Section: Radiodiagnosis

Original Research Article

3-TESLA MAGNETIC RESONANCE IMAGING (3T MRI) OF THE FINGERS: IMAGING FINDINGS AND CORRELATION WITH FINAL DIAGNOSIS

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ABSTRACT

Background: Optimised MRI of the fingers utilises dedicated multi-channel, high-frequency surface coils to enhance signal reception on modern scanners equipped with powerful gradient systems. 3T MRI provides significant benefits by offering a stronger signal-to-noise ratio, enabling higher spatial resolution and shorter scan times. **Objective:** To enlighten the role of 3T MRI in imaging fingers, focusing on its diagnostic capabilities and accuracy in detailed visualisations of finger anatomy and pathology.

Materials and Methods: A cross-sectional observational study was conducted over three years (2021–2024) involving 60 patients presenting with symptomatic finger conditions. All subjects underwent high-resolution MRI on a GE Signa Architect 3T system using an 18-channel small flex coil.

Results: ROC analysis of MRI diagnosis with the final diagnosis result. It found that the AUC for MRI diagnosis was 0.62, and the association between MRI diagnosis and final diagnosis was statistically significant ($p<0.05$). The sensitivity, positive predictive value, and accuracy of the MRI method of diagnosing finger pathology compared to the final diagnosis were 91.6%, 91.6%, and 95.0%, respectively.

Conclusion: The reliability and diagnostic value of 3T MRI in identifying various musculoskeletal and vascular conditions involving the fingers, leading to effective and targeted treatments. Despite minor limitations in specificity, 3T MRI remains an indispensable tool for accurately diagnosing finger disorders and guiding appropriate therapeutic interventions.

Keywords: 3-Tesla Magnetic Resonance Imaging (3T MRI), Accuracy, Correlation, Finger lesions.

INTRODUCTION

The anatomy of the finger involves a sophisticated interplay among bones, joints, tendons, ligaments, nerves, and blood vessels.[1,2] In the long fingers, the distal and proximal interphalangeal joints (DIP and PIP) function primarily as hinge joints, whereas the metacarpophalangeal joints (MCP) act as ellipsoid joints to a certain degree.[3]

Finger joints are frequently among the earliest sites affected in rheumatoid arthritis (RA) and psoriatic arthritis (PsA),[4] and they are also commonly involved in osteoarthritis (OA).[5] In RA and PsA, the initial months of inflammation are particularly crucial, as irreversible structural damage may develop during this stage.[6,7] Such musculoskeletal destruction often results in loss of joint function.[8] Notably, the presence of bone erosions at diagnosis is strongly associated with unfavourable long-term radiographic and functional outcomes.

Optimised MRI of the fingers utilises dedicated multi-channel, high-frequency surface coils to enhance signal reception on modern scanners equipped with powerful gradient systems.[9] 3T MRI provides significant benefits by offering a stronger signal-to-noise ratio, enabling higher spatial resolution and shorter scan times.[10,11] Magnetic Resonance Imaging (MRI) plays a vital role in the

early identification of erosive changes, synovitis, and joint inflammation. Additionally, it is an excellent modality for evaluating ligament and tendon injuries, as well as detecting finger tumours and vascular abnormalities.[12] So, the present study was conducted to elucidate the role of 3T MRI in imaging fingers, focusing on its diagnostic capabilities and accuracy in detailed visualisation of finger anatomy and pathology.

MATERIALS AND METHODS

Study Setting:
This hospital-based cross-sectional analytical study was conducted among 60 Patients with finger symptoms undergoing 3T MRI at our tertiary care centre in Chennai, Tamil Nadu, from November 2021 to October 2024. The hospital is a tertiary care centre that serves patients from diverse socio-economic backgrounds in Chennai and neighbouring districts.

Inclusion Criteria

- Patient with symptoms pertaining to the fingers undergoing 3T MRI in our institution.
- Patients in whom the final clinical, laboratory and histopathological diagnosis was known.

Exclusion Criteria

- Any patient who was not compatible with an MRI study, i.e., patients with recent metallic implants, pacemakers, claustrophobic patients, etc.
- Patients with an unknown final diagnosis.
- Patients who have undergone a 1.5T MRI.
- Patients in whom a 1.5/3 T MRI of the thumb was performed.

