Original Research

SONOGRAPHY AS A FIRST LINE TOOL IN SOFT TISSUE MASSES OF WRIST AND HAND: A RADIOPATHOLOGICAL CORRELATION

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ABSTRACT
Soft tissue masses of the wrist and hand are frequently encountered in clinical practice and represent a diverse range of pathologies, including tumors, infections, and inflammatory disorders. Accurate preoperative diagnosis is essential for guiding management and avoiding unnecessary surgery. This study aimed to evaluate the sonographic findings of wrist and hand swellings and discuss the comparative roles of ultrasonography (USG) and Magnetic Resonance Imaging (MRI) in their assessment. A prospective study was conducted on 45 patients presenting with wrist and hand lesions. All patients underwent clinical examination, high-resolution ultrasonography (5-13 MHz), and radiography. Contrast-enhanced MRI was performed in 16 cases where USG findings were equivocal. Imaging findings were correlated with final diagnoses obtained through fine-needle aspiration cytology (FNAC), histopathology, or clinical follow-up. The majority of lesions were benign (97.78%), with only one malignant case (Bednar's tumor) identified. The most common entities were ganglion cysts (26.67%), followed by inflammatory pseudomasses (28.89%) and vascular malformations (13.33%). Sonography was "diagnostic" in 86.67% of cases and proved highly reliable in differentiating cystic from solid lesions, identifying 100% of cystic and mixed lesions correctly. MRI provided a higher prediction rate of 87.5% compared to 75% for USG within the subset of patients who received both scans. USG is an effective first-line modality for initial characterization and differentiating cystic from solid masses due to its accessibility and real-time capability. MRI offers superior tissue characterization and is reserved for complex cases requiring detailed anatomical mapping.

INTRODUCTION
Soft tissue masses located at the wrist and hand are frequently encountered in daily practice. The wrist is a complex structure with extensive differential diagnosis for a presenting mass and is mostly secondary to tumors, infections, inflammations, degenerative and traumatic disorders. The majority of these are Ganglia. Other common masses include Hemangiomas, lipomas, focal synovitis, giant cell tumor of the tendon sheath (GCTTS), nerve sheath tumours, glomus tumor, vascular malformations and synovial pathology.[1] Conventional radiographs have little ability to detect or evaluate most soft tissue lesions in the extremities. Radiographs can detect soft tissue calcification and ossification which can assist with characterization.[2]

www.ajmrhs.com
eISSN: 2583-7761

Date of Received: 09-02-2026
Date Acceptance: 17-02-2026
Date of Publication: 18-03-2026

However, they cannot assess synovitis, bone edema, and early marginal erosions.[3]
Ultrasound is sensitive, readily accessible, cost effective and radiation free and provides an opportunity for correlation of findings on clinical examination. In addition, an examination of the contralateral side for direct comparison and relevant additional regions can be performed at the same time.[4] Sonography helps in assessing mass size, internal structure, relation to adjacent structures and internal vascularity and it can guide biopsy. Dynamic imaging may expose certain pathologies, such as intermittent tendon subluxation, not present on a static examination. Magnetic Resonance Imaging (MRI) is favoured modality for evaluating soft tissue tumours and tumour like conditions because of its superior soft tissue characterization, multiplanar imaging capability and lack of radiation exposure.
The present study was planned to present the sonographic findings of the swellings of the wrist and hand and to discuss the role of sonography in their assessment. MRI was done when diagnosis could not be made on ultrasound. Comparison of

imaging diagnosis was done with final diagnosis achieved by FNAC/histopathology.

METHODOLOGY

The prospective study was conducted on forty-five patients who clinically presented to outpatient and inpatient departments of Pt. B.D. Sharma PGIMS, Rohtak with a lesion in the wrist and hand. The detailed patient history and thorough clinical examination was followed by a multimodality imaging approach. Ultrasonography and radiography was done in all the patients. CT scan and contrast enhanced MRI (CE-MRI) was done wherever required. The final diagnosis was achieved by FNAC/histopathology or follow up in all patients. All patients with a history of acute trauma were excluded from the study.

High resolution ultrasonography was performed using broadband linear array transducers (5-13 MHz) with the patient sitting on a chair opposite the radiologist, with the hand placed in an appropriate position for imaging of the specific areas of interest. A large amount of gel was used to allow optimal visualization of most superficial structures. Transverse, longitudinal and extended field of view images were obtained. MRI was done on Philips Gyroscan Intera Nova 1.5 Tesla MRI machine wherever required. Different protocols were followed depending on the site of lesion. T1-weighted, T2- weighted, STIR/SPIR sequences were done in sagittal, coronal and axial planes. The sequences were repeated after bolus injection of 10 ml of gadolinium dimeglumine contrast given @ 5 ml/sec. The findings were then correlated with fine needle aspiration cytology (FNAC)/histopathological findings.

RESULTS

The majority of the wrist swellings were benign (97.78%). Only one lesion was found to be malignant. Most common lesion in our study was ganglion cyst (26.67%) followed by tenosynovitis (15.56%). Other common lesions were haemangiomas (11.11%), nerve sheath tumours (8.8%), synovitis (6.6%), lipoma (4.4%) and epidermoid cyst (4.4%). Less common lesions were tendinitis, AVM, GCTTS, pseudoaneurysm, glomus tumour, angioleiomyoma, myofibroma, abscess, Bednar's tumour. (Table 1)

Table 1. Final Categorisation of Soft Tissue Masses (N=45)

