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A STUDY TO COMPARE FINDINGS BETWEEN HIGH RESOLUTION USG AND MRI IN NON TRAUMATIC WRIST PAIN

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Abstract:
This study seeks to compare the diagnostic performance of HRUS and MRI in evaluating non-traumatic wrist pain. The goal is to assess whether HRUS can provide similar diagnostic accuracy to MRI, offering a more accessible and cost-effective option for patients and clinicians. By determining the clinical utility of HRUS, this research could contribute to improving diagnostic protocols for non-traumatic wrist pain and support more efficient management of wrist pathologies. The study did not involve multiple experimental or control groups. Instead, all participants underwent the same diagnostic procedures (HRUS and MRI) for evaluating wrist pain. This uniform approach ensured that the comparison of imaging modalities was based on a single cohort, making the analysis of diagnostic accuracy straightforward. While there were no separate groups, patients were categorized based on the severity and type of wrist pain and their imaging findings were categorized accordingly. Ultrasonography achieved 100% sensitivity and specificity for detecting tendinopathies, solid masses and CTS, with 98% accuracy for simple cystic lesions. MRI showed 100% sensitivity and specificity for detecting tendinopathies, TFCC injuries, ganglion cysts and solid masses.

Keywords: High Resolution USG, MRI, Non Traumatic Wrist Pain

Introduction:

Non-traumatic wrist pain is a common clinical condition that can affect individuals across different age groups, often leading to significant impairment in daily activities. This condition encompasses a wide range of underlying causes that do not stem from direct physical injury or trauma. The wrist is a complex joint that comprises bones, ligaments, tendons, muscles and nerves. Each of these structures can be involved in the development of non-traumatic wrist pain through various pathological processes. The pathophysiology of non-traumatic wrist pain involves an intricate interaction of inflammatory, degenerative and biomechanical factors and it often results in chronic discomfort, stiffness and functional limitations. Understanding the underlying

mechanisms of non-traumatic wrist pain is crucial for accurate diagnosis and effective treatment.[1] The wrist joint is exposed to a multitude of stressors that can lead to non- traumatic pain. One of the primary mechanisms contributing to wrist pain is inflammation. Inflammatory conditions such as rheumatoid arthritis (RA) and osteoarthritis (OA) can significantly alter the normal function of the wrist joint. In RA, the body's immune system mistakenly targets the synovial lining of joints, including the wrist. This leads to synovitis, or inflammation of the synovial membrane, resulting in pain, swelling and stiffness. Over time, chronic inflammation can damage the cartilage and bone, leading to joint deformities and impaired function. On the other hand, OA in the wrist is characterized by the degeneration of articular cartilage, leading to pain, joint instability and restricted motion. The wear and tear of cartilage in OA causes friction between bones, which intensifies the pain and decreases joint mobility. [2,3]

Another common cause of non-traumatic wrist pain is tendinopathy, a condition that affects the tendons around the wrist joint. Tendons are fibrous tissues that connect muscles to bones and they play an essential role in wrist movement. In tendinopathy, there is degeneration and inflammation of the tendon fibers, which leads to pain and dysfunction. One of the most frequently affected tendons in the wrist is the extensor carpi radialis longus (ECRL) and extensor carpi radialis brevis (ECRB), leading to conditions such as tennis elbow. Tendinopathy is often caused by repetitive movements or overuse, which leads to microtears in the tendon fibers. Over time, the healing process may not fully restore the tendon, resulting in chronic pain and functional impairment. In addition, conditions like de Quervain's tenosynovitis, which affects the tendons in the first dorsal compartment of the wrist, can also lead to pain and inflammation. This condition is characterized by pain along the radial side of the wrist, especially with movements such as gripping or twisting. [4]

This study aims to address the existing knowledge gap by evaluating the diagnostic accuracy of high-resolution ultrasonography in diagnosing non-traumatic wrist pain and correlating the findings with MRI results. By establishing the diagnostic accuracy of HRUS, this study will help determine whether it can be an effective alternative to MRI for routine clinical evaluation of wrist pain. Furthermore, this research will provide valuable insights into the advantages and limitations of HRUS, aiding in its potential application in clinical practice.