Data Collection and Methodology

Procedure:

3T MRI was performed in patients with symptoms pertaining to the finger, i.e swelling, mass or stiffness, pain, etc., in the finger. Cases without histopathology or a final clinical or laboratory diagnosis have been excluded from the study. Imaging analysis of the confirmed patients has been done.

Laboratory Parameters: CBC, ESR, CRP, RF factor, Anti-CCP, Infective panel (Pus/Blood culture, AFB, Gene Xpert)

All the Images acquired in 3T MRI surface.

An 18 Channel Small Flex Coil was used (Figure 1)

The following sequences have been performed.

a) Axial/coronal/Sagittal- T1WI.
b) Axial/coronal/Sagittal- T2 WI.
c) Axial/coronal/Sagittal- PDFS.
d) Axial/coronal/Sagittal- STIR.
e) Axial/coronal/Sagittal- GRE.
f) Axial/coronal/Sagittal- DWI.
g) Coronal/Sagittal Dynamic MRA and TRICKS.

Contrast has been in challenging cases. Gadolinium has been used as an intravenous contrast agent at a dose of 0.1 mmol/kg body weight.

Machines Used: GE Signa Architect- 3T

Figure 1: 18-channel small flex coil

Data Analysis

Data were entered into Microsoft Excel and analysed using SPSS (version XX). Descriptive statistics, including mean, standard deviation, and percentages, were applied—sensitivity, PPV, accuracy and ROC curve statistics assessed between MRI diagnosis and final diagnosis. A p-value <0.05 was considered statistically significant.

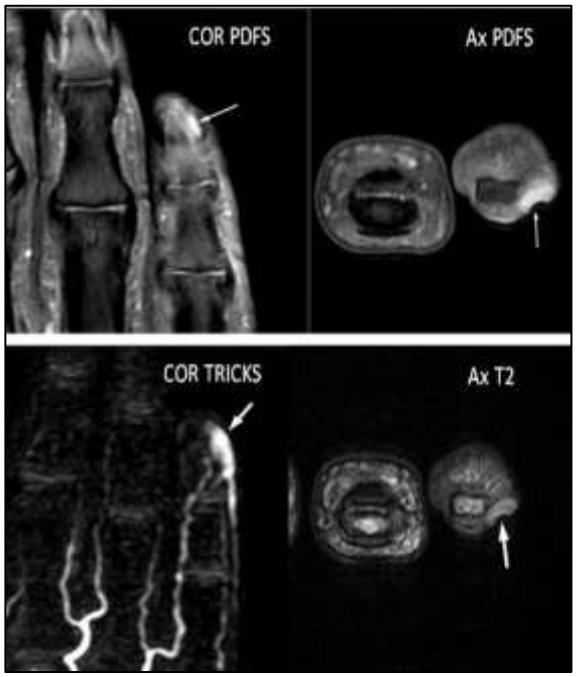

Figure 3: Glomus tumour [Case: 54-year-old male presented with pain in the little finger: MRI Findings - A well-defined T2/STIR/PDFS hyperintense is noted in the ulnar aspect of the subungual region of the little finger. It is seen extending into the lateral fold of the nail on the ulnar aspect. The lesion shows homogeneous, intense post-contrast enhancement. No evidence of blooming on the GRE. On Dynamic MR Angiography, it shows enhancement on the arterial phase of the study.]

