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TO CORRELATE THE USG AND MRI FINDINGS IN NON-OSSEOUS PATHOLOGIES OF THE HAND AND WRIST AND OPINE REGARDING THE SENSITIVITY AND SPECIFICITY OF ULTRASONOGRAPHY AND MAGNETIC RESONANCE IMAGING FOR A PARTICULAR PATHOLOGY

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Abstract

Background: Wrist pain is a challenge, and imaging plays an important role in the evaluation of wrist pain. The aim is to correlate the USG and MRI findings in non-osseous pathologies of the hand and wrist and opine regarding the sensitivity and specificity of ultrasonography and magnetic resonance imaging for a particular pathology. **Materials and Methods:** Prospective study of 50 patients was done in the department of orthopedic. Patients with hand and wrist pain, swelling or restricted joint mobility and the patient should have any non-osseous lesion that was confirmed on ultrasonography/magnetic resonance imaging was included into his study. Patients who were referred for hand/wrist USG and MRI without history of trauma were evaluated for non-osseous lesions and those who met with the inclusion criteria were included. **Result:** The sensitivity and specificity analysis of diagnostic tests revealed that 88% and 100% sensitivity and specificity in USG was observed for tendinopathy and CTS respectively. MRI showed 100% sensitivity and specificity for tendinopathy, TFCC & ligament injury, ganglion cyst, vascular and solid masses. The results of sensitivity and specificity analysis of diagnostic tools viz. **Conclusion:** According to the results of our investigation, ultrasound and MRI correlation is an effective imaging technique for locating non-osseous disorders that cause hand and wrist pain. It can diagnose these illnesses in a sizable number of patients and has a high sensitivity and specificity for doing so.

INTRODUCTION

Diagnostic imaging of the wrist and hand is often challenging because they are made up of so many structures with intricate morphologies and complex anatomical variations.[1] The radio-carpal, distal radio-ulnar, and mid carpal articulations make up the wrist's articular complex. These are kept together by numerous ligaments, tendons, and other soft tissues that give carpal stability along both the dorsal and volar aspects, and they are covered by a fibrous capsule.[2] One of the most frequent problems seen in orthopaedics, wrist and hand pain is conventionally categorised as either acute pain brought on by a specific injury or subacute/chronic pain that typically develops gradually with or without a preceding traumatic event.[3] Pain is the main complaint for over one third of the patients at PHC. In central India, the majority of them experienced chronic pain.[4] Subacute or chronic pain might be brought on by overuse, have neurological or gastrointestinal origins, or be a complication of a previous injury. Patients who have sustained these wounds may have a history of repetitive wrist motion, whether for work or play. The inclusion of sensory abnormalities, such as tingling or numbness, suggests that the nerves are involved. To define the structures implicated, radiologic techniques like X-rays, ultrasound scans (US), computerised tomography scans (CT), and magnetic resonance imaging (MRI) are frequently utilised. When the diagnosis is still unclear following a history and physical examination, further imaging, such as conventional radiography, bone scans, ultrasonography (USG), computed tomography (CT), or magnetic resonance imaging (MRI), may be helpful.[5] To understand subtle damage patterns and articular diseases, one must be conversant with the pertinent anatomy, developmental changes, and biomechanics of this complex joint. In some instances, radiographic imaging will indicate that a CT, MR, or sonographic imaging evaluation is required.

