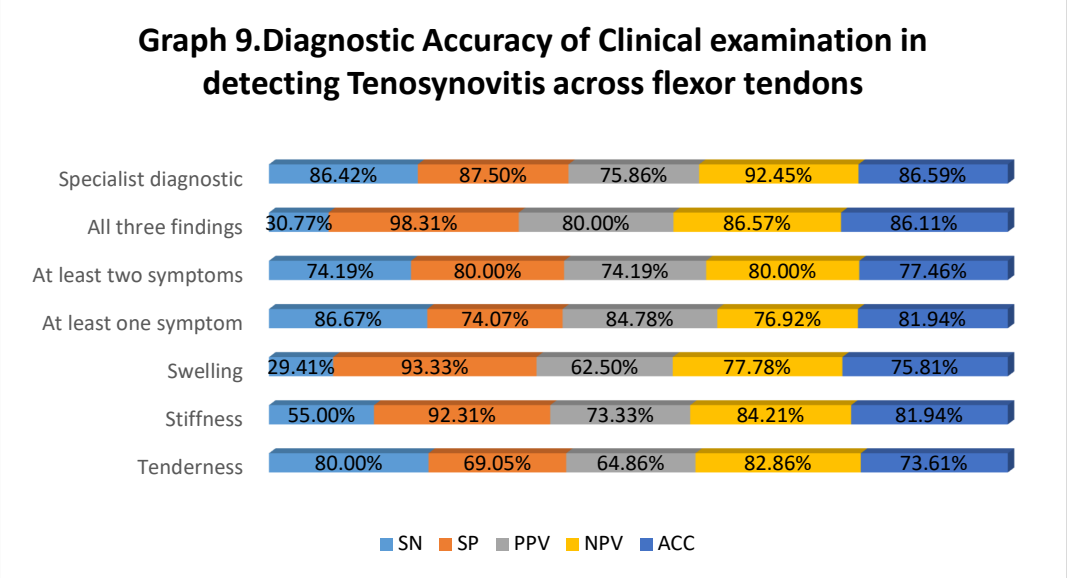
Out of the 288 flexor tendon sheaths examined, all three symptoms were present in 67 joints.

Table 9. Comparison of Tenosynovitis across flexor tendons between CE and USG (Gold Standard)

CE		USG positive	USG Negative	
Tenderness	Positive	134	13	147
	Negative	12	129	141
Stiffness	Positive	46	9	55
	Negative	16	217	233
Swelling	Positive	31	4	35
	Negative	12	241	253
At least one symptom	Positive	176	9	185
	Negative	14	89	103
At least two symptoms	Positive	120	8	128
	Negative	17	143	160
All three findings	Positive	16	3	19
	Negative	11	258	269
Specialist diagnostic	Positive	122	4	126
	Negative	7	155	162

Diagnostic Accuracy of Clinical examinationin detecting Tenosynovitis across flexor tendons compared to USG (Gold Standard)

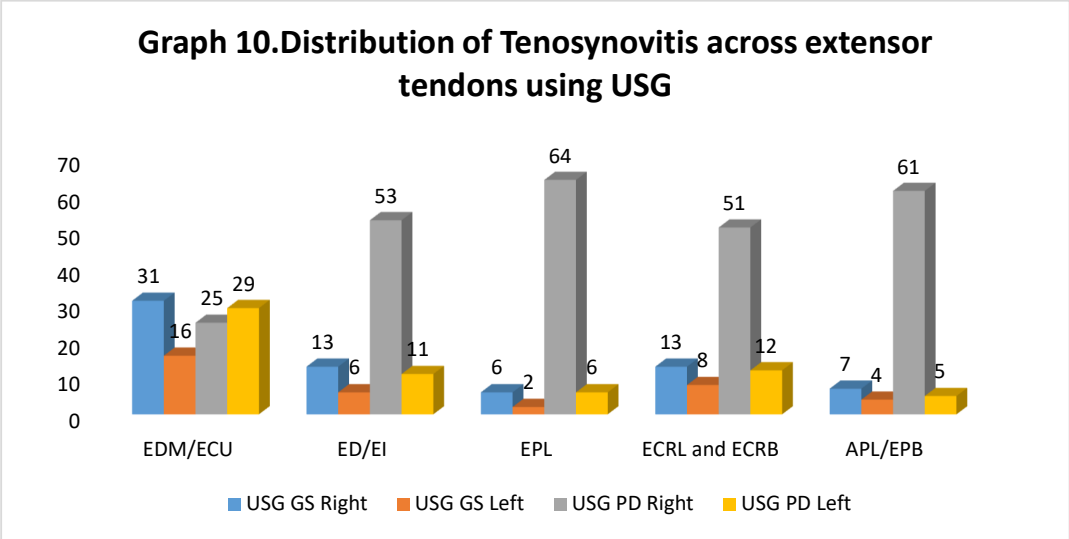
Finding	SN	SP	PPV	NPV	ACC
Tenderness	80.00%	69.05%	64.86%	82.86%	73.61%
Stiffness	55.00%	92.31%	73.33%	84.21%	81.94%
Swelling	29.41%	93.33%	62.50%	77.78%	75.81%
At least one symptom	86.67%	74.07%	84.78%	76.92%	81.94%
At least two symptoms	74.19%	80.00%	74.19%	80.00%	77.46%
All three findings	30.77%	98.31%	80.00%	86.57%	86.11%
Specialist diagnostic	86.42%	87.50%	75.86%	92.45%	86.59%



The highest sensitivity and PPVwere observed in detecting at least one symptom (86.67% and 84.78% respectively). Specificity and NPV were highest (98.31%, 86.57% respectively) in detecting all three findings. Diagnostic accuracy was highest for specialist diagnostic (86.59%).

Table 10. Distribution of Tenosynovitis across extensor tendons using USG

Extensor tendons	Tenosynovitis Present in USG GS		Tenosynovitis Absent in USG GS	Tenosynovitis Present in USG PD		Tenosynovitis Absent in USG PD
	Right	Left		Right	Left	
Extensor digiti minimi and carpi ulnaris	31	16	25	29	15	28
Extensor digitorum &indicis	13	6	53	11	4	57
EPL	6	2	64	6	1	65
ECRL and ECRB	13	8	51	12	8	52
APL/EPB	7	4	61	5	2	65
Total	70	36	254	63	30	267



Out of the 360extensor tendon sheaths examined, tenosynovitiswas detected in 106 tendons in USG Gray scale, while power doppler detected tenosynovitis in 93 joints. Tenosynovitis was most prevalent in EDM/ECU tendon followed by ECRL and ECRB tendon. Least affected was EPL tendon.

Table 11. Distribution of Tenosynovitis across extensor tendons in Clinical Examination

Extensor tendons	Tenosynovitis Present in CE		Tenosynovitis Absent in CE
	Right	Left	
Tenderness	137	98	125
Stiffness	54	27	279
Swelling	23	11	326
At least one symptom	153	92	115
At least two symptoms	86	37	237
All three findings	49	12	299
Specialist diagnostic	116	56	188

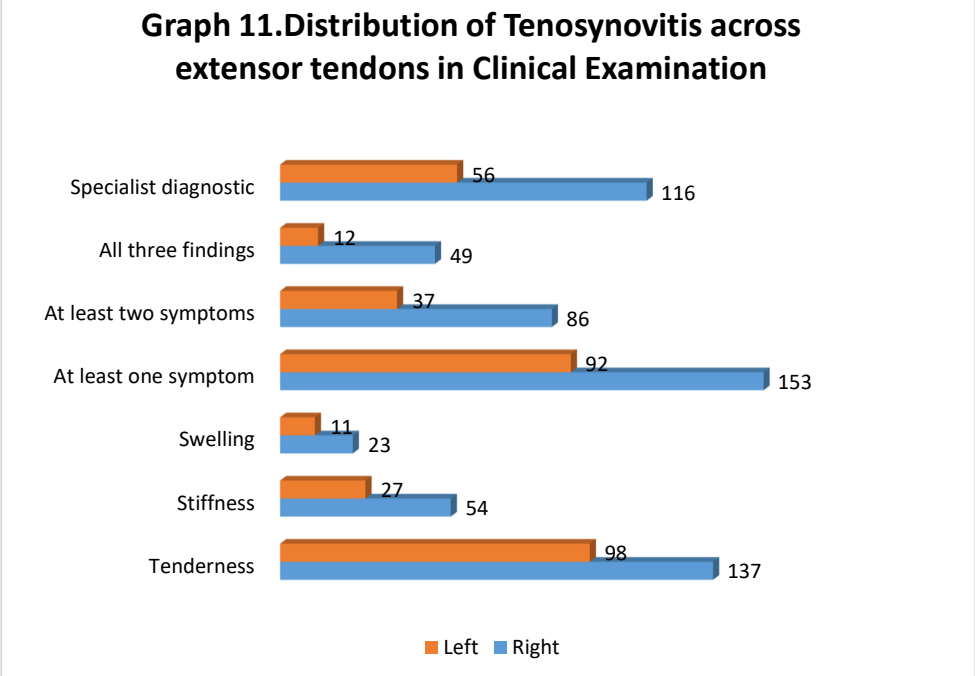
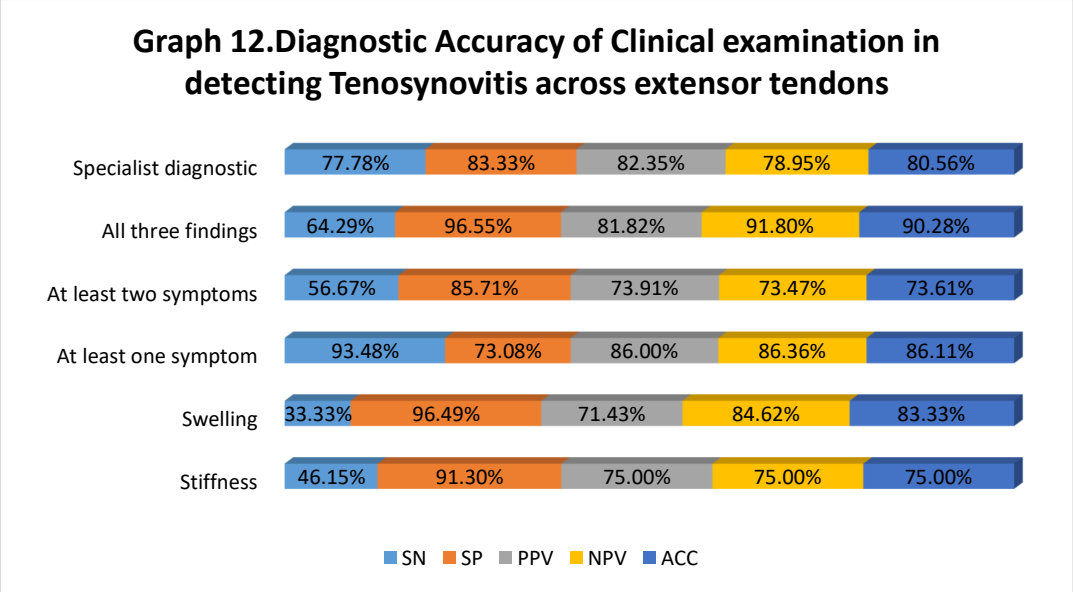