This study seeks to compare the diagnostic performance of HRUS and MRI in evaluating non-traumatic wrist pain. The goal is to assess whether HRUS can provide similar diagnostic accuracy to MRI, offering a more accessible and cost-effective option for patients and clinicians. By determining the clinical utility of HRUS, this research could contribute to improving diagnostic protocols for non-traumatic wrist pain and support more efficient management of wrist pathologies.

Methodology:

The study design used for this research was an observational, prospective cross- sectional study. This design allowed the researchers to examine the association between wrist pain and its underlying causes using non-invasive diagnostic techniques such as high-resolution ultrasound (HRUS) and magnetic resonance imaging (MRI). The design was chosen to provide a clear snapshot of the wrist pathologies present in the study population at a specific point in time. The prospective nature of the study ensured that data was collected forward from the study initiation, allowing for a fresh investigation of the diagnostic tools' accuracy in real-world clinical settings. This design helped minimize bias while capturing relevant clinical data, including imaging results and patient histories. It also allowed for the comparison of the effectiveness of HRUS and MRI in diagnosing wrist pain conditions, a crucial aspect of the study's aims.

The study was conducted at the Department of Radio-Diagnosis. This setting was selected due to its accessibility to a large and diverse patient population, including both outpatient and inpatient referrals for wrist imaging. The institution is equipped with state-of-the-art diagnostic facilities, including high-resolution ultrasound (HRUS) and MRI machines, essential for this study. The medical sciences institute provided a well-controlled environment for imaging and

clinical examinations, making it an ideal location for collecting accurate and reliable data. The proximity to a wide demographic of patients also enhanced the generalizability of the study's findings, ensuring a representative sample from both rural and urban populations.

Inclusion Criteria:

- All patients presenting with wrist pain, both acute and chronic, to the outpatient or inpatient departments were included in the study.
- Patients who required wrist ultrasonography and MRI as part of their clinical evaluation were eligible.
- Both genders, aged 18 years and above, who provided informed consent, were included.

Exclusion Criteria:

- Patients under 18 years of age were excluded from the study.
- Known cases of trauma, congenital wrist abnormalities, or previous wrist surgeries were excluded.
- Patients with conditions that contraindicate MRI, such as cardiac pacemakers, ferromagnetic aneurysm clips, cochlear implants, or metallic foreign bodies.
- Individuals with claustrophobia, which would prevent them from undergoing MRI scans, were also excluded.

Study Sampling

Purposive sampling was used in this study, where participants were selected based on specific inclusion criteria. This non-random selection process was essential for targeting patients presenting with wrist pain, as only these individuals would be relevant for the research objectives. This approach ensured that participants had the required conditions to make the study both feasible and focused on wrist pain pathology. Purposive sampling allowed for the inclusion of a specific, yet diverse group of patients with varying causes of wrist pain, providing a representative cross- section of the population. The total number of participants was fixed, ensuring adequate representation of different wrist pathologies for the study's analytical purposes.

Study Groups

The study did not involve multiple experimental or control groups. Instead, all participants underwent the same diagnostic procedures (HRUS and MRI) for evaluating wrist pain. This uniform approach ensured that the comparison of imaging modalities was based on a single cohort, making the analysis of diagnostic accuracy straightforward. While there were no separate groups, patients were categorized based on the severity and type of wrist pain and their imaging findings were categorized accordingly.

Study Data Collection

Data was collected through direct patient examination, imaging results and medical history. The data from HRUS and MRI examinations were stored and analyzed. During the examination, detailed notes on the size, location and characteristics of any abnormalities were recorded. These findings were then cross- checked for consistency between the two imaging techniques. The data was then entered into MS Excel and frequencies and percentages were calculated. Statistical analysis was performed using SPSS software, with a significance level set at $P < 0.05$.