Sr. No.			No. of Patients N=45	Percentage of Patients
A)	**INFLAMMATORY PSEUDOMASSES n=13**			28.89
	a) NON-INFECTIVE n=9			20
	1.	Tenosynovitis	5	11.11
	2.	Synovitis	3	6.67
	3.	Tendinitis	1	2.2
	b) INFECTIVE n=4			8.8
	1.	Tubercular tenosynovitis	2	4.4
	2.	Cysticercosis	1	2.2
	3.	Abscess	1	2.2
B)	**BENIGN TUMOURS n=31**			68.89
	1.	Ganglion cyst	12	26.67
	2.	Haemangioma/malformations	6	13.33
	3.	Nerve sheath tumour	4	8.8
	4.	Epidermoid cyst	2	4.4
	5.	Lipoma	2	4.4
	6.	Pseudoaneurysm	1	2.2
	7.	Glomus tumour	1	2.2
	8.	Giant cell tumour of tendon sheath	1	2.2
	9.	Angioleiomyoma	1	2.2
	10.	Myofibroma	1	2.2
C)	**MALIGNANT TUMOURS n=1**			2.2
	1.	Bednar's tumour	1	2.2
	TOTAL		45	100

Maximum number of patients were of the age group 21-30 years. Ganglion cyst was most common in the second to fourth decade of life. Inflammatory lesions were common in older patients. Only malignant lesion i.e. Bednar's tumour was found in a young male.

In our study, 27 were males and 18 were females. Ganglion cyst were found equally in both sexes. Haemangioma was more common among females. The only malignant tumour, Bednar's tumour, was found in a young male.

Dorsal wrist was found to be the most common site of the swellings. 75% of the ganglia occurred on the dorsal aspect of the wrist. Inflammatory pseudo-masses were also most commonly found at the dorsal wrist. Both cases of lipoma occurred on the thenar eminence. Both the cases of tubercular infection were seen to involve both the wrist and the hand.

Plain radiographs of wrist and hand were normal in 55.56% patients. Soft tissue mass could be appreciated in 18 cases only. Phleboliths were detected in 3 out of 5 cases of haemangioma and soft tissue calcification in a case of chronic synovitis. Bony abnormality was not seen in any case.

In our study, sonography was considered 'diagnostic' when correct pathological diagnosis could be suggested. When correct pathological diagnosis could not be suggested but the presence of tumour could be suggested, sonography was described as 'useful'. When solid lesions were diagnosed as cystic on sonography and vice versa, it was considered 'misleading'. Sonography was diagnostic in 86.67%, useful in 8.8% and misleading in 4.4% cases. 1 case of ganglion cyst and another of epidermoid cyst were diagnosed as solid lesions on sonography (Table 2)

Table 2: Comparison of Final Diagnosis with Sonography Diagnosis N=45

Final Diagnosis	No. of Cases	Sonography		
		Diagnostic	Useful but not Diagnostic	Misleading
Inflammatory lesion	13	13	-	-
Benign tumours				
Ganglion cyst	12	11	-	1
Haemangioma/AVM	6	6	-	-
Nerve sheath tumour	4	3	1	-
Lipoma	2	2	-	-
Epidermoid cyst	2	1	-	1
GCTTS	1	1	-	-
Pseudoaneurysm	1	1	-	-
Glomus tumour	1	1	-	-
Angioleiomyoma	1	-	1	-
Myofibroma	1	-	1	-
Bednar's tumour	1	-	1	-
Total	45	39	4	2

Ultrasound was diagnostic in 57.14%, 100% and 100 % of the solid, mixed and cystic lesions respectively. Sonography was misleading in 2 solid lesions only. It was found to be very reliable in differentiating solid and cystic lesions. (Table 3)

Table 3: Correlation of Sonography Diagnosis with Consistency/Echotexture of Lesion N=45

Role Of Sonography	Echotexture of Lesion on Sonography		
	Cystic	Mixed	Solid
Diagnostic n=39	14	17	8
Suggestive n=4	-	-	4
Misleading n=2	-	-	2
Total	14	17	14

In our study, MRI was done in 16 out of 45 cases. MRI was useful in all cases. However, definite diagnosis was made in 87.5 %(14) cases. Myofibroma and Bednar's tumour were histopathological diagnosis and MRI could suggest the presence and extent of tumour without predicting the final diagnosis. Our results showed that MRI provides an advantage to evaluate soft tissue masses at the wrist and hand with a prediction rate of 87.5% compared to USG (75% prediction rate).

Discussion

Soft tissue swellings of the wrist and hand are a frequent clinical presentation encountered across surgical, orthopedic, and medical departments. Accurate preoperative diagnosis is crucial to guide management and to avoid unnecessary surgical interventions. In our prospective study of 45 patients with clinically palpable wrist and hand swellings, multimodality imaging including ultrasonography (USG), radiography, and magnetic resonance imaging (MRI) was performed, followed by cytological or histopathological confirmation wherever possible. The lesions demonstrated a wide

pathological spectrum ranging from benign cystic masses to solid neoplastic and inflammatory lesions. The most common lesions in our study were ganglion cysts (n = 12), followed by inflammatory pseudomasses (n = 13), vascular lesions (n = 6), nerve sheath tumors (n = 4), lipomas (n = 2), and epidermoid cysts (n = 2). Less frequent entities included giant cell tumor of tendon sheath (GCTTS), pseudoaneurysm, glomus tumor, angioleiomyoma, myofibroma, and Bednar's tumor. This distribution is in concordance with previous literature where ganglia, vascular malformations, and GCTTS constitute the predominant causes of hand swellings.[4,5] Aaken et al.[5] and Cheng et al.[2] reported similar findings, although their series demonstrated a slightly higher proportion of GCTTS. These variations may reflect differences in referral patterns and inclusion criteria.

High-resolution ultrasonography (HRUS) proved highly effective in differentiating cystic from solid lesions. In our study, USG correctly identified 100% of cystic and mixed lesions and 57.14% of solid lesions, with only two solid masses misclassified. These findings reaffirm the utility of USG as a first-line modality due to its real-time capability, accessibility, and lack of ionizing radiation. Our diagnostic accuracy parallels that reported by Aaken et al.[5], who found HRUS accurate in 94% of solid lesions and 100% of cystic lesions, significantly outperforming clinical examination. Similarly, Teefey et al.[6] reported 87% accuracy for cystic lesions and 73% for solid lesions. Thus, sonography remains an indispensable tool for initial characterization of wrist and hand swellings.