Table 12.Comparison of Tenosynovitis across extensor tendons between CE and USG

CE		USG positive	USG Negative	
Tenderness	Positive	227	8	235
	Negative	11	114	125
Stiffness	Positive	72	9	81
	Negative	17	262	279
Swelling	Positive	25	9	34
	Negative	15	311	326
At least one symptom	Positive	233	12	245
	Negative	6	109	115
At least two symptoms	Positive	112	11	123
	Negative	224	13	237
All three findings	Positive	9	52	61
	Negative	23	276	299
Specialist diagnostic	Positive	156	16	172
	Negative	164	24	188

Diagnostic Accuracy of Clinical examinationin detecting Tenosynovitis across extensor tendons compared to USG (Gold Standard)

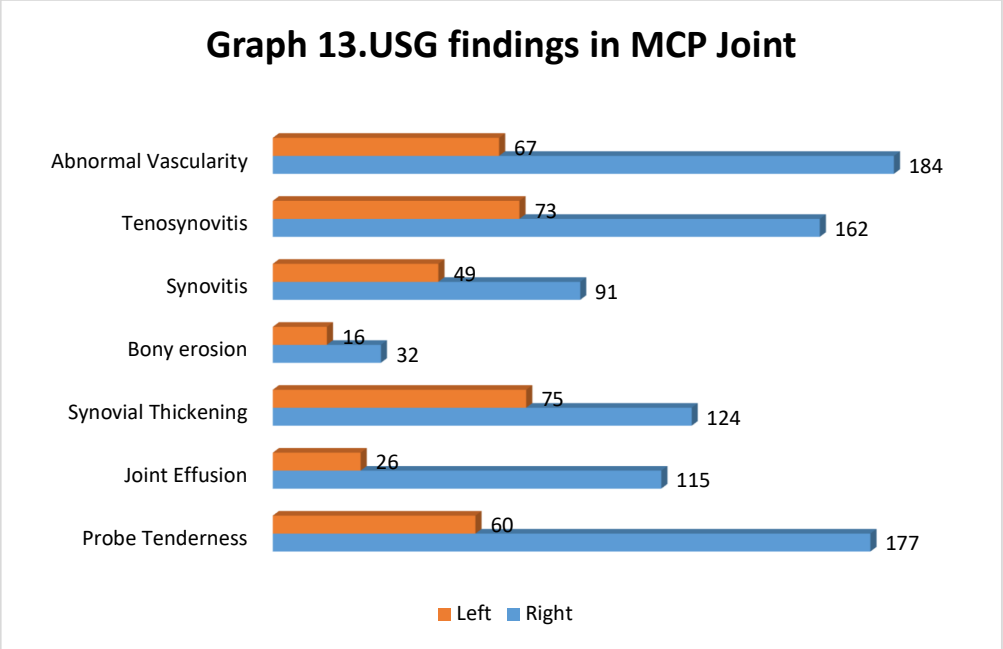
Extensor tendons	SN	SP	PPV	NPV	ACC
Tenderness	77.08%	69.23%	82.22%	62.07%	74.32%
Stiffness	46.15%	91.30%	75.00%	75.00%	75.00%
Swelling	33.33%	96.49%	71.43%	84.62%	83.33%
At least one symptom	93.48%	73.08%	86.00%	86.36%	86.11%
At least two symptoms	56.67%	85.71%	73.91%	73.47%	73.61%
All three findings	64.29%	96.55%	81.82%	91.80%	90.28%
Specialist diagnostic	77.78%	83.33%	82.35%	78.95%	80.56%



The highest sensitivity and PPVwere observed in detecting at least one symptom (93.48% and 86.00% respectively). Specificity, NPV and diagnostic accuracy were highest (96.55%, 91.80% and 90.28%respectively) in detecting all three findings.

Table 13. USG findings in MCP Joint

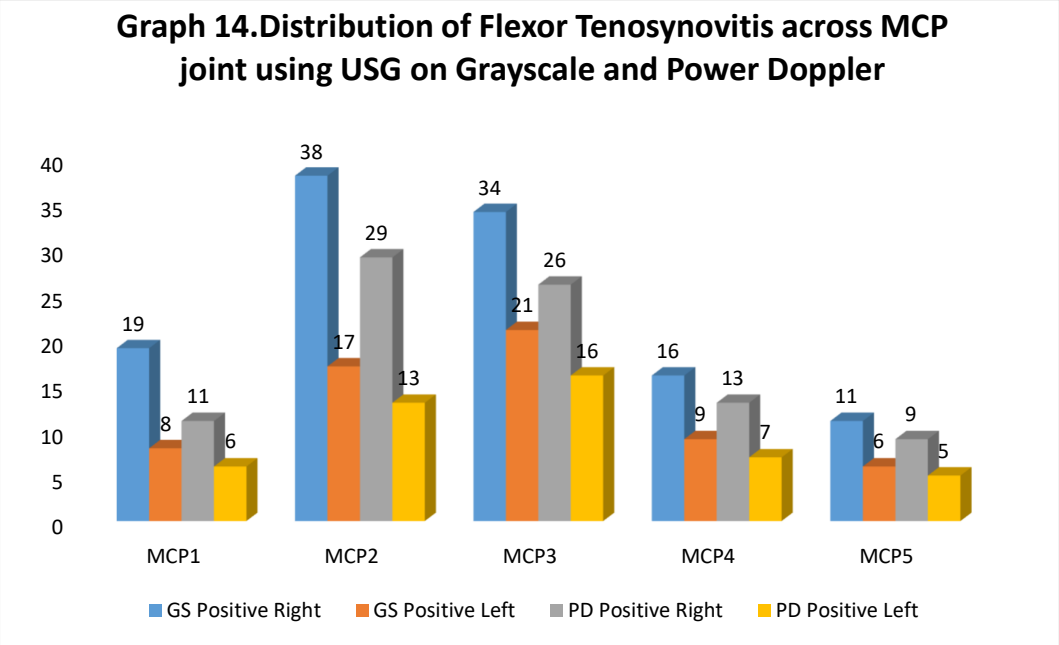
USG findings	Present		Absent
	Rt	Lt	
Probe Tenderness	177	60	123
Joint Effusion	115	26	219
Synovial Thickening	124	75	161
Bony erosion	32	16	312
Synovitis	91	49	220
Tenosynovitis	162	73	125
Abnormal Vascularity	184	67	109



Abnormal vascularity (251 joints) was the major UGS finding followed by Probe tenderness (237 joints). Tenosynovitis was present in 235 joints (162 Right and 73 Left).