High-resolution MRI can be used to improve the diagnosis and evaluation of a variety of wrist problems since it can distinguish between soft tissue structures like marrow, ligaments, tendons, cartilage, muscles, nerves, and blood vessels. Avascular necrosis, tendinopathy, nerve entrapment syndromes, synovial abnormalities, and soft tissue masses can all be evaluated using MRI, along with carpal instability, disorders of the triangular fibrocartilage (TFC), ulnar impaction syndrome, distal radioulnar joint (DRUJ) instability, and fracture.[6] It's hard to get an MRI for wrist pain. For thorough decision-making in wrist surgery, accurate assessment of the TFC, hyaline cartilage, ligaments, and tendons has become essential. For the examination of the TFC, MR arthrography with gadolinium-containing contrast material injection into the DRUJ is advised.[7] The wrist may be the body's most complex joint as well as the most crucial one for modern humans living in the computer and internet age. Since so many bones, ligaments, and tendons must cooperate, it makes sense from an evolutionary perspective that tension will lead to conflict. The initial symptom is frequently pain. Therefore, it is not surprising that the aching wrist provides a diagnostic problem to the doctor. Ultrasonography (USG) is an imaging modality that uses sound waves in the higher frequency range which normally cannot be heard by human beings. Audible sounds are in the range of 30 Hertz (Hz) - 20 KHz (Kilo Hertz) frequency range. Ultrasound travels as a longitudinal wave, and images are generated when pulses of ultrasound from the transducer produce echoes at tissue or organ boundaries.[4].Diagnostic ultrasound applications use frequencies in the 1 MHz (Mega Hertz) – 30 (Mega Hertz) frequency range. Clinical musculoskeletal (MSK) ultrasound needs as high frequency as practical that can still allow adequate visualisation depth into tissues. Higher frequencies are associated with improved spatial detail or better resolution.[8] Sonography is an excellent modality for investigating many structures of the hand and wrist. It is best used when the problem is well localized and when the clinical question is relatively specific. Patients with diffuse hand and wrist symptoms and poorly defined clinical questions are generally best evaluated with magnetic resonance imaging.[9]

MATERIALS AND METHODS

Prospective study of 50 patients was done in the department of orthopedic at Kempegowda Institute of Medical Sciences and research center, Bengaluru from December 2020 to February 2023.

Inclusion Criteria

- Patients with hand and wrist pain, swelling or restricted joint mobility.
- The patient should have any non-osseous lesion that will be confirmed on ultrasonography/magnetic resonance imaging.

Exclusion Criteria

- The situations where magnetic resonance imaging is contraindicated.
- In patients who are intolerant to contrast injection wherever it is indicated.

Methodology

Patients who were referred for hand/wrist USG and MRI without history of trauma were evaluated for non-osseous lesions and those who met with the inclusion criteria were included. Detailed clinical history was taken and then written informed consent was obtained from all patients.

Ultrasonographic examinations were performed using 4–10-MHz superficial linear array transducer of Voluson730, GE Medical Systems, and Germany. During examination of wrist joints, the patients were examined while sitting upright, with the hand placed on a cushion and fully pronated then supinated. According to the clinical presentation of the patient, USG images were obtained in different positions of the wrist (flexion and extension, pronation and supination), with the patient seated in front of the examiner. The examination of dorsal aspect was done by placing the transducer on a transverse plane over the dorsal aspect of the wrist to identify the extensor tendons. The examination of the first compartment was started by positioning the patient’s wrist halfway between pronation and supination; the probe is placed over the lateral aspect of the radial styloid and the first compartment of the extensor tendons—abductor pollicis longus (ventral) and extensor pollicis brevis (dorsal) was examined. With the palmar aspect of the wrist facing the examination table, the probe was shifted medially on transverse planes to visualize the second compartment—extensor carpi radialis longus and extensor carpi radialis brevis tendons. The third compartment was examined by finding the Lister tubercle over the dorsal radius as a bony landmark and the extensor pollicis longus tendon was looked at. For the examination of the fourth and fifth compartments, the transducer was placed on the transverse plane over the mid dorsal wrist to examine the fourth compartment (extensor digitorum communis and extensor indicis proprius) and fifth compartment (extensor digiti minimi

