

High-Resolution Ultrasound in Wrist Tendon Pathologies with MRI Correlation

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Abstract:

Background: Wrist tendons may be affected by a variety of pathologic conditions, including those caused by trauma and overuse, inflammatory and metabolic disorders, or infection.

Improvements in high-resolution ultrasound are producing high-quality images of the superficial tendinous and peritendinous structures. The present study aimed to evaluate wrist tendon pathologies using high-resolution ultrasound and further correlate with MRI.

Materials and Methods: The study was conducted in the Department of Radiology, Rajendra Institute of Medical Sciences, Ranchi, Jharkhand, India from February 2019 to August 2020. For this study, 62 patients (36 men and 26 women) with symptoms indicative of tendon pathology were enrolled.

Results: The majority of patients (29%, n=18) were 30-39 years old. Male patients made up 54.8% of the total (n = 34), while female patients made up 45.2% (n = 28). The majority of the patients (33.9 %; n = 21) had tendon tears.

Conclusion: The majority of our patients complained of pain and movement restrictions. Tendon injuries in younger patients typically resulted from direct trauma. When diagnosing tendon pathology, sonography and MRI shown very high sensitivity and specificity. Clinical diagnosis and USG & MRI findings are significantly correlated (p<0.05). Both MRI and sonography are non-invasive, precise tools for diagnosing tendon damage, planning therapy, and evaluating the efficacy of treatment.

Keyword: High-resolution ultrasound, Wrist tendon pathologies, MRI.

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Introduction

The wrist is an articular complex composed of the radio-carpal, distal radio-ulnar, and midcarpal articulations. These are covered by a fibrous capsule and are held together by multiple ligaments, tendons, and other soft tissues that provide carpal stability along both the dorsal and volar aspects [1]. Wrist tendons may be affected by a variety of pathologic conditions, including those caused by trauma and overuse, inflammatory and metabolic disorders, or infection[2]. Pathologic conditions of the wrist tendons include de Quervain tenosynovitis, extensor carpi ulnaris tendinopathy, rheumatoid tenosynovitis, infectious synovitis, tendon tears, hydroxyapatite deposition disease, intersection syndrome, tenosynovial giant cell tumor, and fibroma of the tendon sheath [3].

Most of the patients with wrist tendon pathologies usually present with pain and movement restriction. Accurate and timely diagnosis of the wrist tendon pathologies is crucial for effective management and prevention of its associated complications and worsening of symptoms compromising daily activities. Improvements in high-resolution ultrasound are producing high-quality images of the superficial tendinous and peritendinous structures. Thus, ultrasound is a valuable first-choice tool for visualizing traumatic, inflammatory, and degenerative conditions of the extensor and flexor tendons, particularly with the advantage of possible dynamic examination. The additional use of duplex-Doppler and power Doppler ultrasound imaging is recommended for detection of tenosynovitis in overuse injury, inflammatory

disease, infection, and after traumatic conditions [4]. Magnetic resonance imaging (MRI) has high spatial and contrast resolution, and can characterise bone and soft tissue without using ionising radiation, making it an ideal imaging modality to assess pathologic conditions affecting joints [5].

Aims and Objectives: The present study aimed to evaluate wrist tendon pathologies using high-resolution ultrasound and further correlate with MRI.

Materials and Methods

This study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. Ethical approval was obtained from the Institutional Ethics Committee of Rajendra Institute of Medical Sciences, Ranchi. Informed consent was obtained from all participants before their inclusion in the study. Confidentiality and data protection measures were strictly adhered to throughout the research process.

Study Design and Participants

This hospital-based cross sectional observational study was conducted in the Department of Radiology, Rajendra Institute of Medical Sciences, Ranchi, Jharkhand, India from February 2019 to August 2020. For this study, 62 patients (36 men and 26 women) with symptoms indicative of tendon pathology were enrolled. The patients' ages ranged from 9 to 78 years.

Inclusion Criteria:

- Patients who have a clinical suspicion of wrist tendon pathology referred to the Department of Radiology from different departments of hospital
- Patients who had wrist tendons pathological diagnosis and were under monitoring
- Patients unintentionally discovered wrist tendon diseases on ultrasound while undergoing upper limb colour doppler

Exclusion Criteria:

- Patients who refuse to engage in study procedures
- Patients with wrist tendon disorders with contraindications of MRI
- Patient with claustrophobia
- Expectant mothers
- People who are allergic to contrast

After taking relevant history and performing a thorough clinical examination all patient underwent high resolution ultrasound and MRI study of both wrist joints.