Table 14. Distribution of Flexor Tenosynovitis across MCP joint using USG on Grayscale and Power Doppler

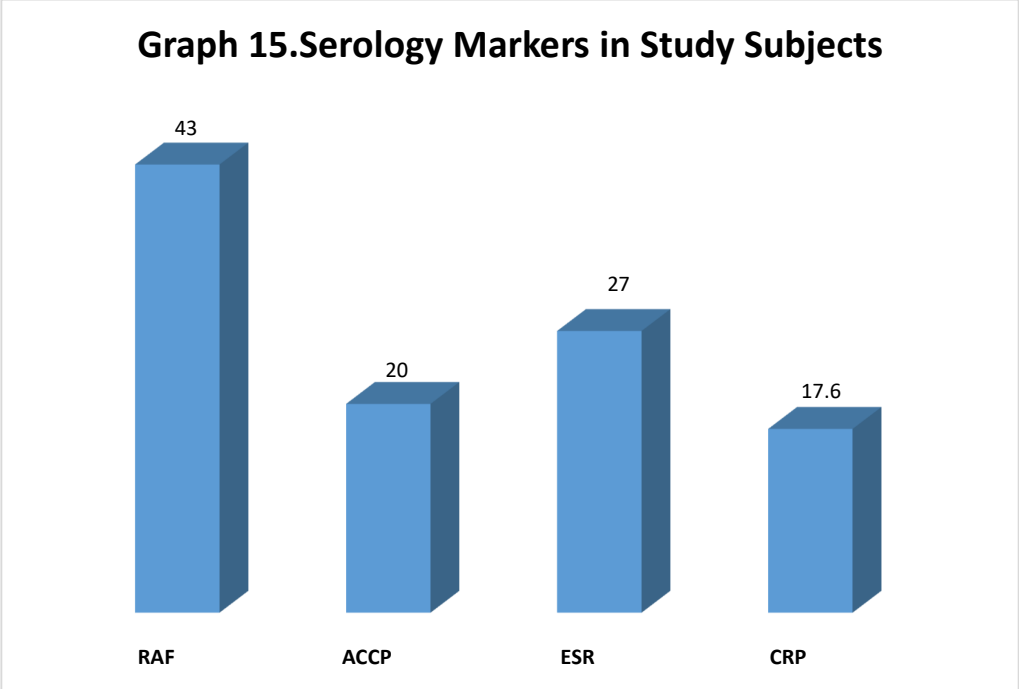
MCP Joint	GS Positive		PD Positive	
	Right	Left	Right	Left
MCP1	19	8	11	6
MCP2	38	17	29	13
MCP3	34	21	26	16
MCP4	16	9	13	7
MCP5	11	6	9	5



A total of 360 joints (i.e. 5 bilateral joints in 36 patients)were included in the analysis. Compared with PD, GS USG showed more changes reflecting early arthritis in all the 5 MCP joints.

Table 15. Serology Markers

Parameter	Mean	SD
RF (U/mL)	43	16.8
ACCP (EU/ml)	20	9.2
ESR (mm/hr)	27	3.6
CRP (mg/dL)	17.6	4.4



The mean values of RF, ACCP, ESR and CRP were 43 U/mL, 20 EU/ml, 27mm/hr, 17.6mg/dL respectively

DISCUSSION

Musculoskeletal ultrasound (MSUS) plays a well-established role in the "early diagnosis and assessment of disease activity". Some researchers have even found it to be superior to clinical examination. MSUS offers the advantage of directly assessing all structures involved in the rheumatoid process, including the synovium, tendons, and cartilage.

However, a critical consideration with MSUS is its reliability, as it heavily depends on the skill of the operator. The accuracy of MSUS relies on both the acquisition and interpretation of ultrasound images. This underscores the importance of standardizing the evaluation of pathologies detected by ultrasound. Therefore, our study adhered to universal guidelines for defining pathologies and utilized semi-quantitative scoring systems to ensure consistency in evaluation.

Considering the potential pitfalls in power Doppler (PD) ultrasound, especially in patients with RA who often receive steroids and "disease-modifying anti-rheumatic drugs (DMARDs)" our study employed grayscale (GS) ultrasound in addition to PD for assessing synovitis. For evaluating tenosynovitis, we relied solely on grayscale ultrasound (GS). This approach was chosen to ensure a comprehensive and accurate assessment of these conditions in RA patients, taking into account the limitations and considerations associated with PD ultrasound in this clinical context[47].

Power Doppler (PD) detection of tenosynovitis did not significantly enhance the assessment beyond grayscale (GS) ultrasound alone, with minimal or no additional value observed. This could be attributed to PD performing more effectively from the dorsal aspect of the joint compared to the palmar aspect.

To optimize PD ultrasound in our study, we emphasized the standardization of gain settings, avoidance of excessive probe pressure, and ensured complete

relaxation of the evaluated area. These precautions were crucial to prevent masking of Doppler activity and to achieve reliable and accurate assessments of tenosynovitis in "*Rheumatoid arthritis*" (RA)patients[45].

Tenosynovitis

Tendon and tendon sheath lesions can manifest early in "*Rheumatoid arthritis*" (RA), and these muscle-tendon lesions are often the primary cause of functional disability in patients. Wang et al. observed that when comparing the rate of positive tendon lesions, there was no statistical signifcant difference between group of patients with RA duration less than 2 years and those with a disease duration of "2 years" or more. This suggests that significant muscle-tendon lesions can occur early in the course of RA, highlighting the importance of early detection and management of these conditions to mitigate functional impairments.

However, tendon lesions are frequently difficult to accurately evaluate using laboratory tests and clinical examinations. As a result, the use of ultrasonography in identifying tendon lesions helps to identify the disease early and makes up for these clinical deficiencies. With the aid of this skill, practitioners can more effectively monitor the course and prognosis of diseases, allowing for timely intervention to lower patient disability rates. good-frequency ultrasonography is a useful method for diagnosing tendon abnormalities, as Wakefield et al[48]. showed that it had a good specificity and positive predictive value in detecting lesions in flexor and extensor tendons.

"One of the main causes of functional limitation in rheumtoid arthritis is tendinitis, which is an early indicator of the disease. Additionally, it is a useful radiological signal for forecasting the early course of the disease. But the typical presentation of tenosynovitis is discomfort and swelling in the joints; this is not very

specific, and it can be difficult to differentiate from other illnesses. Because of this, it is frequently disregarded in clinical practice, and the data on its occurrence are scarce. Early detection of active tenosynovitis is essential in light of these difficulties. Precisely identifying this ailment not only facilitates the development of novel categorization standards for RA but also is vital in averting permanent joint impairment and impairment.

Tenosynovitis was found in 131 tendons on an ultrasonography grey scale and in 119 joints by power doppler among the 288 flexor tendon sheaths thatwere evaluated in this investigation. The FCR tendon has the highest incidence of tenosynovitis, followed by the FDS tendon. The PL tendon was the least damaged. The USG Grey scale identified 106 tendons with tenosynovitis out of the 360 extensor tendon sheaths analysed, whereas the power doppler identified 93 joints with tenosynovitis. The EDM/ECU tendon has the highest frequency of tenosynovitis, followed by the ECRL and ECRB tendon. The EPL tendon was least impacted.

According to Junkui Wang et al[44].'s study, the SNRA group detected more affected tendon synovial sheaths upon GS and PD than the OA group did, with rates of 39.06% and 30.87%, respectively, vs 7.71% and 0.94%, respectively. The SNRA group had higher average scores, total tendon synovial sheath GS scores, total tendon synovial sheath PD scores, and total tendon synovial sheath GS scores. In the OA group, GS grade I tenosynovitis predominated; ninety-eight of these tendon synovial sheaths had injury. No patients in the OA group had for tenosynovitis identified at the time of PD. Most likely, it was because the GS-indicated tenosynovitis in the OA group was not at the active stage. The total PD score and the total GS score of tendon synovial sheaths both demonstrated a good diagnostic value for SNRA, with an AUC

> 0.85 seen for both. The discovery of tenosynovitis contributed to the early detection of SNRA.

In the study by Yang et al.[43], tendon sheath effusion was frequently observed, and the tendon sheaths in both extensor and flexors were notably thicker compared to those in the control group. Due to the absence of tendon sheath in the extensor and the blurring of edges, effusion in the ulnar extensor tendon sheath was more prevalent. Sheath effusion in the flexor tendon was more prevalent and simpler to see.

According to Hmamouchi et al[49]., flexor tenosynovitis was present in 17 people (51.5%) on the US compared to 48.4% patients assessed during clinical examination. Strong intra-reader reliability was seen for both the US and the clinical assessment (kappa = 0.8).

The majority of research involving the clinical evaluation of individuals with long-term RA is the basis for the prevalence reported for the flexor teno-synovitis in RA, which varies from 5% to 55%. Among 60 patients with inflammatory arthritis in the Backhaus M et al study, US was able to detect the widening in tendon sheath I among 21% of the flexor tendons and also 5% of the extensor tendons. According to Wakefield RJ's second study, flexor tenosynovitis was found in a significant number of joints on both US and MRI (64% versus 28.5%)[48].

34 individuals with early RA were assessed by Malla S et al. utilising MRI, ultrasonography, and clinical examination. More than 50% of patients with confirmed RA may have flexor tendon tenosynovitis, which has also been demonstrated to be an early indicator of the illness[36].

A considerable percentage of patients in the Emanuela Bellis et al. study sample had GS tenosynovitis (52.5%) and PD Tenosynovitis (22.7%), although the

prevalence of GS synovitis (71.6%) and PD synovitis (42%), in contrast, was consistent with other research[50].

Comparing this US characteristic to US synovitis, the lower prevalence of tenosynovitis suggests that it may be a more specific technique for identifying subclinical inflammation. In fact, PD synovitis has a low positive predictive value even though it is very sensitive in predicting short-term flares; most RA patients with PD synovitis who are in clinical remission do not return, mostly in cases of long-standing disease. Cader Since it was the only US characteristic that was substantially correlated with FQ, our study's findings imply that PD tenosynovitis may be more specific than PD synovitis in identifying individuals with continued active illness and unstable clinical remission[51].

Abnormal vascularity

Ultrasonography is a sensitive way to identify joint inflammatory activity during imaging exams, and in recent years, it has become a global research hotspot. Increased blood flow signals and varying degrees of synovium thickness can be seen in the synovium using high-frequency ultrasonography. Elevated indications of blood flow within the synovium indicate a comparatively higher level of blood flow and also point to an active phase of the inflammation.