MRI was performed in 16 out of 45 cases in our study. Correct diagnosis was achieved in 75% of cases on USG and 87.5% on MRI. The overall sensitivity of USG and MRI was 86.7% and 87.5%, respectively. Although MRI demonstrated slightly superior diagnostic accuracy, the difference was marginal. These findings are consistent with the observations of Orman et al.[7], who reported a positive predictive value (PPV) of 64% for USG and 50% for MRI in differentiating soft tissue masses. Both modalities were equally effective in identifying ganglion cysts. Therefore, MRI should be reserved for cases where USG findings are equivocal or where delineation of lesion extent and tissue characterization is essential.

Ganglion cysts constituted the most common cystic lesion in our series, predominantly located over the dorsal wrist. Simple ganglia appeared as anechoic, well-defined cysts with posterior acoustic enhancement and absence of internal flow, while complex ganglia demonstrated septations and internal echoes. Our results correspond closely with those of Teefey et al.[8], who reported that most ganglia are complex, exhibiting well-defined margins, thick walls, and posterior acoustic enhancement. A history of trauma was present in 25% of our cases, aligning with the findings of Friere et al.[9], who noted a similar traumatic association.

Inflammatory pseudomasses, including tenosynovitis and tendinitis, displayed a characteristic target sign on sonography. MRI findings of hypointense T1 and hyperintense T2 signal with rice body formation were consistent with those described by Vanhoenacker et al. [10] and Teh et al.[11] These features help in differentiating inflammatory from neoplastic etiologies.

Vascular lesions (hemangioma and AVM) exhibited heterogeneous echotexture on USG with variable color flow. On MRI, they were hypointense on T1-weighted and hyperintense on T2-weighted images with patchy contrast enhancement, in agreement with prior studies by Ergun et al.[12] and Jimenez et al.[13] Such multimodality findings allow confident diagnosis and differentiation between high-flow and low-flow vascular lesions.

Nerve sheath tumors appeared as well-defined hypoechoic solid lesions on USG. MRI demonstrated hypointense T1 and hyperintense T2 signal with enhancement, findings comparable to those described by Cheng et al.[2] and Bianchi et al.[14] Although the "target sign" was observed in only one case, its presence supports the diagnosis of neurogenic origin. Lipomas in our series were located on the thenar eminence and appeared as echogenic, lobulated, well-defined lesions on USG without vascularity. MRI confirmed their fatty nature with T1 and T2 hyperintensity and STIR suppression, consistent with previous reports.[12,15]

Epidermoid cysts, though uncommon, showed variable echogenicity and occasionally contained calcifications, making differentiation from solid lesions difficult. This aligns with the experience of Nahra et al.[16], who noted that epidermoid cysts may mimic neoplasms on imaging.

The single case of GCTTS in our study presented as a well-defined hypoechoic mass adjacent to the flexor tendon and showed classic low-signal intensity on both T1 and T2 sequences, consistent with hemosiderin deposition described in literature.[2,17] Similarly, our cases of glomus tumor, pseudoaneurysm, and rare entities like Bednar's tumor displayed imaging patterns correlating well with published descriptions.[18,12,19]

Limitations

Our study was limited by a relatively small sample size and the heterogeneity of lesion types. MRI was not performed in all patients, restricting direct modality comparison. Moreover, pathological confirmation was based on FNAC in some cases rather than excision biopsy. A larger cohort with uniform imaging and histopathologic correlation would enhance the statistical strength of these observations.

CONCLUSION

Ultrasonography and MRI are complementary modalities in the evaluation of soft tissue swellings of the wrist and hand. Ultrasonography provides an accurate, cost-effective, and dynamic assessment for initial differentiation between cystic and solid lesions, while MRI offers superior tissue characterization and delineation of anatomical extent. Correlation with cytological or histopathological findings remains the cornerstone for definitive diagnosis. Our study reaffirms that a structured multimodality imaging approach substantially improves diagnostic accuracy and guides appropriate clinical management of wrist and hand lesions.

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How to cite this article: Priyanka, Sunil Pawar, Jyotsna Sen, SONOGRAPHY AS A FIRST LINE TOOL IN SOFT TISSUE MASSES OF WRIST AND HAND: A RADIOPATHOLOGICAL CORRELATION, Asian J. Med. Res. Health Sci., 2026; 4 (1):795-806.
Source of Support: Nil, Conflicts of Interest: None declared.