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tendon). For the examination of the sixth compartment, namely the extensor carpi ulnaris tendon, the wrist was placed in slight radial deviation. Axial and longitudinal plane images were obtained over this tendon. For the examination of the ventral aspect of the wrist, namely the proximal carpal tunnel, the patient’s dorsal wrist was kept facing the examination table and the bony landmarks of the proximal carpal tunnel—the scaphoid tubercle (radial sided) and the pisiform (ulnar sided) — placing the probe over the palmar crease on axial plane, were looked at along with: flexor retinaculum and nine long flexor tendons. For the examination of the distal carpal tunnel, we moved the probe to a more distal transverse plane to identify the two bony landmarks of the distal carpal tunnel—the trapezium tubercle (radial sided) and the hamate hook (ulnar sided). The patient's hand was positioned in supinated position for the assessment of the palmar spaces and in prone position for the examination of the anatomical snuff box. In order to study the lateral, medial, and central areas, the transducer was moved axially from proximal to distal. The transducer was pushed distally from the carpal tunnel to the level of the metacarpal region in order to examine the flexor digitorum profundus and superficialis of the hand's palm. The transducer was moved to the fingers for the study of the flexor digitorum superficialis and flexor digitorum profundus tendons of the fingers. Axial and longitudinal plane pictures were collected over this tendon. Axial and longitudinal plane images were obtained over this tendon. For the examination of the extensor tendons of the hand and fingers, namely the extensor digitorum, the transducer was moved to the dorsal aspect of the hand and fingers where axial and longitudinal plane images were obtained over this tendon.[3] Magnetic resonance imaging study following ultrasonography was suggested for patients wherever indicated. All patients were be examined by conventional magnetic resonance imaging. The magnetic resonance imaging machine used was Philips Achieva MRI system (1.5 T). Using dedicated wrist coil, patients were scanned in the prone position with the arm above their head. The examination protocol included coronal, sagittal, and axial planes according to imaging sequences. In case of contrast injection, gadopentetate-dimeglumine (magnevist) was manually injected via cannula inserted in the contra-lateral arm just after the acquisition of the pre-contrast series at a dose of 0.2 ml/kg body weight. The average duration time of the examination was from 25 min upto 40 min in case of contrast injection.[3]

Patient position in MRI: Superman position in prone with ipsilateral limb above their head.

Statistical Analysis:

Statistical Package for Social Sciences [SPSS] for Windows, Version 22.0. Released in 2013. Armonk, NY: IBM Corp. was used to perform statistical analyses. To assess the validity of the diagnostic test Sensitivity, Specificity, PPV, NPV and accuracy was calculated.

RESULTS

A total of 50 patients were considered in the study. The pathological wrist or hand was evaluated in all the patients by USG and using saggital, coronal and axial PDFS sequences on MRI with gadolinium contrast used wherever indicated.

Out of 50 patients, twenty eight percent of patients were between the ages of 31-40 years. Mean age of the patients being 39.8 years. Among the study population, 50% were male patients and 50% were female patients.

Out of 50 (100%) subjects, 22% subjects had pain, 46% subjects had swelling and 32% came with both and all had restricted movements as their chief complaints. Descriptive statistical analysis of chief complaints of study subjects was done based on numbers and percentages, and represented in Table 2. Out of 50 (100%) subjects, wrist was affected in 27 (54%) subjects and hand was affected in 23 (46%) subjects. Out of 23 (100%) subjects, right wrist was affected in 13 (58%) subjects and left wrist was affected in 10 (42%) subjects. Out of 27 (100%) subjects with affected hand, right hand was affected in 14 (52%) subjects and left hand was affected in 13 (48%) subjects.

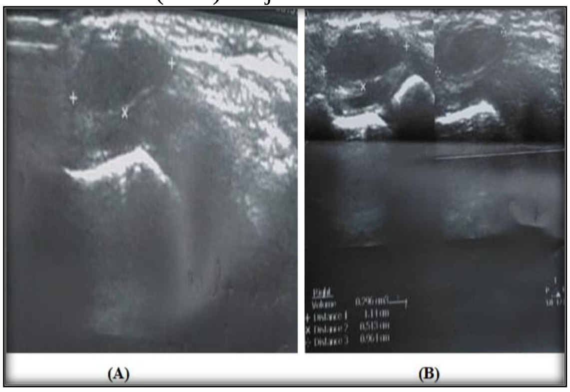

Figure 1: Ultrasound of right wrist - Well defined cystic lesion (A) in intramuscular plane (B) with internal echoes

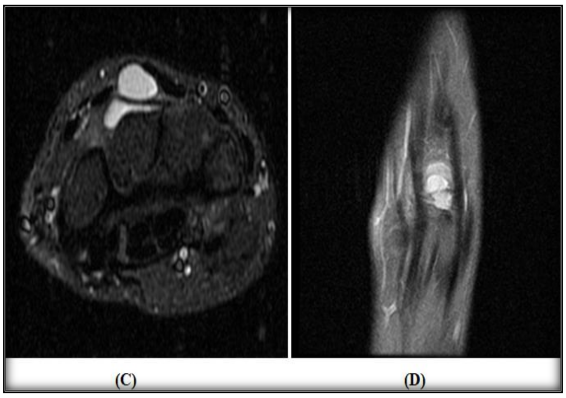

Figure 2: Sagittal PDFS(C) and axial STIR MRI of right wrist –Two cystic lesions in intramuscular and deep to intramuscular plane along dorsal aspect-Dorsal ganglion cysts