High-resolution ultrasound examination

Ultrasound was performed by Philips ultra HD 11 XE ultrasound machine with a 8-12 MHz linear probe. USG images of the wrists were obtained with the patient seated on chair in front of the radiologist with hand resting on cushion. Imaging was carried out both in the longitudinal and transverse axes along the dorsal as well as volar aspects.

Sonographic findings of the wrist tendon pathologies in present study:

- De Quervain's disease- Thickening of abductor pollicis longus (APL) and extensor pollicis brevis (EPB) tendons with thickening and reduced echogenicity of common synovial sheath with or without some fluid collection.
- ECU tendinopathy- Thickening of extensor carpi ulnaris tendon with thickening and reduced echogenicity of its synovial sheath and some fluid collection.
- Rheumatoid tenosynovitis- Hypoechoic tendon sheath with some fluid collection. The tendons are increased in diameter and inhomogeneous with irregular margin. Colour flow Doppler imaging shows prominent hypervascularity of pannus.
- Infection tenosynovitis- increased anechoic oedema and debris in the flexor tendon sheath mainly with thickening of tendons.
- Calcific tendinitis- Varying degree of tendon calcification.
- Tendon tear- focal discontinuity of the tendon with intervening fluid.
- Tenosynovial giant cell tumour- hypoechoic solid mass with well-defined margins in the tendon sheath.

MRI examination

All patients underwent MRI examinations using Siemens Symphony Magnetom 1.5 T MRI equipment. The scans were performed from the proximal metacarpals to the distal radius/ulnar metaphysis. The planes chosen were the axial plane (parallel to the distal radio-carpal joint), coronal plane (parallel to a line drawn from the ulnar to the radial styloid), and sagittal plane (perpendicular to the coronal plane). The sequences included short tau inversion recovery sequence in the coronal plane (TR/TE = 4500/110 ms, section thickness of 3 mm, intersection gap of 0.6 mm, FOV/RFOV = 160/80% and matrix = 224 × 256), T1-weighted fast spin echo in the coronal plane (TR/TE = 450/20 ms, section thickness of 3 mm, intersection gap of 0.6 mm, FOV/RFOV = 160/80% and matrix = 256 × 256), proton density fat suppressed sequence in all the

three planes (TR/TE = 2200/90, section thickness of 3 mm, intersection gap of 0.6 mm, FOV/RFOV = 160/80% and matrix = 240 × 256).

MRI findings of the wrist tendon pathologies in present study:

- De Quervain's disease- Increase in size and irregular APL and EPB tendons within the first extensor compartment with heterogeneously hypointense tendons along with some hyperintense foci in T1W image. Fluid and oedema around APL and EPB tendons on T2 W fat saturated image.
- ECU tendinopathy- Thickening of extensor carpi ulnaris tendon with some hyperintensity in T1W image . On T2W fat saturated image tendon is thickened and hyperintense with peripheral fluid hyperintensity.
- Rheumatoid tenosynovitis- Synovial hypertrophy and soft tissue thickening with inflammatory signs as well as presence of tendon sheath fluid (hyperintense on T2W fat saturated image) suggestive of significant pannus and inflammation around wrist joint.
- Infection tenosynovitis- Fluid and debris distending the tendon sheath, with enlargement and heterogeneous signal intensity of the tendon on T2W fat-saturated image.

- Calcific tendinitis- Ill-defined low signal intensity lesion in the tendon with mild soft tissue oedema around the calcification (hyperintense on T2W fat saturated image).
- Tendon tear- focal discontinuity of the tendon with intervening fluid and oedema in the torn ends.
- Tenosynovial giant cell tumour- Slightly hyperintense lobulated mass in tendon sheath in T2-weighted fat-saturated image.

Statistical analysis

Data was entered into an MS Excel spreadsheet, and IBM Statistical Package for Social Sciences (SPSS) client 26.0 version was used for analysis.