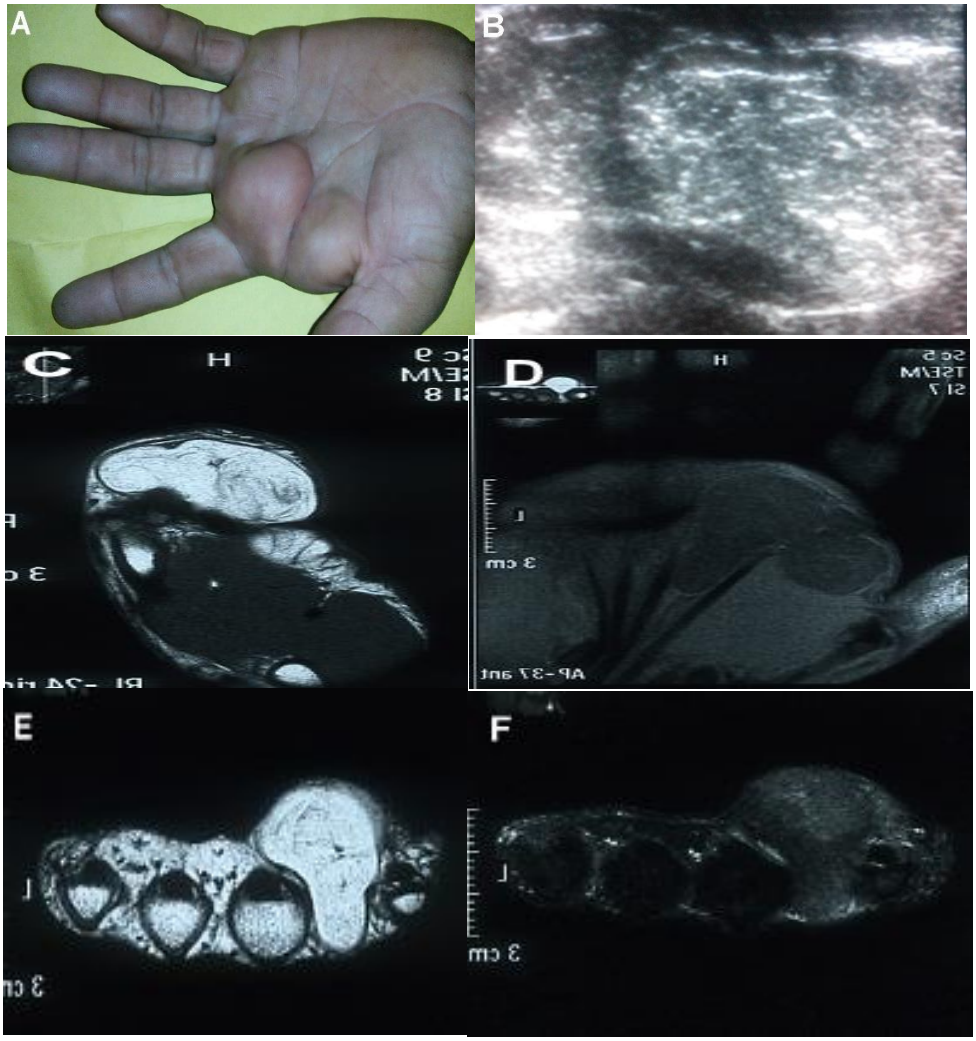

Fig 1. Lipoma over Left Palm

A-Lobulated swelling seen over the palm B-USG image shows large lobulated hyperechoic lesion in the subcutaneous plane and extending to the deeper planes C- T1W saggital image shows well defined lobulated hyperintense lesion in the subcutaneous plane of the left palm D-T1W FS coronal image shows homogenous suppression of the lesion E, F-T2W axial and T2W FS axial images show hyperintense lesion insinuating between first and second metacarpal and showing suppression on FS images.