Nonetheless, when there is stabilization in the condition, the synovium colour flow signal may diminish or even disappear. Strunk et al. reported a substantial association between the Doppler grading of the synovial blood flow among the wrist joints of the RA patients and the severity of synovitis as evaluated by clinical examination. Therefore, it is believed that, using a power doppler can accurately determine the extent of inflammatory process in the pannus.

The two main methods of colour flow imaging, CDFI and CDE imaging, both can determine the increased blood flow signals in the surface of the thickened synovium and also the bone. One can observe short rods, stars, or dots that represent the blood flow.

The primary UGS finding in MCP joints in the current study was abnormal vascularity (251 joints). According to Yang et al.'s study, 104 joints in 36 instances were shown to exhibit pannus, with increased signals of blood flow on the surface of cartilage and thickened synovium being recognised by CDFI and CDE imaging. The blood flow signal in the synovium was predominantly rated I–III, with grade III signals being more prevalent in the wrist joints, per the data. This is probably because the wrist joints had a smaller area of synovial hyperplasia and thin, hyperplastic synovial blood vessels compared to the finger joints, which resulted in greater signals of blood flow in the wrist joints[43].

Zhu et al[52]. employed high-frequency USG to assess the wrist joints of 31 patients with active 36 patients with inactive inflammation. They observed that the intra-articular artery's RI value can be utilized as a marker for clinical detection of the synovial inflammatory lesions of RA. Out of 53 patients, 23 active patients met the active RA inclusion criteria and were examined in this study. Every patient was analysed using signals of synovial blood flow, and average Psv and RI were 6.94±1.41 and 0.58±0.07, respectively. There were eight new blood flow indicators among the thirty inactive RA patients, with an average RI of 0.67±0.03 and Psv of 6.92±0.96. There may be a relationship between the signal richness of synovial blood flow and disease progression because RA patients had a greater detection rate of this signal than did inactive patients.

Clinical examination VS USG

In the present study, clinical examination to detect tenosynovitis in flexor joints showed highest sensitivity and PPV were observed in detecting at least one symptom (86.67% and 84.78% respectively). Specificity and NPV were highest (98.31%, 86.57% respectively) in detecting all three findings. Diagnostic accuracy of clinical examination in detecting tenosynovitis across extensor tendons showed highest sensitivity and PPV in detecting at least one symptom (93.48% and 86.00% respectively). Specificity, NPV and diagnostic accuracy were highest (96.55%, 91.80% and 90.28%respectively) in detecting all three findings of RA.

Similar results from previous studies have also suggested that the deterioration in RA patients may be caused by insufficient sensitivity of clinical exams, even in the presence of clinically satisfactory disease control.[53,54] When compared to MRI, the gold standard, USG has a 78.6% sensitivity in detecting synovial inflammatory signs, according to Malla S. et al.'s study[36]. This is lower than what was found in an earlier study Szkudlarek M, which showed that MRI and ultrasound had almost equal sensitivity[55].

This could be as a result of the 1.5 T MRI with a multichannel extremities coil used in our experiment having a higher resolution than the 0.5 T MR scanner used in the work by Schmidt WA et al[57].

Malla S et al[36]. found six joints where synovitis was visible on greyscale USG but not on MRI; this may be due to the fact that USG shows fibrotic pannus more clearly. Fibrotic pannusis, however, is extremely uncommon because all of our patients had early-stage RA. A total of 136 flexor tendons were evaluated for

tenosynovitis using MRI and USG. The findings demonstrated that ultrasonography had an 86.5% sensitivity and a 100% specificity. In two of our patients, tenosynovitis was the only imaging finding. These subjects only experienced arthritis in their big joints; they did not have arthritis in their smaller joints.

In line with an earlier study by Matsos et al[56]., Rezaei et al[40]. discovered that MSUS considerably raised the diagnostic accuracy for diagnosing the inflammatory arthritis in general and also RA. Additionally, MSUS increased positive diagnostic certainty (≥80% definite of diagnosis) and negative diagnostic certainty (<20% likely to have the diagnosis), and dramatically lowered the proportion of patients with maximal diagnostic ambiguity. These results provide quantitative support for the utility of MSUS in the evaluation of patients with "*Rheumatoid arthritis*" (RA)when there is diagnostic doubt, in line with the recommendation of EULAR for the utilization of joint imaging in the treatment of RA. It was assumed that among individuals exhibiting early indications of arthritis, the presence of MSUS findings would increase the likelihood of developing any form of inflammatory type arthritis, and in particular, Rheumatoid-arthritis. Additionally, MSUS enhanced the diagnostic accuracy when assessed using a traditional (deterministic) method as opposed to clinical assessment alone; as previously shown, there was concordance between final diagnosis and MSUS findings in >95% of patients.

In the study by Matsos et al[56]., two rheumatologists referred 62 patients for MSUS scanning of both hands and feet. Both before and after the MSUS test, the diagnostic accuracy for the diagnosis was established. The study discovered that while the rheumatologist's certainty of identifying seronegative arthritis increased

significantly (46.8% vs 61.3% and P = 0.05), there was no significant improvement in the rheumatologist's confidence in diagnosing RA (46.8% vs 61.3%, P >0.05).

Freeston and colleauges evaluated the ability of disease prediction of MSUS in the diagnosis of inflammatory arthritis in 50 patients who were RF and ACPA negative. In this study, positive results for MSUS increased the probability of detecting inflammatory arthritis from 2% to 30% and from to 50% to 94%.[58]

According to the retrospective study by Pratt et al[59]., MSUS as a adjunct did not offer significant predictive value for distinguishing persistent inflammatory arthritis in patients with early arthritis. In 379 patients, seven clinical and serological markers were independently and significantly linked to chronic arthritis. The risk scale for serological and clinical parameters showed excellent discriminatory ability (AUC = 0.91 and P <0.001). The inclusion of MSUS did not enhance the predictive ability, and the diagnostic value of the new metric was comparable to that of the earlier one.

In the study by Kelly et al[60]., which was presented at the 2013 EULAR conference, the frequent utilization of MSUS in patients with suspected inflammatory-arthritis was significantly associated with earlier detection and also initiation of medication in individuals diagnosed with RA. In this study, patients were categorized into two groups: those who were diagnosed with MSUS and those who were not. A similar variation was observed for patients identified with RA. In the MSUS group, a much larger percentage of patients were diagnosed on their first visit. Patients with RA diagnoses differed greatly in the interval between diagnosis and initiation of treatment.

3424 tendon compartments—that is, 16 bilateral tendon compartments in 107 patients—were included in the analysis of the study conducted by Ilfita Sahbudin et al.[41] At baseline, all patient groups (RA 85%, non-RA persistent disease 71%, and resolving 70%) demonstrated evidence of US-defined TS of at least one anatomical site. Patients with RA were more likely to have digit flexor and wrist extensor US-defined TS, with both GS and PD pathology, than patients with resolving arthritis. US defined extensor carpi ulnaris (ECU) TS was more common in patients with RA than in patients with either resolving arthritis or non-RA patients among the wrist extensor tendon compartments. This applied to both PD and GS. In comparison to the group experiencing resolving arthritis, the RA group had a higher prevalence of US-defined digit flexor GS and PD TS.

No matter the age group or degree of physical activity, tendon anomalies detected by US can be considered as indicators of inflammation, according to a comprehensive study conducted by Trickey J et al[61]. that evaluated 11 ,237 tendons (bilateral digit flexor 1–5 and ECU tendon) from 939 healthy persons. 98% of these tendons had a grade of 0 for tenosynovial effusion, power-Doppler TS, and GS TS. Additionally, 99% (931/939) of people in good health did not have any power-Doppler TS in any tendons.

US data made it easier to identify the individuals “whose arthritis persisted” (including those in the ACPA negative group) in the study by Iqbal K et al[62]., which includes a sizable cohort of patients with early arthritis. “The symptomatic wrist, MCP, and PIP joints' scanning results were interpreted by sonographers, who ‘improved the area under the curve from 0.81 to 0.90’. Nevertheless, the scanning

algorithm in that study did not take tendons into account. The overall Doppler power score and GS scores were highly correlated with the persistence of the condition.

In the Freeston JE et al[55]. study, a cohort of patients with musculoskeletal symptoms lasting less than 12 weeks and without RF or ACPA autoantibodies had a higher risk of developing persistent arthritis if they had 'US features of MCP or wrist synovium', such as grayscale US grade 3 and the presence of power Doppler and at least one US erosion. Unfortunately, because to the small sample size, logistic regression analysis was not possible, so the independent predictive value of joint and tendon US was not evaluated in that study.

CONCLUSION

High-frequency ultrasonography is capable of identifying several early-stage "*Rheumatoid arthritis*" (RA) indicators in joints such as hand MCPand wrist. These include detecting joint cavity fluid, synovial inflammation (including pannus formation and hyperplasia), and the erosion of joint cartilage and bone. This method offers advantages in early diagnosis. Furthermore, it can identify tendon lesions around joints that are often missed in clinical examinations, such as tenosynovitis, tendon sheath effusion adhesions. Color ultrasonography can also detect signals from synovial blood flow, and the synovial arteries resistance index values of are linked to RA activity.