Results

Present study revealed 29% (n=18) of the patients are in the 30-39 year age range. The oldest patient was 78 years old, and the youngest was 9 years old. Male patients made up 54.8% of the total (n = 34), while female patients made up 45.2% (n = 28). 33.9(n=21) of the patients had tendon tears as their primary diagnosis. Out of the total no, of 62 patient we had 36 male and 26 female males: female. Maximum no of patient has a tendon tears 21(34%), followed by infection tenosynovitis 9(14.5%) and rheumatoid tenosynovitis 9(14.5%).

Table 1: Age distribution of patient

Age (yrs.)	Frequency	Percentage(%)
<20yrs	6	9.7%
20-29yrs	13	21.0%
30-39yrs	18	29.0%
40-49yrs	10	16.12%
50-59yrs	11	17.74%
60-69yrs	3	4.83%
≥70yrs	1	1.61%
Total	62	100%

Table 2: Age-wise distribution of various pathologies

Pathology	<20 yrs.	20-29yrs	30-39yrs	40-49yrs	50-59yrs	60-69yrs	≥70 yrs.	Total	Mean Age	SD
De Quervain's disease	0	3	3	1	1	0	0	8	34.6	11.5
ECU tendinopathy	0	2	1	2	1	0	0	6	37.8	12
Rheumatoid tenosynovitis:	0	0	2	3	2	2	0	9	47	11
Infection tenosynovitis	2	2	3	1	1	0	0	9	30	13.7
Calcific tendinitis	0	0	1	0	2	1	1	5	56.4	16.4
Tendon tears	4	6	4	3	4	0	0	21	32.7	15.2
Tenosynovial giant cell tumour	0	0	4	0	0	0	0	4	33.7	1.7
Total	6	13	18	10	11	3	1	62		

Table 3: Sex distribution of various pathologies

Pathologies	Male	Female	Total
De Quervain's disease	1	7	8
ECU tendinopathy	3	3	6
Rheumatoid tenosynovitis:	7	2	9
Infection tenosynovitis	7	2	9
Calcific tendinitis	2	3	5
Tendon tears	12	9	21
Tenosynovial giant cell tumour	2	2	4
Total	34	28	62

Table 4: Distribution of various wrist tendon pathologies

Pathologies	Frequency	Percent
De Quervain's disease	8	12.9%
ECU tendinopathy	6	9.7%
Rheumatoid tenosynovitis:	9	14.5%
Infection tenosynovitis	9	14.5%
Calcific tendinitis	5	8.1%
Tendon tears	21	33.9%
Tenosynovial giant cell tumour	4	6.5%
Total	62	100.0%

Table 5: Comparison of USG diagnosis & Clinical diagnosis

Pathologies	USG diagnosis	Clinical diagnosis
De Quervain's disease	7	8
ECU tendinopathy	6	6
Rheumatoid tenosynovitis:	8	9
Infection tenosynovitis	9	9
Calcific tendinitis	5	5
Tendon tears	21	21
Tenosynovial giant cell tumour	4	4
Total	60	62

Table 6: Comparison of MRI diagnosis & Clinical diagnosis

Pathologies	MRI diagnosis	Clinical diagnosis
De Quervain's disease	6	8
ECU tendinopathy	6	6
Rheumatoid tenosynovitis:	9	9
Infection tenosynovitis	9	9
Calcific tendinitis	5	5
Tendon tears	21	21
Tenosynovial giant cell tumour	4	4
Total	60	62

Table 7: Comparison sensitivity and specificity of MRI and USG

Pathologies	USG sensitivity	USG specificity	MRI sensitivity	MRI specificity
De Quervain's disease	100%	50%	85%	66%
ECU tendinopathy	100%	100%	100%	100%
Rheumatoid tenosynovitis:	100%	50%	100%	100%
Infection tenosynovitis	100%	100%	100%	100%
Calcific tendinitis	100%	100%	100%	100%
Tendon tears	100%	100%	100%	100%
Tenosynovial giant cell tumour	100%	100%	100%	100%

Discussion

In the present study, the oldest patient was 78 years old, and the youngest was 9 years old. Maximum patients (n=31) ranged in age from 20 to 39. Table 1 displays the age incidence of several tendon

diseases. The majority of patients (29% of the total sample) were in the 39–39 year age group. The average patient age in our study was 37.7 years, with a standard deviation of 15.26. The mean patient age in the B.O. Ljung et al. research was 44 years, with a range of 28 to 55 years [6].