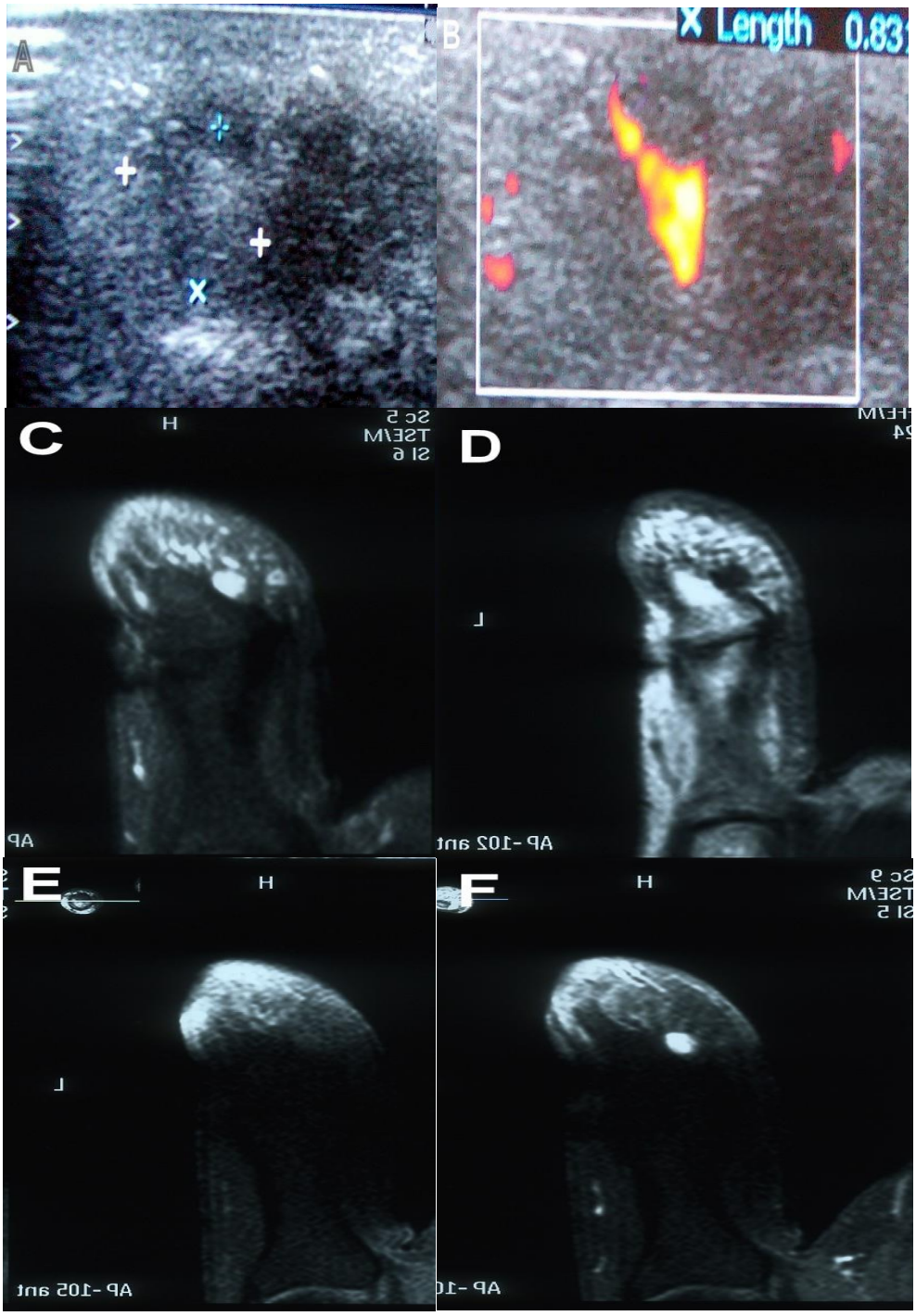

Fig 2. Glomus Tumour Over Dorsomedial Aspect of Right Humb

A,B- USG images show a small well defined hypoechoic to isoechoic lesion in the pulp over dorsomedial aspect of right thumb showing flow on power dopplerC- PDW coronal image shows a small well defined hyperintense lesion in the pulp of the rightbthumb adjacent to the terminal phalanx.D, E-T1W FFE and T1W FS coronal images shows well defined hypointense lesion adjacent to the terminal phalanx of the right thumb.F-T1W FS CE coronal image shows intense homogenous enhancement.

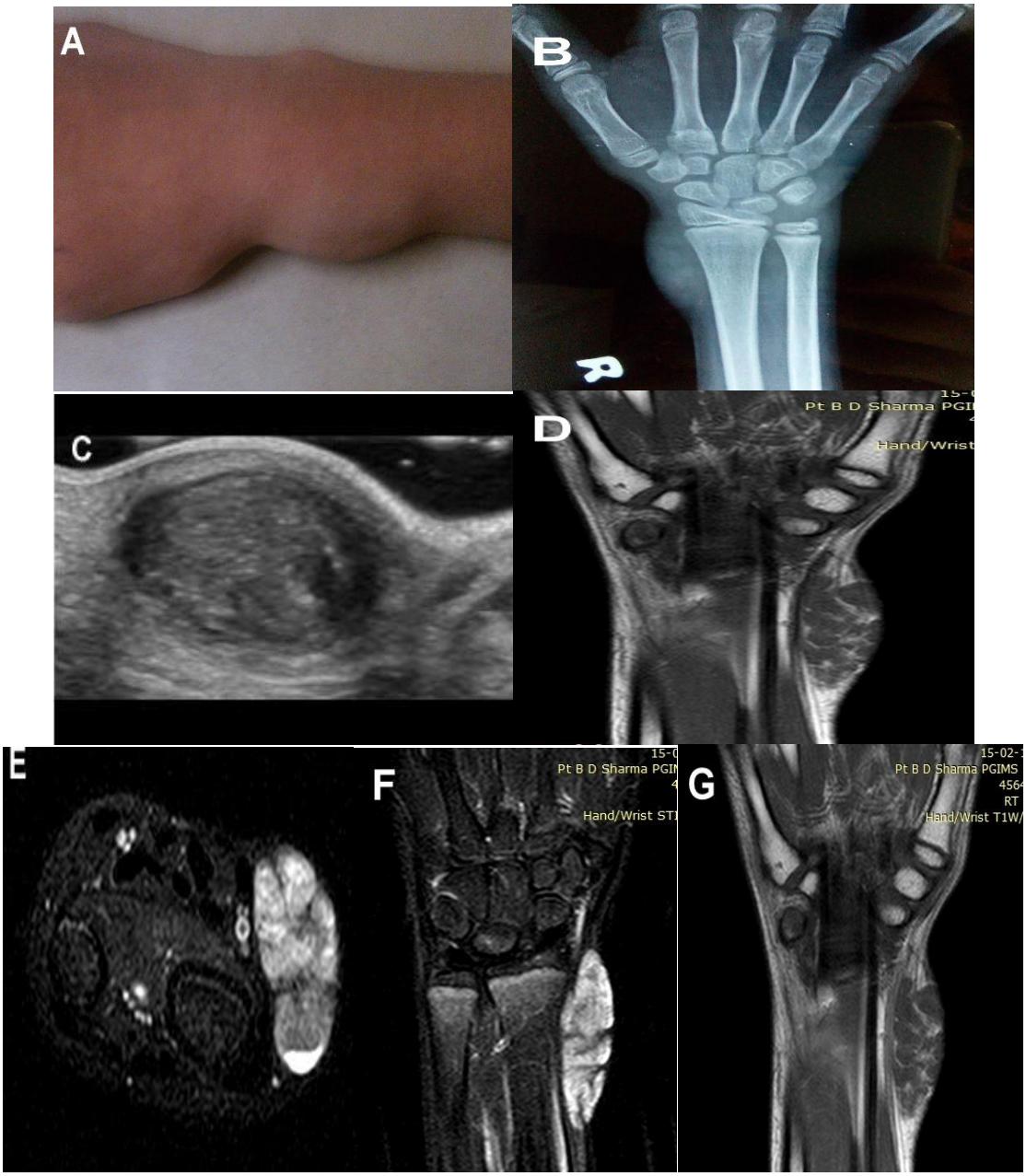

Fig 3. Neurofibroma of Right Wrist

A-Elongated oval shaped swelling seen over the radial aspect of right wrist B-X-ray right wrist (AP view) shows soft tissue density mass lesion on radial aspect of wrist C-USG shows large oval shaped well defined hypoechoic lesion in the subcutaneous plane . Lesion showed flow on color doppler(not shown in figure).D-T1W coronal image shows well defined lobulated oval shaped hypointense lesion lying close to neurovascular bundle on lateral aspect of right wris E,F- T2W axial and STIR coronal image shows lobulated hyperintense lesion G- T1W CE image shows few enhancing areas in predominantly hypointense lesion.