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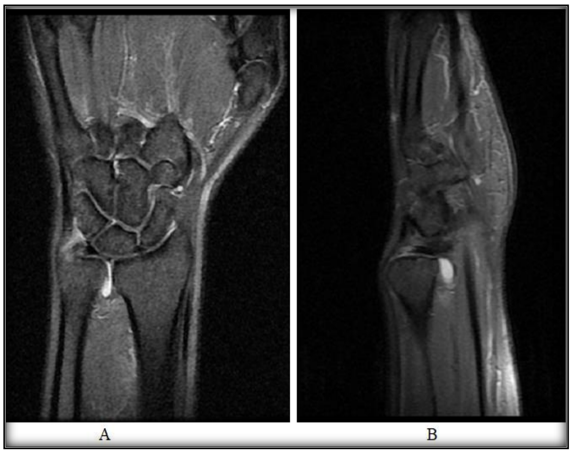

Figure 3: Coronal and Sagittal PDFS MRI of left wrist– Heterogeneous signal in ulnomeniscal homologous with mildly displaced oblique tear in the TFCC disc

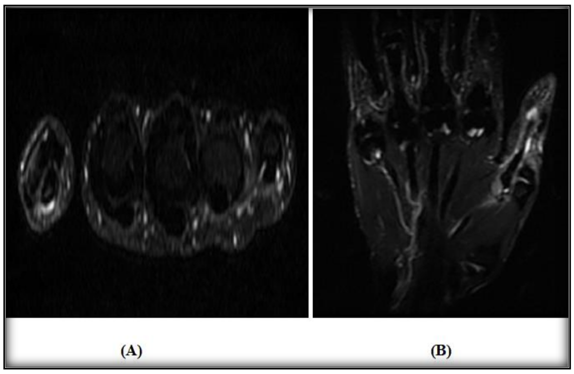

Figure 4: Axial and Coronal STIR MRI of right thumb – Partial thickness tear of ulnar collateral ligament of 1st metacarpophalangeal joint (A, B)- Ulnar collateral ligament injury

Out of 50 (100%) subjects, 2% subjects had De-Quervain's, 24% had flexor and 14% had extensor tenosynovitis. Tendon tear was seen in 22% cases while tendon rupture was seen in 4% of the subjects enrolled in our study.

Median and Ulnar nerve was seen abnormal in 4% subjects. TFCC and ligaments were involved in 2% cases while vascular structures were involved in 14% cases among all the subjects.

Study subjects 10% simple cystic masses while 38% showed infected cystic masses with joint involvement seen in 4% cases as represented in [Table 5].

The findings of distribution of the subjects based on solid mass revealed that in 30% study subjects, solid mass was detected in the affected wrist subjects, while it was absent in 70% study subjects as represented in [Table 6].

MRI findings showed tendon involvement in 44% subjects with flexor tendons being involved in 28% cases and extensor tendon being involved in 16% cases. MRI showed TFCC and ligaments involvement in 22% subjects with presence of soft tissue masses in 66% cases and joint effusion; vascular involvement in 22% cases.

The sensitivity and specificity analysis of diagnostic tests revealed that 88% and 100% sensitivity and specificity in USG was observed for tendinopathy and CTS respectively. MRI showed 100% sensitivity and specificity for tendinopathy, TFCC & ligament injury, ganglion cyst, vascular and solid masses. The results of sensitivity and specificity analysis of diagnostic tools viz. USG and MRI used for the affected joint of the subjects as represented in [Table 7].