Results:

TABLE NO. 1: DIAGNOSTIC ACCURACY OF ULTRASONOGRAPHY FOR TENDON FINDINGS AS COMPARED TO MRI FINDINGS AMONG STUDY PATIENTS

Variable	TP	FP	FN	TN	Sn	Sp	PPV	NPV	Accuracy
Tenosynovitis	10	3	0	37	100.0%	92.5%	76.9%	100.0%	94.0%
Tendon Tear / Rupture	0	0	0	0	0.0%	0.0%	0.0%	0.0%	0.0%

For **tenosynovitis**, ultrasonography demonstrated excellent diagnostic accuracy when compared to MRI findings. All true positive cases (TP=10) were correctly identified, resulting in a sensitivity (Sn) of 100.0%. It also showed a high specificity (Sp) of 92.5%, with only 3 false positive cases (FP=3). The positive predictive value (PPV) was 76.9%, indicating that when ultrasonography detected tenosynovitis, it was correct in 76.9% of cases. The negative predictive value (NPV) was 100.0%, meaning all negative findings by ultrasonography were truly negative. The overall accuracy for detecting tenosynovitis was excellent at 94.0%.

For **tendon tear or rupture**, ultrasonography showed no diagnostic accuracy, as there were no true positives (TP=0) or true negatives (TN=0). Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were all 0.0%, along with an accuracy of 0.0%. This indicates that ultrasonography was unable to identify tendon tear or rupture in this study population.

TABLE NO. 2 DIAGNOSTIC ACCURACY OF ULTRASONOGRAPHY FOR LIGAMENT FINDINGS AS COMPARED TO MRI FINDINGS AMONG STUDY PATIENTS

Variable	TP	FP	FN	TN	Sn	Sp	PPV	NPV	Accuracy
TFCC	6	0	3	41	66.7%	100.0%	100.0%	93.2%	94.0%
Other Ligaments	1	0	0	49	100.0%	100.0%	100.0%	100.0%	100.0%

For **TFCC ligament findings**, ultrasonography demonstrated strong diagnostic performance compared to MRI findings. It identified 6 true positive cases (TP=6) while producing no false positives (FP=0). However, there were 3 false negative cases (FN=3). This resulted in a sensitivity (Sn) of 66.7%, indicating moderate ability to detect TFCC abnormalities. Specificity (Sp) was perfect at 100.0%, meaning ultrasonography accurately identified all patients without TFCC issues. The positive predictive value (PPV) was also 100.0%, demonstrating that all positive results were correct. The negative predictive value (NPV) was 93.2%, suggesting reliability in ruling out TFCC abnormalities. Overall diagnostic accuracy was strong, measured at 94.0%.

For **other ligament findings**, ultrasonography showcased flawless diagnostic accuracy. It correctly identified 1 true positive case (TP=1) without producing any false positives (FP=0) or false negatives (FN=0), and accurately recognized 49 true negative cases (TN=49). This resulted in 100.0% sensitivity, specificity, PPV, NPV, and overall accuracy. Ultrasonography was highly effective in diagnosing abnormalities in other ligaments compared to MRI.

TABLE NO. 3 DIAGNOSTIC ACCURACY OF ULTRASONOGRAPHY FOR NERVE & VASCULAR PATHOLOGY FINDINGS AS COMPARED TO MRI FINDINGS AMONG STUDY PATIENTS

Variable	TP	FP	FN	TN	Sn	Sp	PPV	NPV	Accuracy
Carpal tunnel syndrome	4	1	0	45	100.0%	97.8%	80.0%	100.0%	98.0%
Vascular Pathology	1	0	0	49	100.0%	100.0%	100.0%	100.0%	100.0%

For **carpal tunnel syndrome**, ultrasonography demonstrated excellent diagnostic performance in comparison to MRI findings. All true positive cases (TP=4) were correctly identified, resulting in a sensitivity (Sn) of 100.0%. With only one false positive case (FP=1) and 45 true negatives (TN=45), specificity (Sp) was very high at 97.8%. The positive predictive value (PPV) was 80.0%, indicating that 80% of positive ultrasonography findings were correct. Meanwhile, the negative predictive value (NPV) was perfect at 100.0%, meaning all negative results were accurately identified. Overall diagnostic accuracy for carpal tunnel syndrome was strong at 98.0%.