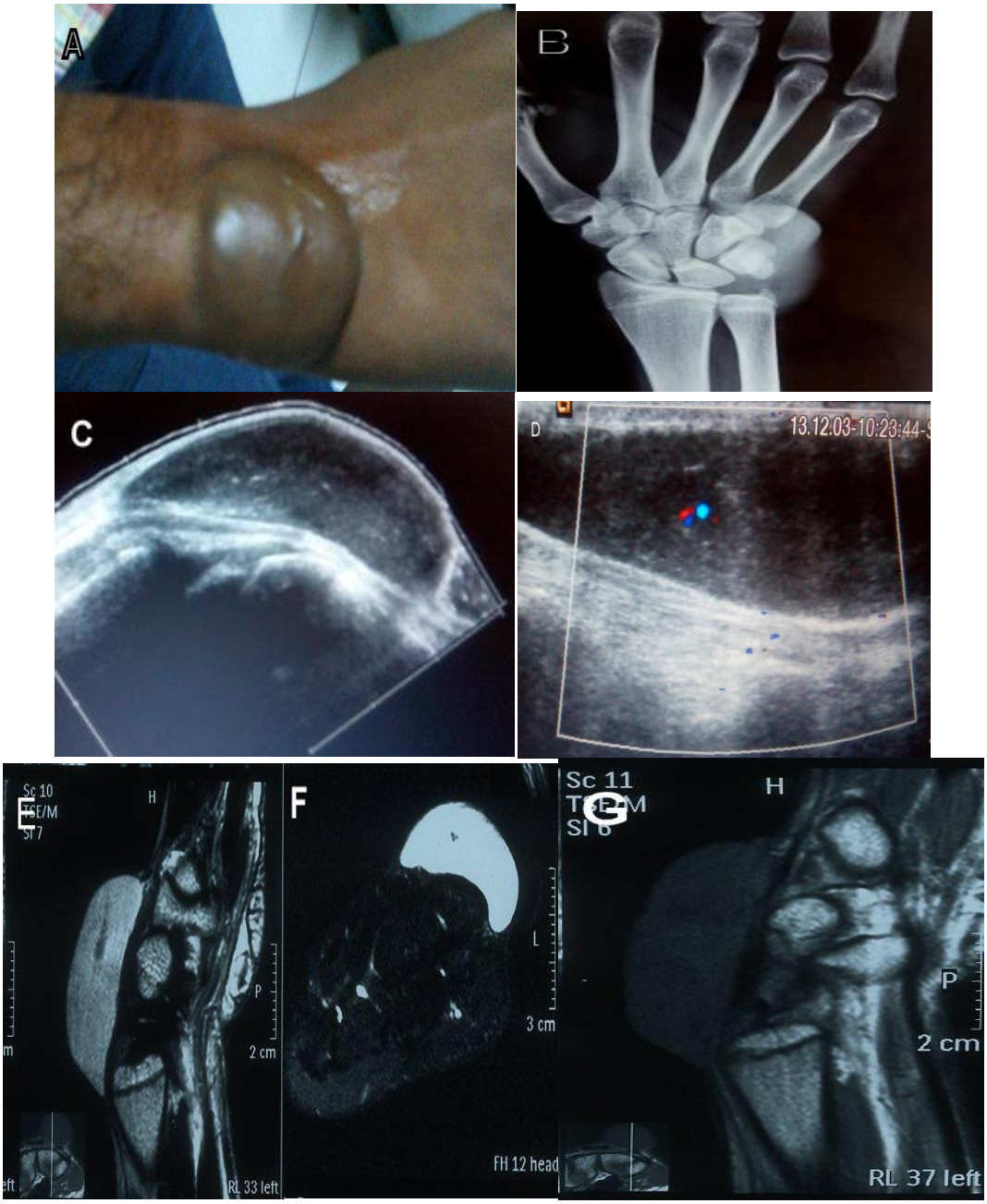

FIG 4. Bednar's Tumour of Dorsum of Right Wrist

A-Bluish swelling over the dorsal wrist B-X-ray Right wrist (AP view) with hand shows a soft tissue density mass over the ulnar aspect of the wrist C, D-USG images well defined hypoechoic lesion showing minimal flow on color Doppler E, F- T2W saggital and T2W FS axial images show well defined hyperintense lesion G- T1W saggital image shows lesion is hypointense.