Table 1: Distribution of the subjects based on age groups

Variable	**N**	**%**
Age		
< 20 yrs.	5	10%
21-30 yrs.	10	20%
31-40 yrs.	14	28%
41-50 yrs.	7	14%
51-60 yrs.	8	16%
> 60 yrs	6	12%
	Mean	SD
Mean	39.88	15.74
Range	15 – 74	

Table 2: Distribution of the subjects based on chief complaints

Chief Complaints	**Number**	**Percentage**
Pain	11	22.0
Swelling	23	46.0
Swelling & Pain	16	32.0
Total	50	100.0

Table 3: Distribution of the subjects based on tendon involvement-USG

USG Findings					
Tendon		**Absent**		**Present**	
		Count	**%**	**Count**	**%**
Tenosynovitis	De Quervain's	49	98	1	2
	Flexor	38	76	12	24
	Extensor	43	86	7	14
Tendon tear		39	78	11	22
Tendon rupture		48	96	2	4

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Table 4: Distribution of the subjects based on nerves, TFCC, ligaments and vascular structures involvement – on USG

USG Findings				
	Abnormal		**Normal**	
	Count	**%**	**Count**	**%**
Median (CTS)	2	4	48	96
Ulnar	0	0	50	100
TFCC & ligaments	1	2	49	98
Vascular	7	14	43	86

Table 5: Distribution of the subjects based on cystic masses –USG

USG Findings					
Focal Masses		**Absent**		**Present**	
		Count	**%**	**Count**	**%**
CYSTIC	SIMPLE	45	90	5	10
	INFECTED	31	62	19	38

Table 6: Distribution of the subjects based on solid masses –USG

USG Findings		
Solid mass	**No of Cases**	**Percent**
Present	15	30
Absent	35	70

Table 7: Sensitivity and specificity of diagnostic tools

Findings		Method	No	Sensitivity %	Specificity %	PPV %	NPV %	Accuracy
Tenosynovitis	Flexor	USG	12	86%	100%	100%	95%	96%
		MRI	14	100%				
	Extensor	USG	7	88%	100%	100%	88%	88%
		MRI	8	100%				
TFCC & ligaments	Abnormal	USG	1	9%	100%	100%	79%	80%
		MRI	11	100%				
Solid/cystic mass	Present	USG	15	45%	100%	100%	48%	64%
		MRI	33	100%				
Vascular	Present	USG	7	64%	100%	100%	91%	92%
		MRI	11	100%				
Synovium and Joint effusion	Present	USG	2	18%	100%	100%	81%	82%
		MRI	11	100%				

DISCUSSION

There were exactly as many men and women in the study population, and their average age was 39.8. An key part of characterising hand and wrist diseases is played by USG and MRI. MRI is useful in evaluating different ligaments, tendons, and nerves. It can also help with the visualisation of lesions in the bones and soft tissues, such as the marrow, cartilage, and blood vessels,[10] whereas USG can assist with diagnosis based on the imaging patterns of lesions to reliably determine whether they are cystic or solid.[11] While 22% subjects had pain, 46% subjects had swelling and 32% came with both and all of these patients had restricted movements as their chief complaints. This was comparable to Kumar *et al* study where swelling was the most commonly associated symptom noted in 47.72% patients and 31.81% patients also complained of associated restricted movement.[12]

Tenosynovitis, which causes swelling, stiffness, and joint pain, is an inflammation of the fluid-filled sheath (known as the synovium) that surrounds a tendon. Both infectious and non-infectious tenosynovitis exists. De Quervain's tendinopathy and stenosing tenosynovitis are two common clinical scenarios of non-infectious tenosynovitis (also known as trigger finger). 2% of the individuals had De Quervain's, 24% had flexor tenosynovitis, and 14% had extensor tenosynovitis. In the study by El-Deek and Hassan *et al*., isolated tenosynovitis with peritendinous fluid collection and enhanced vascularity was diagnosed by USG in 20 of 20 cases (100%) and by MRI in 100% of cases. USG had an 88% sensitivity and MRI had a 100% sensitivity for diagnosing tendon diseases. When diagnosing tenosynovitis, USG is extremely sensitive and specific.[13]

Median and Ulnar nerve was seen abnormal in 4% subjects in our study. The Kumar *et al* study showed 15.90% patients in their study group who were finally diagnosed to have median nerve pathology had increased wrist forearm ratio of cross sectional area of median nerve.[12] Our findings are comparable to previous studies by Ziswiler HR who found that the maximum cross sectional area of median nerve in carpal tunnel increases in patients with carpal tunnel syndrome and there was a high concordance between sonography and nerve conduction.[14]