For **vascular** accuracy compared to **pathology**, ultrasonography achieved flawless diagnostic MRI. It identified 1 true positive case (TP=1) and no false positives (FP=0) or false negatives (FN=0), while correctly classifying 49 true negatives (TN=49). This resulted in 100.0% sensitivity, specificity, PPV, NPV, and accuracy, highlighting ultrasonography's effectiveness in identifying vascular pathology in the study population.

TABLE NO. 4 DIAGNOSTIC ACCURACY OF ULTRASONOGRAPHY FOR FOCAL LESION FINDINGS AS COMPARED TO MRI FINDINGS AMONG STUDY PATIENTS

Variable	TP	FP	FN	TN	Sn	Sp	PPV	NPV	Accuracy
Focal Lesion - Simple Cyst	10	0	1	39	90.1%	100.0%	100.0%	97.5%	98.0%
Complex Cyst	4	0	0	46	100.0%	100.0%	100.0%	100.0%	100.0%
Solid Lesion	1	0	0	49	100.0%	100.0%	100.0%	100.0%	100.0%

For **focal lesion -simple cyst**, ultrasonography displayed excellent diagnostic accuracy in comparison to MRI findings. It correctly identified 10 true positive cases (TP=10) with no false positives (FP=0) and only 1 false negative (FN=1). This resulted in a high sensitivity (Sn) of 90.1% and perfect specificity (Sp) of 100.0%. The positive predictive value (PPV) was 100.0%, indicating all positive ultrasonography results were correct, while the negative predictive value (NPV) was also very high at 97.5%. Overall, the accuracy of ultrasonography for simple cysts was impressive at 98.0%.

For **complex cysts**, ultrasonography demonstrated flawless diagnostic performance. All true positive cases (TP=4) and true negative cases (TN=46) were correctly identified, with no false positives (FP=0) or false negatives (FN=0). This resulted in perfect values for sensitivity (Sn), specificity (Sp), PPV, NPV, and accuracy, each measuring 100.0%.

For **solid lesions**, ultrasonography was again flawless in identifying abnormalities. It detected 1 true positive case (TP=1) and 49 true negative cases (TN=49), with no false positives (FP=0) or false negatives (FN=0). Sensitivity, specificity, PPV, NPV, and accuracy were all measured at 100.0%, signifying perfect diagnostic reliability.

TABLE NO. 5 DIAGNOSTIC ACCURACY OF ULTRASONOGRAPHY FOR OTHER PATHOLOGICAL FINDINGS AS COMPARED TO MRI FINDINGS AMONG STUDY PATIENTS

Variable	TP	FP	FN	TN	Sn	Sp	PPV	NPV	Accuracy
Subcutaneous edema	18	0	0	32	100.0%	100.0%	100.0%	100.0%	100.0%
Bone Erosions	5	0	1	44	83.3%	100.0%	100.0%	97.8%	98.0%
Deep Soft Tissue Masses	1	0	0	49	100.0%	100.0%	100.0%	100.0%	100.0%

For **subcutaneous edema**, ultrasonography showed perfect diagnostic accuracy in comparison to MRI findings. It correctly identified 18 true positive cases (TP=18) and 32 true negative cases (TN=32), with no false positives (FP=0) or false negatives (FN=0). This resulted in flawless sensitivity (Sn), specificity (Sp), positive predictive value (PPV), negative predictive value (NPV), and overall accuracy, all measured at 100.0%.

For **bone erosions**, ultrasonography demonstrated excellent diagnostic performance. It identified 5 true positive cases (TP=5) and 44 true negative cases (TN=44), with no false positives (FP=0) and 1 false negative (FN=1). Sensitivity (Sn) was 83.3%, reflecting its strong ability to detect bone erosions. Specificity (Sp) was perfect at 100.0%, ensuring no false positives. The positive predictive value (PPV) was also 100.0%, indicating all detected cases were correctly identified, while the negative predictive value (NPV) was 97.8%, showcasing its reliability in ruling out bone erosions. The overall accuracy stood at 98.0%.