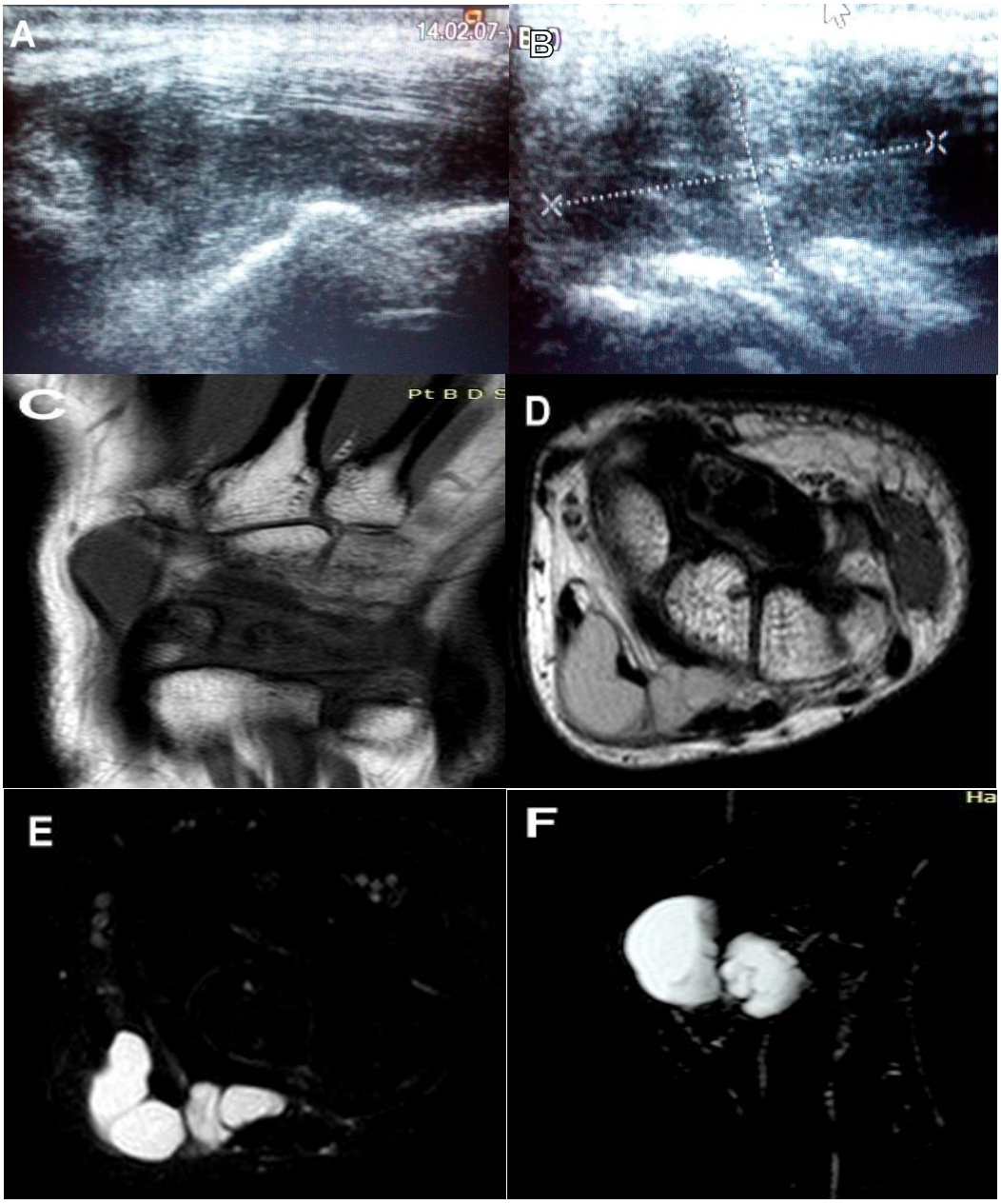

Fig 5.Solid Appearing Ganglion

A-Longitudinal sonogram and B- transverse sonogram over dorsolateral aspect of right hand shows hypoechoic lesion composed entirely of soft tissue with ill-defined margins and no definite wall. C-T1W coronal image shows hypointense oval shaped lesion over the dorsolateral aspect of RT hand. D-PDW axial image shows intermediate signal intensity lesion E, F-T2W SPIR axial and coronal image shows a lobulated hyperintense lesion.