Sonography provides a rapid, readily available, noninvasive, and inexpensive technique for examining superficial structures with excellent resolution. However, despite the growing use of wrist sonography, little attention has been paid to the triangular fibrocartilage.[15] Chiou et al,[16] using 7- and 10-MHz probes, described the normal and pathologic appearances of the triangular fibrocartilage on sonography compared with arthrography. Chiou et al. scanned over the volar aspect of the wrist and found scanning through the extensor carpi ulnaris tendon to be more helpful and, with the benefit of highresolution probes and real-time spatial compound imaging, thought that they could visualize tears directly as hypoechoic lines. The combination of MRI with arthrography may improve accuracy further.[15] TFCC and ligaments were involved in 2% cases while vascular structures were involved in 14% cases among all the subjects enrolled in our study. MRI in El-Deek and Hassan *et al* study adequately detected its pathologies (75% sensitivity); which showed promising results with regard to the detection of TFCC tears as compared to USG where no cases were detected by it.[3] This study was comparable to our study.

Among the masses, ganglion cysts (48%) were the most common lesions where our subjects showed 10% simple cystic masses while 38% showed infected cystic masses with joint involvement seen in 4% cases. While USG showed 45% sensitivity in detecting solid/ cystic lesions, MRI showed 100% sensitivity. 52% of the lesions were seen on the volar aspect as was the lesions described by Bianchi S. *et al* in 2008.[17]

Our subjects showed 30% solid mass lesions, out of which tenosynovial giant cell tumours predominated followed by tendon sheath fibroma. Approximately 82% of FTS occur in the hand and wrist region. Tendon sheath fibroma is most often confused with localized type tenosynovial giant cell tumor (TSGCT) both at clinical examination and even at gross pathology. Tenosynovial giant cell tumors generally, show susceptibility artifacts on Gradient Echo images.[18] According to Teh J *et al* study, Giant cell tumour of the tendon sheath is the second commonest mass in the hand and wrist following ganglia where, MRI is considered the imaging investigation of choice.[19]

The rest of the solid mass lesions included nerve sheath tumours, glomus tumour and vascular lesions like arterio-venous malformation and hemangioma; soft tissue infections like abscess and paronychia. Teh J *et al* study showed that the benign peripheral nerve sheath tumors (PNST) have classically been divided into schwannomas and neurofibromas which are relatively common masses of the hand and wrist.[19] Only one case of glomus tumour was found amongst the lot accounting for 6% of the solid mass lesions found in our study which was comparable to the study stating that Glomus tumors are small hamartomas of the neuromyoarterial apparatus within the glomus body and account for up to 5% of soft tissue tumors of the hand.[19,20]

Our study showed cases of abscess and paronychia which was well demonstrated on USG as comparable to the Ganguly A *et al* study which stated that soft-tissue infections with abscess formation may present as a soft-tissue mass and imaging has a role in both the diagnosis and management of these conditions.[19] Synovium and joint involvement of the hand and wrist showed 18% sensitivity on USG and 100% on MRI in our study. MRI findings showed tendon involvement in 44% subjects with flexor tendons being involved in 28% cases and extensor tendon being involved in 16% cases. TFCC and ligaments involvement was seen in 22% subjects with presence of soft tissue masses in 66% cases and joint effusion; vascular involvement in 22% cases. The sensitivity and specificity analysis of diagnostic tests revealed that 88% and 100% sensitivity and specificity in USG was observed for tendinopathy and CTS respectively. MRI showed 100% sensitivity and specificity for tendinopathy, TFCC & ligament injury, ganglion cyst, vascular and solid masses. These findings were in corroboration with the findings of Kumar S *et al* wherein the number of positive cases of MRI was 100%, compared to ultrasound i.e. 80% for ganglion cysts, haemangioma, nerve sheath tumours, tenosynovial giant cell tumours, tendosynovitis and TFCC tears.[15]

CONCLUSION

According to the results of our investigation, ultrasound and MRI correlation is an effective imaging technique for locating non-osseous disorders that cause hand and wrist pain. It can diagnose these illnesses in a sizable number of patients and has a high sensitivity and specificity for doing so.

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