De Quervain's disease: In table No. 2, the mean age of de Quervain's disease patients is 34.6 years, with a standard deviation of 11.5 years. The mean age was 37 years, with a standard deviation of 7 years, in the study of Francesco Giovagnorio, MD et. al. about sonographic examination of de Quervain's illness [7]. Table No. 3 shows that there were 8 de Quervain's disease patients, 1 male and 7 female. 1:7 is the male to female ratio. The ratio of male to female was 1:6 in N. R. M. Kay's study on de Quervain's disease.[8]. There were a total of 8 patients in table number 4 out of a total of 62 patients, yielding a frequency of 12.9%. According to Maryam Ali et al. [11], frequency was 50% in patients who sent more than 50 SMS in a day [9].

In our study's Table No. 5, a total of 7 out of 8 cases had USG diagnoses that were accurate. Consequently, $p < 0.001$, Sensitivity: - 100%, Specificity: 50%, PPV: 87%, and NPV: 100% were obtained. Similar findings were made in Masahiro Nagaoka et al.'s study of an ultrasonographic evaluation of de Quervain's disease, which revealed that 84% of patients had a septum as the disease's primary aetiology [10]. Table No. 6 illustrates this. 6 out of 8 patients had diagnoses that were accurate in MRI study. Consequently, $p = 0.001$, Sensitivity: 85%, Specificity: 66%, PPV: 85%, and NPV: 66% were obtained. In the investigation by Glajchen et al. on MRI findings in de Quervain's tenosynovitis of the wrist and roles, only 3 out of 5 patients had a valid MRI diagnosis [11].

Extensor carpi ulnaris tendinopathy: As indicated in table no. 2, there were a total of 6 individuals who had the condition, with a mean age of 37.8 years and a standard deviation of 12 years. The mean patient age in a different study by G Inoue et al. about the causes of numerous extensor carpi ulnaris tendon dislocations was 37.7 years, with a range of 34 to 40 years [12]. The average patient age was 25.0 years, with a standard variation of 2.8 years, according to Ghazi M. Rayan's study on recurrent extensor carpi ulnaris dislocation in athletes. Similar to table no. 3, there were 6 patients with extensor carpi ulnaris tendinopathy, with a male to female ratio of 1:1 and 3 male and 3 female patients. One male and one female were present, making the male to female ratio in the case report by Ghazi M. Rayan et al. 1:1 [13]. In the study by B. Montalvan et al. on 28 professional tennis players with wrist pain, 17 of the participants were men and 11 were women; the ratio was 1:0.6 [14]. In our study, the frequency of ECU tendinopathy is 9.7%, as shown in table no. 4. The incidence of ECU tendinopathy was 28% in the study by B. Montalvan [14].

Regarding table number 5, in our study, USG properly identified all six cases out of six, yielding a p-value of 0.001, sensitivity of 100%, specificity of 100%, PPV of 100%, and NPV of 100%. Similar

to this, all of the cases in a study by MacLennan et al.[15] were diagnosed by USG.

Table No. 6 illustrates this. 6 out of 6 patients had diagnoses that were accurate in MRI. Consequently, $p < 0.001$, Sensitivity: - 100%, Specificity: 100%, PPV: 100%, and NPV: 100% were obtained. In the investigation by B. Montalvan, every patient with ECU tendinopathy had a proper diagnosis [14].

Rheumatoid tenosynovitis: As shown in table no. 2, there were 9 patients with rheumatoid tenosynovitis, with an average age of 47 years and an SD of 11 years. In the study of Abhilash Jain et al. on the management of rheumatoid arthritis patients with diagnosed cases. The age range is from 23 to 81 years, with 53 being the average [16]. As shown in table No. 3, there were nine patients diagnosed with rheumatoid tenosynovitis, of which 2 were men and 7 women, yielding a male to female ratio of 1:3.5. There were 80 patients in the study by Abhilash Jain et al. on the impact of steroids and methotrexate on wound complications following elective rheumatoid hand and wrist surgery, with a male to female ratio of 1:3 [16]. 18 patients in all, 5 men and 13 women, with a male to female ratio of 1:2.2, participated in the Bachir Taouli et al. study for rheumatoid arthritis of the hand and wrist: comparison of three imaging techniques [17]. Rheumatoid tenosynovitis occurs 3.5% of the time, as shown in table no.4 similar to the study conducted by Abhilash et. al., which revealed that the incidence was around 2% [16]. Regarding table number 5, in our investigation, USG successfully detected 8 out of 9 cases, yielding a p-value of 0.001 and the following metrics: sensitivity (100%) specificity (50%) PPV (88%) and NPV (100%). Similar to this, USG properly diagnosed each of the 20 patients in a study by Flaviis et al. [18]. As displayed on table number 6. Out of 9 patients, 9 cases were successfully diagnosed by MRI. P value = 0.001, Sensitivity = - 100%, Specificity = 100%, PPV = 100%, NPV = 100%. In the study by Taouli et. al., an MRI scan was used to accurately diagnose each patient [17].