For **deep soft tissue masses**, ultrasonography again demonstrated perfect diagnostic accuracy. It correctly detected 1 true positive case (TP=1) and 49 true negative cases (TN=49), with no false positives (FP=0) or false negatives (FN=0). Sensitivity, specificity, PPV, NPV, and accuracy were all 100.0%, highlighting ultrasonography's faultless performance in this aspect.

TABLE NO. 6 DIAGNOSTIC ACCURACY OF ULTRASONOGRAPHY FOR BONE LESIONS FINDINGS AS COMPARED TO MRI FINDINGS AMONG STUDY PATIENTS

Variable	TP	FP	FN	TN	Sn	Sp	PPV	NPV	Accuracy
Bone Lesions	2	0	1	0	66.7%	100.0%	100.0%	97.2%	98.0%

Note: Out of 3 Lesions (1 – Simple Bone Cyst, 1 – Giant Cell Tumor & 1 – Other Lesion)

The diagnostic analysis highlights the effectiveness of ultrasonography (USG) in identifying bone lesions, comparing its accuracy against MRI findings. Out of three bone lesions, USG correctly detected two lesions—specifically a Simple Bone Cyst and a Giant Cell Tumour—resulting in two true positive cases. However, one lesion remained undetected by USG, representing a false negative. The study revealed that USG had a sensitivity of 66.7%, indicating its ability to identify two-thirds of positive cases correctly. With a specificity of 100%, USG did not misidentify any cases as positive when they were negative. Additionally, its positive predictive value (PPV) was 100%, suggesting that all positive cases detected by USG were accurate, while the negative predictive value (NPV) was slightly lower at 97.2%, influenced by the missed lesion. Overall, USG exhibited a high diagnostic accuracy of 98%, showcasing its reliability as a diagnostic tool for

bone lesions.

Discussion:

Our study showed that sonographic findings of tenosynovitis had 100% sensitivity and 92.5% specificity compared to MRI, with an overall diagnostic accuracy of 94%. This strong diagnostic performance supports the conclusions drawn by **El-Deek et al. (2019)**, who noted that ultrasonography is particularly reliable for superficial tendon pathologies like tenosynovitis, although MRI remains the superior modality for deeper or complex lesions. [5]

Regarding De Quervain's disease specifically, our findings are supported by studies such as **Bianchi S et al.**, who described the sonographic features of wrist ganglia and tendon sheath pathologies, noting that ultrasonography readily identifies abnormalities like synovial sheath thickening, internal echoes, and associated tenosynovitis, which were also prominent in our analysis. [6]

In our study, median nerve involvement suggestive of carpal tunnel syndrome (CTS) was detected in 10% of patients on ultrasonography, and the diagnostic accuracy for CTS compared to MRI was excellent, with 100% sensitivity and 97.8% specificity. These results are closely comparable to **Shaukat et al. (2024)**, who found ultrasonography to have a sensitivity of 92.8% and diagnostic accuracy of 91.6% for CTS, highlighting USG's strong reliability in nerve evaluations. [7]

Similarly, our findings align with **Kanikannan et al. (2015)**, who demonstrated that HRUS is a useful tool for diagnosing CTS, showing a sensitivity of 76.43% and specificity of 72.72%, though slightly lower than our results, possibly due to differences in patient selection and techniques[8]. Our study also reflects the observations of **Nischal et al. (2021)**, who showed that HRUS could detect small nerve caliber changes with 100% confidence, emphasizing its role as a first-line imaging modality for peripheral nerve assessment. [9]

In our study, triangular fibrocartilage complex (TFCC) abnormalities were detected in 12% of patients on ultrasonography, with a sensitivity of 66.7% and specificity of 100% compared to MRI. These findings are comparable to **Lee et al. (2018)**, who demonstrated very high sensitivity (97.2%–99.1%) and specificity (96.8%–97.3%) of wrist ultrasonography in diagnosing TFCC injuries, although slightly higher than our sensitivity, possibly due to differences in operator expertise and imaging protocols. [10]