SUMMARY

Tenosynovitis is widely accepted to be common in "*Rheumatoid arthritis*" (RA)and postulated to be the first manifestation of RA, but its true prevalence in early disease and in particular the hand has not been firmly established. The aim of this study was first to investigate the frequency and distribution of wrist, MCP joints tenosynovitis using ultrasound in early arthritis, second to compare clinical examination with ultrasound (US) using the latter as the gold standard.

36 consecutive patients who were initially diagnosed with polyarthritis and suspected of polyarthritis and clinical suspicion of inflammatory arthritis of the hands and wrists were assessed during consecutive, routine presentations to the orthopedics outpatient clinic. We scanned a total of 360 fingers tendons and subsequent comparisons were made using clinical examination.

- In the present study, majority of the patients (36.1%) were in the age group of 51-60 years, followed by 30.6% patients in 41-50 years age group. Patients in 31-40year age range comprised 16.7%.
- Out of a total of 36 patients, 20 (55.5%) were female and 16 (44.4%) were males.
- Pain was present in 52 joints out of which, 30 were right side joints and 22 joints were left side. Swelling of joints was observed in 9 joints, out of which 7 were on the right side. Stiffness was mostly observed in right side joints compared to left side.
- Most common comorbidity in the study patients was DM (63.9%), followed by Hypertension, present in 47.2% patients. Prevalence of smoking and alcohol habits was 19.4% and 27.7% respectively.

- USG examination of the wrist revealed that, Tenosynovitis was present in 62 joints, followed by Probe tenderness in 50 joints.
- The most affected side was right side (69.4%) and left side joints were affected in 30.6% patients
- Out of the 288 flexor tendon sheaths examined, tenosynovitis was detected in 131 tendons on ultrasonography gray scale, while power doppler detected tenosynovitis in 119 joints. Tenosynovitis was most prevalent in FCR tendon followed by FDS tendon. Least affected was PL tendon.
- On clinical examination, out of the 288 flexor tendon sheaths examined, all three symptoms were present in 67 joints. The highest sensitivity and PPV were observed in detecting at least one symptom (86.67% and 84.78% respectively). Specificity and NPV were highest (98.31%, 86.57% respectively) in detecting all three findings. Diagnostic accuracy was highest for specialist diagnostic (86.59%).
- On USG examination of 360 extensor tendon sheaths, tenosynovitis was detected in 106 tendons in USG Gray scale, while power doppler detected tenosynovitis in 93 joints. Tenosynovitis was most prevalent in EDM/ECU tendon followed by ECRL and ECRB tendon. Least affected was EPL tendon
- The highest sensitivity and PPV were observed in detecting at least one symptom (93.48% and 86.00% respectively). Specificity, NPV and diagnostic accuracy were highest (96.55%, 91.80% and 90.28%respectively) in detecting all three findings.
- USG findings in MCP joint showed Abnormal vascularity (251 joints) was the major UGS finding followed by Probe tenderness (237 joints). Tenosynovitis was present in 235 joints (162 Right and 73 Left).

- A total of 360 joints (i.e. 5 bilateral joints in 36 patients) were included in the analysis. Compared with PD, GS USG showed more changes reflecting early arthritis in all the 5 MCP joints.
- Serological examination showed that The mean values of RF, ACCP, ESR and CRP were 43 U/mL, 20 EU/ml, 27 mm/hr, 17.6mg/dL respectively

LIMITATIONS

Our study has both strengths and limitations. Firstly, the observed results might be slightly higher than those of the entire patient population because arthritis often involves phases of exacerbation and remission. Secondly, although we incorporated power Doppler, it was deemed unlikely to enhance ultrasound sensitivity as Doppler signals are infrequent in tendon sheaths that can appear normal on grayscale imaging. Nevertheless, the increasing frequency of studies comparing Doppler ultrasonography with clinical examination of joint, and highlighting the benefits of incorporating Doppler assessment alongside ultrasound, implies that that it will soon emerge as a standard component of joint evaluation. However, numerous procedural and technical aspects regarding the utilization of Doppler ultrasonography still require clarification.

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ANNEXURES

ANNEXURE – I CONSENT FORM

TITLE OF THE STUDY: "ULTRASONOGRAPHIC EVALUATION OF TENOSYNOVITIS OF WRIST, MCPJOINT'S IN RHEUMATOID ARTHRITIS WITH CLINICAL AND SEROLOGICAL CORRELATION- A ONE YEARHOSPITAL BASED OBSERVATIONAL STUDY"

NAME OF STUDENT/PRINCIPAL INVESTIGATOR: REG NO. BS0121010

OBJECTIVE: The study aims to evaluate tenosynovitis of wrist and MCP joints in rheumatoid arthritis (RA) with clinical and serological correlation.

INTRODUCTION: Rheumatoid arthritis is a chronic autoimmune disease that damages bone, cartilage, ligaments, and tendons, primarily through the inflammation of the synovium and can cause impairments and functional disabilities. The wrist and hand joints, particularly the metacarpophalangeal (MCP) joints, are among the most affected in early RA.

Early diagnosis and monitoring disease activity is crucial for effective management. Traditional radiography may not detect early-stage RA, but ultrasound has proven to be more sensitive in identifying bone and cartilage damage. US can also detect synovitis accurately and is recommended for joint assessments.

Ultrasound (US) has emerged as a valuable tool for tracking RA disease activity and joint destruction. Grayscale US and Power Doppler (PD) US are more sensitive than clinical examinations in detecting synovitis, tenosynovitis, and the degree of inflammation in RA.

US can visualize soft tissues, detect blood flow signals in thickened synovium, and identify bone and cartilage erosions. Its non-invasive, repeatable, and dynamic nature makes US a promising technique for diagnosing joint lesions in RA patients.

The study aids to develop and validate ultrasound (USG) as a diagnostic tool for rheumatoid arthritis.

EXPLANATION OF PROCEDURE: I request you to kindly participate in the study titled "**ULTRASONOGRAPHIC EVALUATION OF TENOSYNOVITIS OF WRIST, MCPJOINT'S IN RHEUMATOID ARTHRITIS WITH CLINICAL AND SEROLOGICAL CORRELATION- A ONE YEAR HOSPITAL BASED OBSERVATIONAL STUDY**" at Dr Prabhakar Kore Hospital and Medical Research Centre, Belagavi is being conducted by REG NO. BS0121010, Postgraduate in Radio diagnosis at J.N. Medical College, Belagavi, Karnataka, under the guidance of _____.

Dept. of Radio-diagnosis, J. N. Medical College, Belagavi.

We request you to participate in this study as you are eligible to be included. During the survey, you will be asked questions regarding your present and past medical history and required to answer to the best of your knowledge. You will also be clinically examined as per the protocol drawn.

If you agree to participate in the study, please furnish the details about the study.

BENEFITS: No use of surgical equipment /risk associated with it.

ALTERNATIVES: If you are not willing to take part in the study, your treatment or any other further investigations the patient wants to undergo, in the future, in KLE will not be affected by your decision.

WITHDRAWAL FROM PARTICIPATION IN THE STUDY: Participation in this study is voluntary. You can decide whether to participate in this study or continue participation once enrolled. In case you decide to withdraw your participation, you are free to do so. However, please convey the decision to the principal investigator.

POSSIBLE BENEFITS FROM PARTICIPATING IN THE STUDY: You will/will not have nor get any benefits by participating in this study. The data gathered will help the population at large.

POSSIBLE RISKS FROM PARTICIPATING IN THE STUDY: There are no risks involved in participating in this study.

PRIVACY AND CONFIDENTIALITY: The information collected from you will be coded to prevent any person from identifying you. Your identity will never be revealed. The data collected from you will be kept confidential, and only processed or aggregated data will be used for publication.

COSTS: NIL (The study is to be conducted on the participants who are advised for USG as an investigation by the referring consultant and the participants will not bear the charges for it).

FINANCIAL INCENTIVES: You will not receive any payment for participating in this study.

AUTHORISATION FOR PUBLICATION OF AGGREGATED DATA: Results obtained after

processing of the aggregated data will be published for scientific purposes and or presented to scientific groups. However, your identity will never be revealed.

QUESTIONS: In case of any questions about this study, you are free to contact:

REG NO.BS0121010	**DR. _____**	**DR. HARSHA HEGDE**
Post-Graduate, Department of Radio-Diagnosis. J.N. Medical College, Belagavi	Guide, Professor, Department of Radio-Diagnosis J.N. Medical College, Belagavi	CHAIRPERSON, JNMC, IEC & SCIENTIST D, ICMR, NATIONAL INSTITUTE OF TRADITIONAL MEDICINE, BELAGAVI

LEGAL RIGHTS: By signing this consent form, we are not waiving any of your legal rights.

CONSENTSTATEMENT

I am making a voluntary decision to participate in the study **"ULTRASONOGRAPHIC EVALUATION OF TENOSYNOVITIS OF WRIST, MCPJOINT'S IN RHEUMATOID ARTHRITIS WITH CLINICAL AND SEROLOGICAL CORRELATION- A ONE YEAR HOSPITAL BASED OBSERVATIONAL STUDY".** My signature below indicates that I have decided to participate and I have read the information provided above or the information provided above has been read to me in the language that I understand best. I was given the opportunity to ask questions and that they have been answered to my satisfaction.

Name of the participant:

Signature or left thumb impression of the participant:

Name of the witness:

Signature or left thumb impression of the witness:

Name of the investigator:

Signature of the investigator

ANNEXURE- II -PROFORMA FOR DATA COLLECTION

1.PATIENT PARTICULARS:

NAME	
AGE	
SEX	
ADDRESS	
MOBILE NUMBER	

2.