Infection tenosynovitis: As shown in table no. 2, there were 9 patients with infection tenosynovitis, with a mean age of 30 years and a standard deviation of 13.7 years. The majority of patients in the study by Reinus et al. were middle-aged men with an average age of 42.2 and a standard deviation of 10.2, whereas women were less prevalent and more likely to present at an earlier age (34.3 with a standard deviation of 5.6). As shown in table no.2, there were a total of 9 patients diagnosed with infection tenosynovitis, with 7 of them being men and 2 being women, for a male to female ratio of 3.5:1. There were 19 patients in total in the study by William R. Reinus et al. about

Changing patterns of septic tenosynovitis of the distal extremities, and 15 of them were men and 4 were women, resulting in a male to female ratio of 3.6:1 [19]. An additional study by Chao-Yu Hsu et al. on MRI evaluation of wrist tuberculosis. A total of 8 patients with wrist tuberculosis participated in this study, of which 6 were men and 2 women, for a male to female ratio of 3:1 [20]. Tenosynovitis cases account for 10.5% of all cases, as shown in table no. 4. It is comparable to a research by Yamina Benkeddache et al., which estimated that 6.9% of cases of infectious tenosynovitis occur [21]. 9 cases of infection-related tenosynovitis were successfully diagnosed by USG, as shown in table no. 5. As a result, $p = 0.001$, Sensitivity = 100%, Specificity = 100%, PPV = 100%, and NPV = 100%. Similar to this, in a research on wrist tendon pathology by Gibbon et al., ultrasonography was used to diagnose every case [22]. Similar to table no. 6, MRI was able to identify nine cases of infection-related tenosynovitis. As a result, $p = 0.001$, Sensitivity = 100%, Specificity = 100%, PPV = 100%, and NPV = 100%. Similar to the wrist tuberculosis study by Chao-Yu Hsu et al., an MRI scan was able to accurately identify 9 cases with infection tenosynovitis [23].

Calcific tendinitis: In our study, the mean age of the five patients with calcific tendinitis was 56.4 years, with a standard deviation of 16.4 years. The calcific tendinopathy study by Nicholas M. Beckmann et al. on MRI revealed that the mean age was 51.6 years [24]. There were 5 patients diagnosed with calcific tendinosis overall, of which 2 were male and 3 were female. 1:1.5 in terms of male to female ratio. According to Table 4, calcific tendinosis occurred in 3% in our study. The incidence of calcific tendinosis was 2% or less in Ferdinando Draghi et al.'s study [25]. All 5 of the calcific tendinosis cases were appropriately diagnosed by USG, as shown in table no. 5. As a result, $p = 0.001$, Sensitivity = 100%, Specificity = 100%, PPV = 100%, and NPV = 100%. When compared to conventional radiographs, an identical study by Pekka et al. on the calcific tendinosis of the rotator cuff identified calcifications in the cuff. Ultrasonography demonstrated a sensitivity of 94% (87 of 93), a specificity of 99% (873 of 878), and an accuracy of 99% (960 of 971). Sonography had a 95% positive predictive value (87 of 92) and a 99% negative predictive value (873 of 879). All 5 cases of calcific tendinosis were successfully diagnosed by MRI, as shown in table no. 6. As a result, $p = 0.001$, Sensitivity = 100%, Specificity = 100%, PPV = 100%, and NPV = 100%. On the study of osseous involvement in calcific tendinitis, Flemming et al. also came to a similar conclusion with disease more common in females [26].