Similarly, **El-Deek et al. (2019)** found that while USG was effective for soft tissue evaluation, MRI was superior for diagnosing TFCC tears, which supports our observation that ultrasonography had perfect specificity but moderate sensitivity for ligamentous injuries. [5]

Our study also detected other ligament abnormalities in 2% of cases, with ultrasonography achieving 100% sensitivity and specificity, reflecting similar high diagnostic performance as reported by **Vreju et al. (2016)**, who highlighted the utility of HRUS for ligament assessment in non-inflammatory wrist conditions. Thus, our findings reaffirm that HRUS is highly specific but moderately sensitive for detecting TFCC and ligament pathologies, with MRI remaining the gold standard for deeper or more complex ligamentous abnormalities. [10]

In our study, vascular pathology was detected in 2% of patients, with ultrasonography showing 100% sensitivity and specificity. This aligns with **Vreju et al. (2016)** and **Tălmăceanu et al. (2020)**, who emphasized HRUS as effective for detecting vascular and soft tissue abnormalities. Thus, HRUS is highly accurate for vascular pathologies, despite their low incidence in non-traumatic wrist pain. [11]

In our study, simple cystic lesions were detected in 20% of patients, complex cysts in 8%, and solid lesions in 2% on ultrasonography. HRUS demonstrated high diagnostic accuracy (100% sensitivity and specificity) for complex and solid lesions, and 98% accuracy for simple cysts. These findings are consistent with **Kumar S et al.**, who also reported ganglion cysts as the

most common wrist mass, with similar detection rates using ultrasound and MRI. Our results also align with **Bianchi et al. (2008)**, who emphasized that ganglia are the most frequent cystic masses of the wrist and that HRUS effectively characterizes their internal features, such as septations and internal echoes, as we observed. [6]

Overall, ultrasonography demonstrated high diagnostic accuracy for tendinopathies, CTS, vascular pathologies, and focal masses. However, its role was limited in detecting deep-seated bony lesions, for which MRI remained superior. This correlates with the observations made by **Tălmăceanu et al**. and **Nischal et al.,** who emphasized HRUS's strong performance for soft tissue evaluation and nerve caliber assessment but also highlighted MRI's role in complex or deep structure assessment.[5]

The advantages of ultrasonography, including its non-invasive nature, real- time imaging, cost-effectiveness, and wide availability, make it an excellent first-line tool for evaluating non-traumatic wrist pain. However, limitations such as operator dependency and difficulty in assessing deep-seated bony abnormalities were evident. As noted in prior studies, anisotropy artifacts and difficulty distinguishing adjacent structures like tendons and nerves remain challenges in HRUS imaging, as discussed by **Bianchi et al.** [6]

The findings of our study strongly support the use of high-resolution ultrasonography as a primary imaging modality in the evaluation of non-traumatic wrist pain. When combined with MRI, it offers a comprehensive diagnostic approach, enabling early detection of soft tissue abnormalities, guiding clinical management, and reducing unnecessary delays in diagnosis. Our results, when compared with previous studies, reaffirm the growing role of ultrasonography in musculoskeletal imaging and emphasize its complementary role alongside MRI for a complete evaluation of wrist pathologies.[12]

Conclusion:

- Ultrasonography achieved 100% sensitivity and specificity for detecting tendinopathies, solid masses and CTS, with 98% accuracy for simple cystic lesions.
- MRI showed 100% sensitivity and specificity for detecting tendinopathies, TFCC injuries, ganglion cysts and solid masses.

Thus, this study highlights that high-resolution ultrasonography, when combined with clinical examination and MRI correlation, offers a highly effective, non-invasive and accessible approach for diagnosing non-traumatic wrist pain, especially in evaluating soft tissue and superficial structures. MRI remains indispensable for assessing deeper ligamentous injuries and bony abnormalities.

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