SYMPTOMATOLOGY	**ASYMPTOMATIC**	
	SYMPTOMATIC	

3. PERSONAL HISTORY

DM	**PRESENT/ABSENT**
HTN	**PRESENT/ABSENT**
CKD	**PRESENT/ABSENT**
SMOKING	**PRESENT/ABSENT**
ALCOHOL	**PRESENT/ABSENT**
OTHERS	**PRESENT/ABSENT**

4.CHIEF COMPLAINTS

	+ (RT/LT)	-	IF PRESENT DURATION OF ILLNESS
WRIST JOINT PAIN			
WRIST JOINT SWELLING			
EARLY MORNING STIFFNESS			
PATTERN OF JOINT INVOLVEMENT ASYMMETRICAL/SYMMETRICAL			

5. SEROLOGICAL MARKERS

	NORMAL	ABNORMAL
RF		
ACCP		
ESR		
CRP		

6. USG FINDINGS

	PRESENT (RT/LT)		ABSENT
PROBE TENDERNESS			
SOFT TISSUE SWELLING			
JOINT EFFUSION			
SYNOVITIS			
TENOSYNOVITIS			

7.FLEXOR COMPARTMENT

	USG FINDINGS IN WRIST JOINT			
	GREY SCALE(RT)	**POWER DOPPLE(RT)**	**GREY SCALE(LT)**	**POWER DOPPLER(LT)**
FLEXOR CARPI ULNARIS				
FLEXOR CARPI RADIALIS				
PALMARIS LONGUS				
FLEXOR DIGITORUM SUPERFICIALIS				

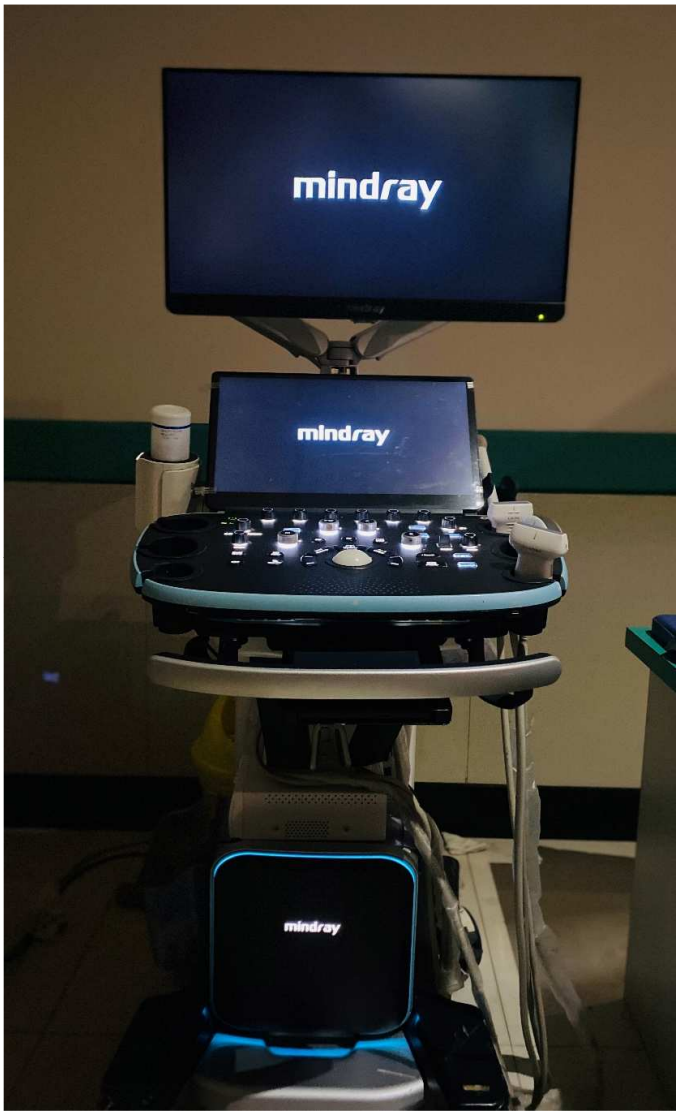
8. EXTENSOR COMPARTMENT

	USG FINDINGS IN WRIST JOINT			
	GREY SCALE(RT)	**POWER DOPPLE(RT)**	**GREY SCALE(LT)**	**POWER DOPPLER(LT)**
ABDUCTOR POLLICIS LONGUS & EXTENSOR POLLICIS BREVIS				
EXTENSOR CARPI RADIALIS LONGUS & BREVIS				
EXTENSOR POLLICIS LONGUS				
EXTENSOR DIGITORUM &INDICIS				
EXTENSOR DIGITI MINIMI& CARPI ULNARIS				

9.MCP JOINTS

TABLE-9	USG FINDINGS IN THE MCP JOINT			
	GREY SCALE(RT)	**POWER DOPPLE(RT)**	**GREY SCALE(LT)**	**POWER DOPPLER(LT)**
MCP-1				
MCP-2				
MCP-3				
MCP-4				
MCP-5				

ANNEXURE- III: IMAGES

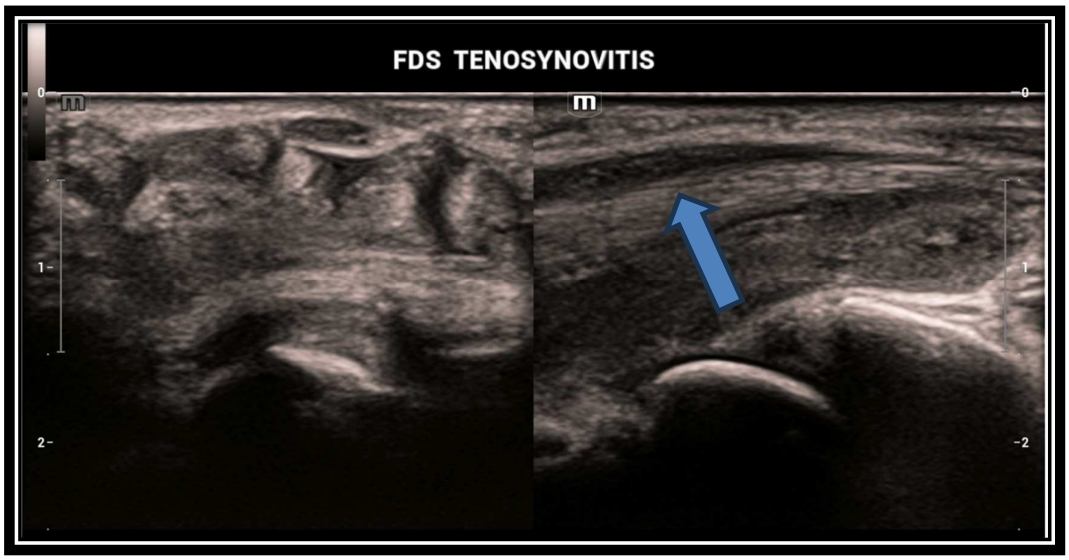


MINDRAY RESONAI9 Machine used for study

L14-3WS High frequency linear array transducer

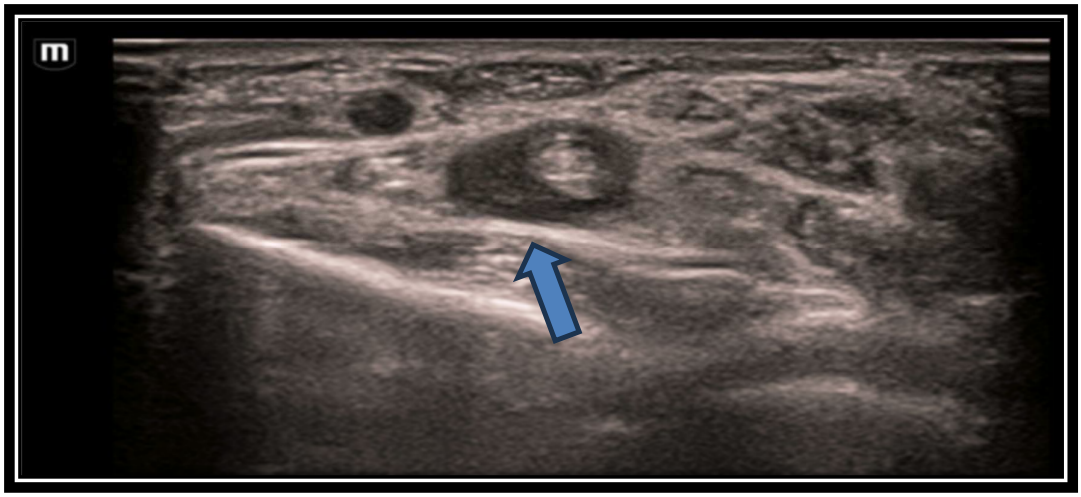
PHOTOGRAPHS OF CASES

CASE 1: A 52yr old female patient presented with acute history of pain in the wrist joint since 6months. Her Rheumatoid factor was positive. A clinical diagnosis of rheumatoid arthritis was made and patient was referred for USG. On USG of wrist joint (Flexor tendons) The Flexor Digitorum tendon appears normal (echogenic and homogenous) but the tendon sheath is distended with fluid and there is increased doppler signal suggestive of tenosynovitis.