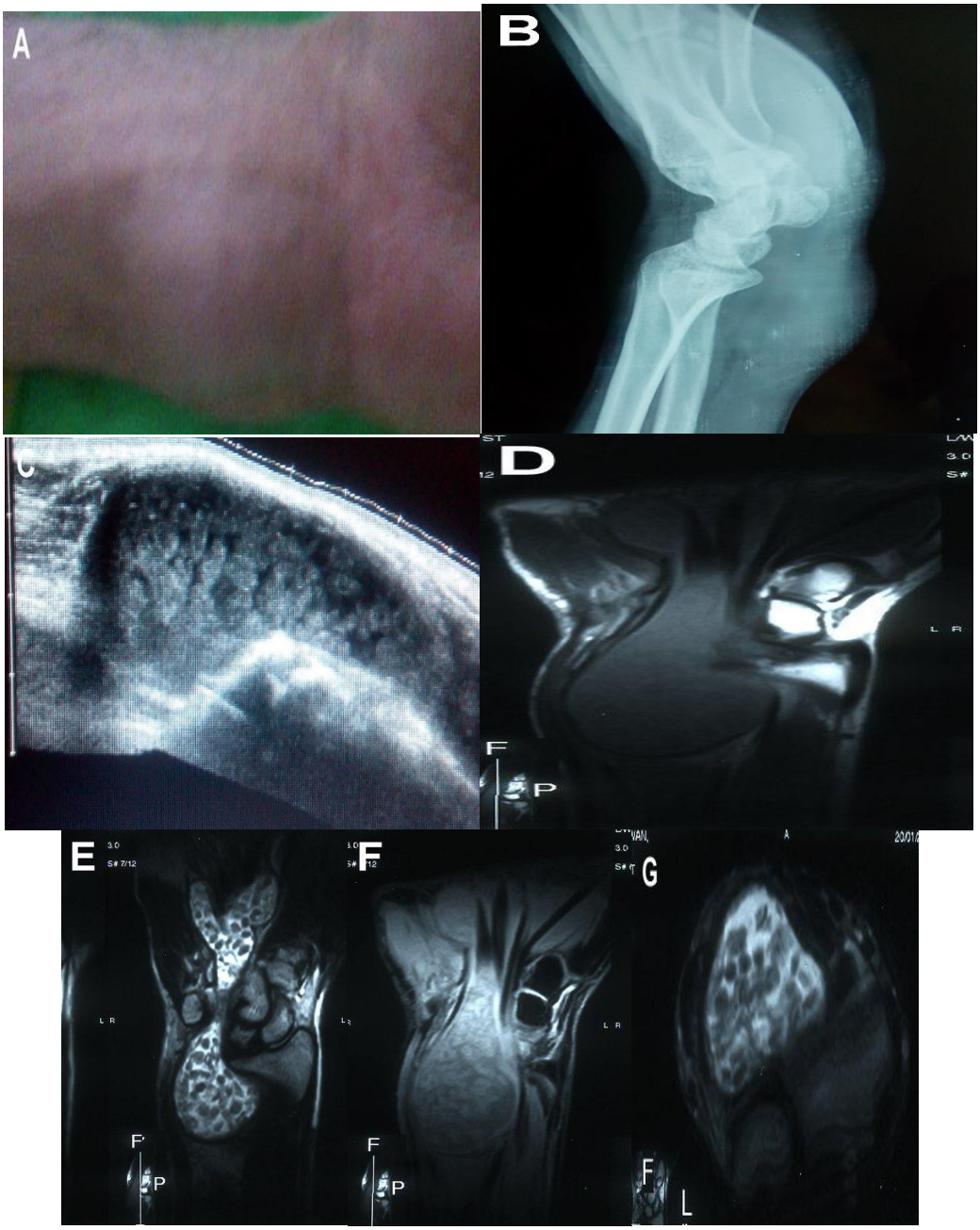

Fig6. Non Specific Synovitis of Wrist

A-Diffuse swelling seen over ulnar aspect of left wrist **B-**X-ray wrist (oblique view) shows soft tissue density lesion over wrist. C-USG (panoramic view) shows cystic lesion with multiple echogenic nodules within it D-T1W coronal image shows hypointense lesion at wrist extending along flexor tendonsE,F,G - T2W coronal , T2W GRE FS coronal and STIR axial images show hyperintense fluid collection with multiple hypointense nodules in it seen in tendon sheath of flexor tendons.

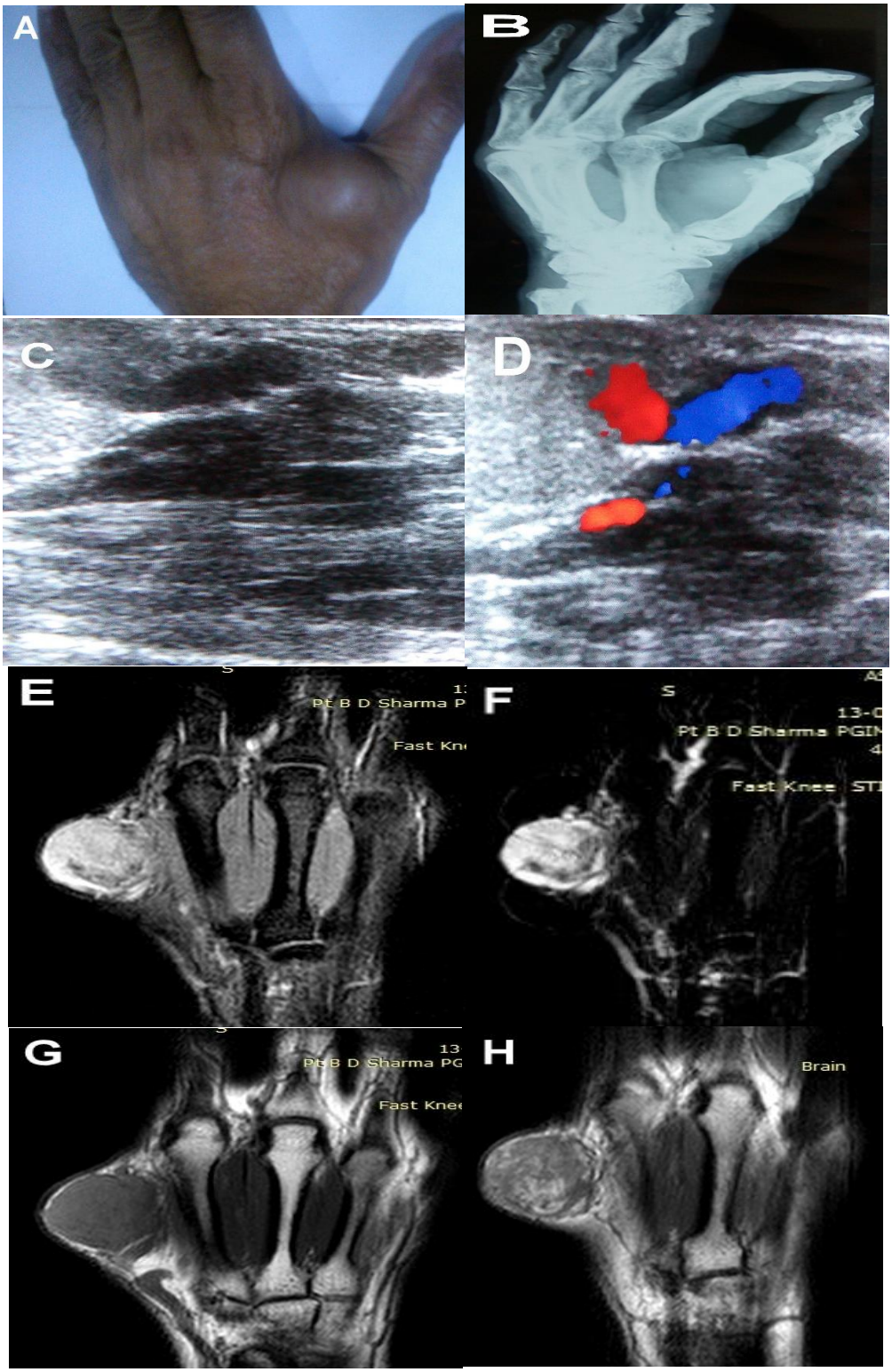

Fig 7. Arteriovenous Malformation on Dorsum of Left Hand

A-Fluctuant swelling seen over the dorsum of left hand B-X-ray left hand (oblique view) shows soft tissue density mass lesion near the first metacarpal C,D- USG images show predominantly hypoechoic lesion with cystic areas showing flow on color doppler. F,G- T2W FFE coronal and STIR coronal images show well defined rounded predominantly hyperintense lesion with few hypointense areas in the subcutaneous plane .G,H-T1W coronal precontrast and post contrast images show hypointense lesion showing patchy enhancement after contrast administration.