Tendon tears: As shown in table no. 2, the mean age of the 21 patients who had wrist tendon rips

was 32.7 years, with a standard deviation of 15.2 years. Age ranged from 62 to 74 years with a mean age of 68 years in the Maeseneer et al. research for sonography of a rupture of the tendon of the extensor pollicis longus muscle [27]. 12 (57%) of the 21 patients in our study were men, and 9 (43%) were women, as shown in table no. 3 of the results. The study by Taneja et al. on Extrinsic Wrist Ligaments: Prevalence of Injury by Magnetic Resonance Imaging and Association with Intrinsic Ligament Tears had similar findings, with 52% of men (39/75) and 48% of women (36/75) [28]. The frequency of tendon tears is 21/62 in our table number 4, or 33.5%. Wrist anatomy: Incidence, distribution, and association of anatomic abnormalities, rips, and arthrosis by Viegas SF et al. noted that the incidence of wrist tendon was around 36% [29]. The USG correctly identified 21 cases of tendon tears, just like in table no. 5. As a result, $p = 0.001$, Sensitivity = 100%, Specificity = 100%, PPV = 100%, and NPV = 100%. In a research on wrist tendon pathology by Singh et al., 4/5 (80%) of the cases were identified using ultrasonography [30]. Similar to table no. 6, MRI was able to identify 21 tendon tears with accuracy. As a result, $p = 0.001$, Sensitivity = 100%, Specificity = 100%, PPV = 100%, and NPV = 100%. Similar to this, a study on wrist tendon by Singh et al. found that all 5 tendon tear cases could be accurately diagnosed with an MRI scan [30].

Tenosynovial giant cell tumour: In table no.2, of the four patients with this tumour, the mean age is 33.7 years, with a standard deviation of 1.7 years. The patient's age in the case report by David R. Lucas, MD was 25, which indicates that these cases tend to affect younger people [31]. In Table 3, we discovered two male and two female patients who had tenosynovial giant cell tumours. 50% men and 50% women are the outcome. comparable research was conducted by R. C. Martin et al. with comparable findings [32]. Of the 35 participants, 18 were men and 17 were women. Tenosynovial giant cell tumours are present in our table No. 4 with a frequency of 4/62, or 6.5%. However, in their study Pigmented Villonodular Synovitis: Radiologic-Pathologic Correlation1, Murphy et al. reported that the incidence of Tenosynovial Giant Cell Tumour was approximately 9% [33]. In accordance with table no. 5, USG successfully diagnosed 4 cases of tenosynovial giant cell tumours. As a result, $p = 0.001$, Sensitivity = 100%, Specificity = 100%, PPV = 100%, and NPV = 100%. In a study on wrist tendon pathology conducted by Wang Y et al., 30 patients (100%) had their diagnoses made by ultrasonography [34]. As shown in table no. 6, MRI was able to accurately identify 4 cases of tenosynovial giant cell tumour. As a result, $p = 0.001$, Sensitivity = 100%, Specificity = 100%, PPV = 100%, and NPV = 100%.

Limitations

The study has some limitations that should be acknowledged. Firstly, it was conducted at a single center, which may limit the generalisability of the findings of other populations. Further multi-center studies with larger sample sizes are warranted to validate the results. Secondly, the study focussed on the wrist tendons only. Additional important components of wrist like ligaments and nerves could provide further insights into the pathophysiology involved in wrist pain, swelling and movement restriction.

Conclusion

The majority of our patients complained of pain and movement restrictions and were diagnosed as tendon tear. Most of them were in the 20 to 40 age range. Tendon injuries in younger patients typically resulted from direct trauma. For identifying tendon pathology, sonography demonstrated exceptionally high sensitivity and specificity. Sonography has a 94% sensitivity and an 83% specificity in identifying wrist tendon disease while MRI had 98.18% sensitivity and 85.1% specificity. Clinical diagnosis and USG & MRI findings are significantly correlated ($p < 0.05$). It can be inferred that sonography and MRI are both non-invasive, accurate tools for diagnosing tendon pathology, planning therapy, and evaluating the efficacy of treatment. However, ultrasound should be the first choice of investigation for wrist tendon pathologies as it is fast with widespread availability, less expensive and allow dynamic examination of the wrist.

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