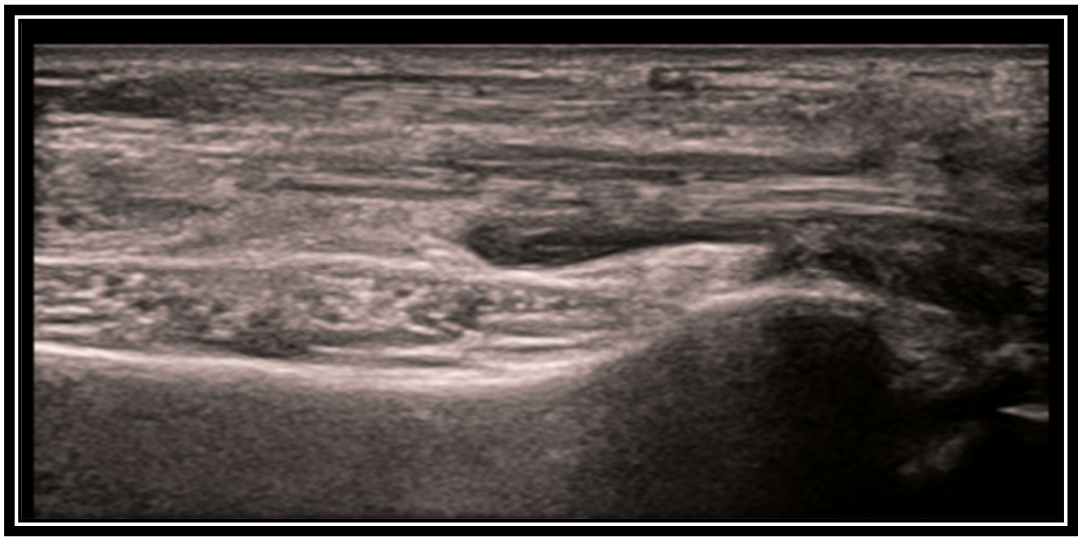


Tenosynovitis of Flexor digitorum tendon in the wrist joint

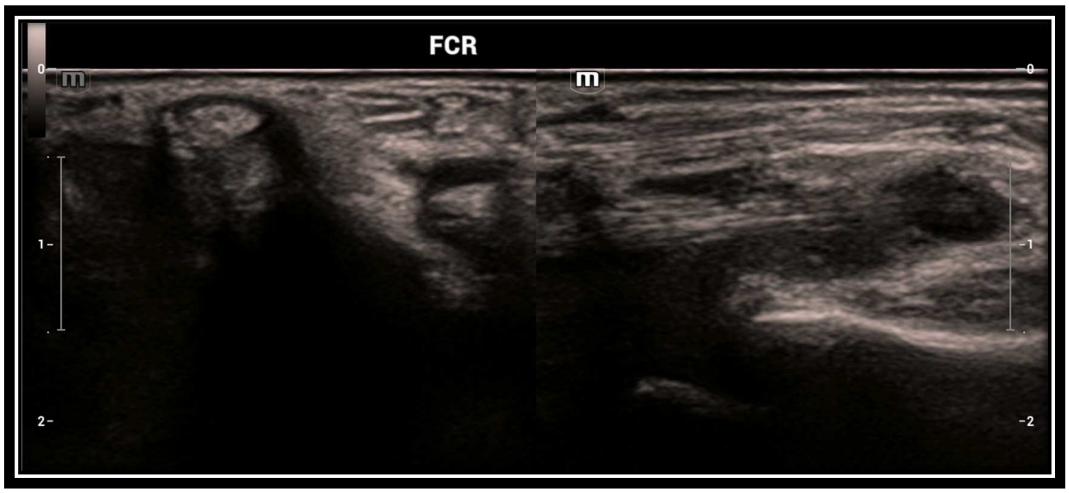
CASE 2: A 48yr old male patient came with complaints of pain in the wrist joint and early morning stiffness. His serology markers came positive. Clinically rheumatoid arthritis was suspected and patient was sent for Ultrasonography to rule out tenosynovitis**.**



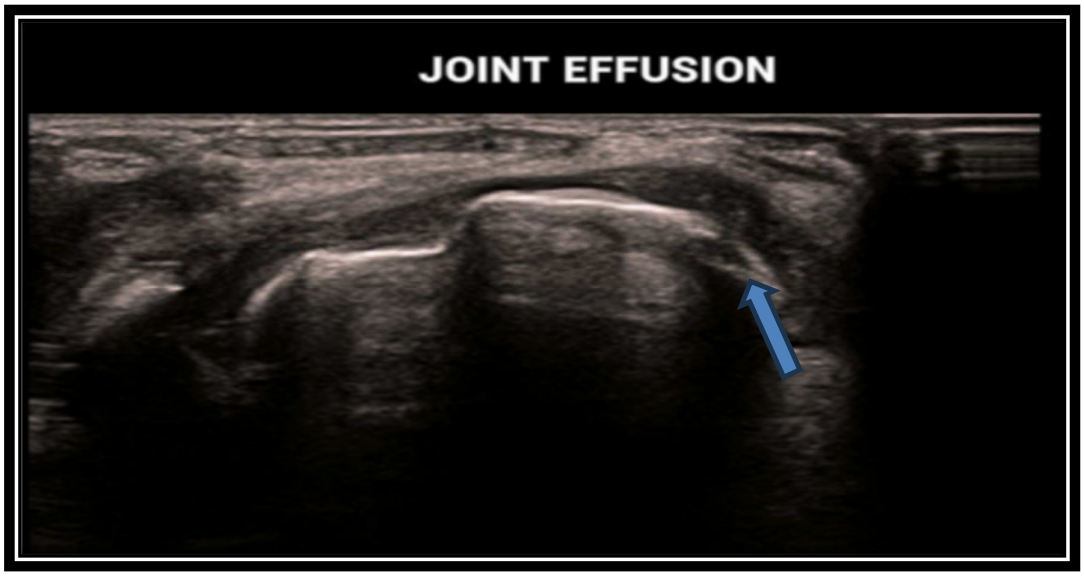
On USG:Transverse view showing focal area of fluid around flexor digitorum superficialis near attachment site.



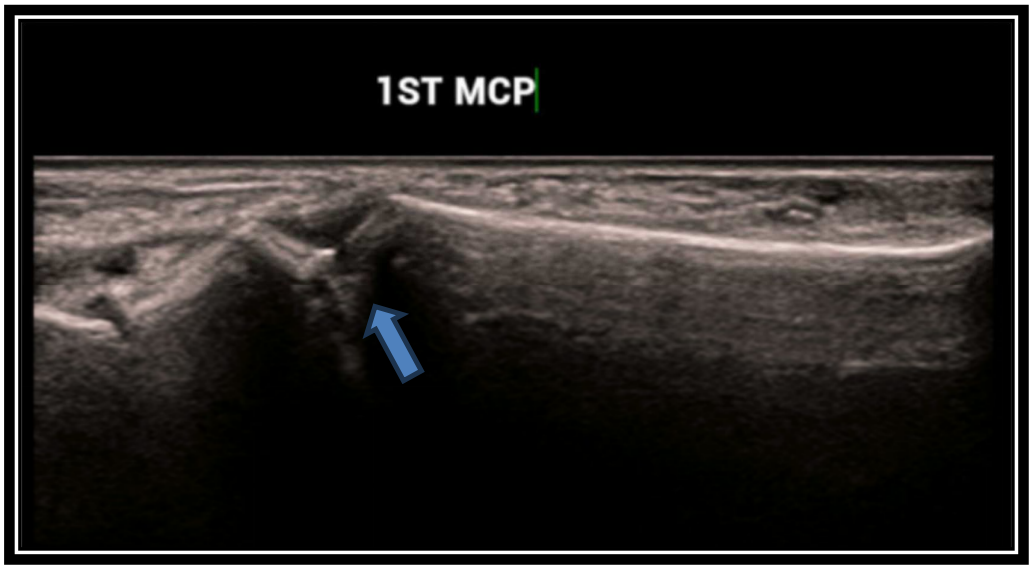
Longitudinal view showing fluid along tendon sheath with mild synovial thickening



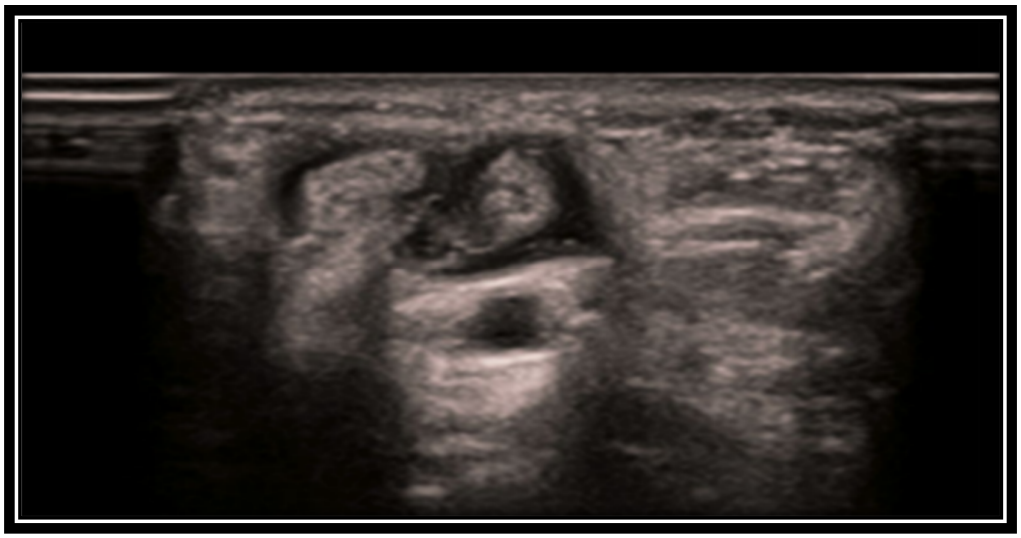
USG Right wrist - Transverse (A) and Longitudinal (B) view through the Flexor carpi radialis tendon shows increased fluid in the tendon sheath along with synovial thickening



Longitudinal view of wrist joint shows mild joint effusion



USG MCP JOINT: Longitudinal view of 1st MCP joint showing mild effusion



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Transverse view showing 1st compartment of extensor tendons (APL, EPB) The tendon appears normal (echogenic and homogenous) but the tendon sheath is distended with fluid and there is increased doppler signal suggestive of tenosynovitis.

ANNEXURE– IV – KEY TO MASTER CHART

MALE	**M**
FEMALE	**F**
PRESENT	**P**
ABSENT	**A**
RIGHT SIDE	**RT**
LEFT SIDE	**LT**

DM	Diabetes Mellitus
S	Smoking
A	Alcoholic
CKD	Chronic kidney disease
Probe Ten	Probe tenderness
Soft T sw	Soft tissue swelling
J effusion	Joint effusion
Tenos	Tenosynovitis
FDS	Flexor digitorum superficialis
PL	Palmaris longus
FCR	Flexor carpi radialis
FCU	Flexor carpi ulnaris
EDM/ECU	Extensor digiti mini/carpi ulnaris
ED/I	Extensor digitorum/indices
EPL	Extensor policis longus
ECRL/ECRB	Extensor carpi radialis longus/ brevis
MCP	Metacarpophalangeal joint

S.NO	NAME	AGE	GENDER	Symptomatology Pain (RT LT)	Swelling	Stiffness	Comorbidities		USG FINDINGS Probe Ten Soft T Sw (RT LT)	(RT LT)	J Effusion Synovitis (RT LT)	(RT LT)	Tenosyno Bursitis (RT LT)	(RT LT)
1	01N	63	F	Rt Lt	Rt	Rt	DM, SH		P P		P	P	P P	P
2	02P	21	F	Rt Lt			SH		p	P	P	P	P	P
3	03M	46	M	Rt			DM S		P	P	P	P P	P P	P
4	04M	58	M	Lt			SH S A		p	P	P		P P	
5	05S	33	F	Lt			DM CKD		p	P	P	P P	P P	P P
6	06S	48	F	Rt	Rt		DM		P P	P	P	P	P	P
7	07P	58	M	Lt			SH A		p	P	P	P P	P P	P
8	08R	50	F	Rt Lt			DM			P	P		P	P
9	09S	42	M	Rt Lt			DM SH		p P	P P	P	P	P P	P
10	10S	24	F	Rt		Rt	DM SH		p			P P	P P	P
11	11G	60	M	Rt Lt			DM S A		P	P	P		P	P
12	12K	59	F	Rt Lt			SH		p	P		P P	P P	P
13	13S	41	F	Rt Lt	Rt Lt		DM		p P	P		P	P	P
14	14B	59	M	Rt			DM SH		p	P	P P	P	P P	
15	15U	48	F	Rt Lt			DM		P			P	P P	
16	16K	40	F	Rt			SH		p	P	P	P	P P	P P
17	17M	27	M	Lt		Lt	DM S A		p			P	P	
18	18S	56	F	Rt Lt			SH		p P	P	P P	P P	P P	P
19	19G	55	M	Rt		Rt	DM SH					P	P P	
20	20I	49	M	Rt	Rt		SH		p	P	P	P	P	
21	21B	58	M	Rt Lt	Lt		DM S A		p P		P	P	P P	P P
22	22V	42	F	Rt			SH		p	P	P	P	P P	
23	23M	60	F	Lt			DM		p P			P	P	P
24	24R	39	F	Lt			DM SH		p P	P P	P P	P	P	P
25	25L	39	F	Rt			DM		p P			P	P P	
26	26G	38	M	Rt			SH S A			P	P	P P	P P	P
27	27P	55	M	Rt Lt	Rt		DM CKD		p P	P		P	P P	
28	28H	52	F	Rt			SH		p P	P	P	P	P P	
29	29S	36	F	Rt Lt			DM		P	P	P	P P	P P	
30	30N	50	F	Rt			SH		p	P		P	P	
31	31S	46	M	Rt Lt	Rt	Rt	DM A		p P			P P	P P	
32	32S	56	M	Rt Lt			SH A		p P			P	P P	
33	33S	46	F	Rt			DM		p P	P	P P	P P	P P	P
34	34V	51	M	Rt Lt			DM S A		p P			P	P P	
35	35S	29	F	Rt	Rt		SH		p P		P	P	P P	
36	36M	68	M	Rt Lt			DM A		p P	P		P	P P	P P

S.NO	Tenosynovitis in flexor tendons FDS (RT LT)	PL (RT LT)	FCR (RT LT)	FCU (RT LT)	Tenosynovitis in Flexor T in C/E FDS (RT LT)	PL (RT LT)	FCR (RT LT)	FCU (RT LT)	Tenosynovitis in extensor tendons EDM&CU (RT LT)	ED & I (RT LT)	EPL (RT LT)	ECRL&ECRB (RT LT)	APL/EPB (RT LT)
1	**P P**	P	P	P P	**P**	P		P P	P	P P	P	P	P
2	P	P	P P	P	P	P	P P		P			P	
3	**P**	P	P	P	**P**		P		P	P		P	
4	P	P	P	P	P	P	P	P	P P		P		P
5	P		P P	P	P		P P	P	P P	P		P	
6	P	P	P	P	P	P	P	P	P		P	P	
7	P		P	P	P			P	P P				
8	P	P	P	P	P	P	P	P	P	P		P P	
9	P P	P	P	P	P P	P	P	P	P	P			
10	P	P	P	P	P	P	P	P	P			P	
11	P		P		P		P		P		P		P
12	P P		P	P	P P		P		P P	P			
13		P	P P	P		P	P P	P	P			P	
14	P P		P		P P		P		P P	P		P	
15		P	P	P		P	P	P	P	P			
16	P	P	P P		P		P P				P	P	P
17		P	P	P		P	P	P	P	P			
18	P P		P		P P				P P			P	P
19		P	P	P		P	P	P	P	P	P	P	
20	P P		P P	P	P		P P	P	P P				P
21		P	P	P		P		P	P	P		P P	
22	P		P		P		P		P	P P	P		
23	P	P	P P	P	P		P P	P	P			P P	
24	P		P	P	P		P	P	P P				
25	P		P P	P	P		P P		P	P			
26	P	P	P		P	P	P		P P			P P	
27	P		P	P	P		P	P	P	P			P
28	P		P P	P	P		P P	P			P		
29		P	P	P		P	P	P	P				P
30	P	P	P		P	P	P		P P	P P		P	
31	P P		P P	P P	P P		P P	P P	P				
32	P		P		P		P		P P				P
33	P P		P P	P	P P		P P	P	P	P			P
34	P		P		P		P		P P				
35	P P		P	P	P P		P	P	P				P
36	P				P				P P			P	

S.NO	Tenosynovitis in extensor tendons EDM&CU (RT LT)	ED & I (RT LT)	EPL (RT LT)	ECRL&ECRB (RT LT)	APL/EPB (RT LT)	USG Findings in MCP JOINT MCP 1 (RT LT)	MCP 2 (RT LT)	MCP 3 (RT LT)	(Synovitis Present) MCP 4 (RT LT)	MCP 5 (RT LT)	C/E IN MCP JOINT MCP 1 (RT LT)	MCP 2 (RT LT)	MCP 3 (RT LT)	MCP 4 (RT LT)	MCP 5 (RT LT)
1	P P	P P			P	P	P		P	P	P	P		P	P
2	P			P		P P		P			P P		P		
3	P			P		P P	P	P		P	P P		P		
4	P P		P			P			P		P			P	
5	P P	P		P		P	P			P					P
6	P		P	P		P		P	P				P	P	
7	P P						P					P			
8	P			P P		P		P			P				
9	P	P				P P	P		P	P	P	P			
10				P											
11	P P		P		P	P	P	P	P			P	P		
12	P P	P				P				P	P				P
13	P					P	P	P			P	P	P		
14	P P	P		P			P		P	P					P
15	P	P				P		P					P		
16			P	P	P	P	P				P	P			
17						P		P	P	P	P			P	P
18	P P			P			P	P				P			
19	P	P	P	P		P P					P				
20	P				P		P			P					P
21	P	P		P P		P	P	P	P		P	P	P	P	
22	P	P P	P							P					
23	P			P P		P		P P	P		P		P P	P	
24	P P					P				P	P				P
25	P	P						P P	P				P	P	
26	P P			P P		P	P					P			
27	P	P			P			P		P					P
28			P						P						
29					P	P		P		P	P				
30	P P	P P					P	P		P			P		P
31	P								P					P	
32	P P				P		P	P		P		P	P		P
33	P	P			P		P	P				P			
34	P P						P		P	P		P		P	P
35	P				P			P					P		
36	P P			P		P	P	P		P	P	P	P		P