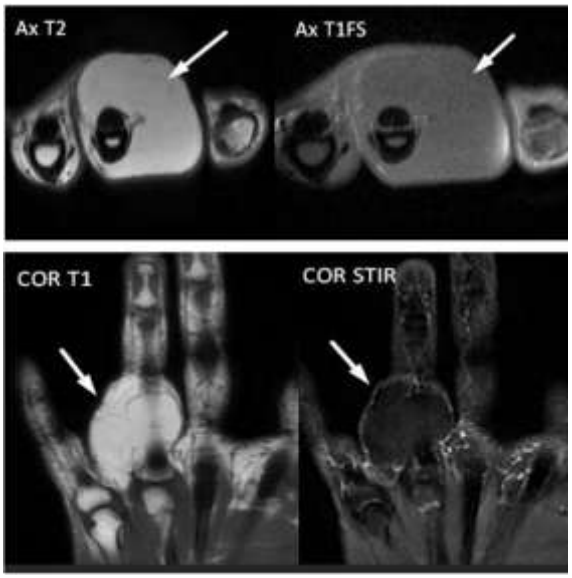

Figure 4: Lipoma [Case: 24-year-old female with swelling in the ring finger. MRI findings - An encapsulated, lobulated T1, T2 hyperintense, STIR homogeneously hypointense lesion in the proximal phalanx of the ring finger. Multiple thin septae are noted within the lesion. • Lesion is seen predominantly in the ventral and medial aspect. • The medial and dorsal part of the lesion is seen extending proximal to the level of the metacarpophalangeal joint. Interosseous muscles are not involved. • Distally extends up to the level of the proximal PIP joint. The lesion is seen enveloping the flexor and extensor tendons along their superficial surfaces. • Medial digital neurovascular bundle is encased within the lesion. • Lateral digital neurovascular bundle is abutted without encasement.]

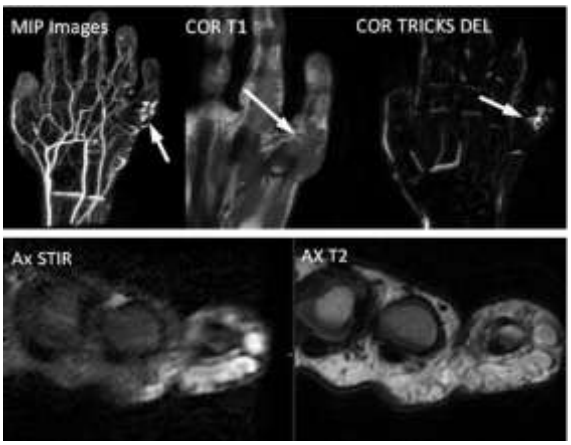

Figure 5: Arteriovenous malformations [Case: 13-year-old male with swelling around the fifth digit and skin discolouration. MRI findings: A T2/STIR hyperintense lobulated lesion is seen in the subcutaneous and intermuscular plane of the proximal ring finger (predominantly in the palmar lateral aspect) and also involving the proximal phalanx of the ring finger. It extends just distal to the proximal interphalangeal joint up to the 4th webspace, extending along the proximal phalanx of the V finger. The lesion extends along the palmar and volar compartments. Multiple fluid-fluid levels with tiny phleboliths are seen throughout the entire extent of involvement. On Dynamic MRA – The lesions show opacification in the venous and delayed phases. Strong enhancement seen in the post-contrast images.]

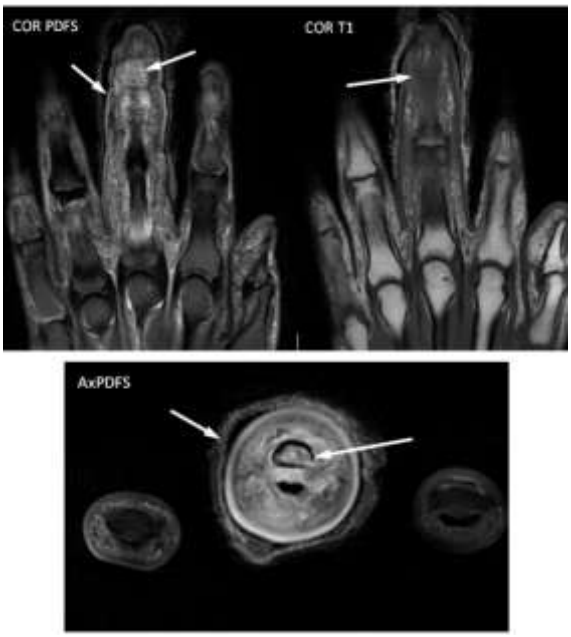

Figure 6: Osteomyelitis of the middle and distal phalanges of the third digit. [Case: A 57-year-old male with complaints of pain and swelling in the right middle finger. MRI findings: Altered marrow signal intensity is seen in the middle and distal phalanges of the third digit. Cortical irregularity is seen at the distal end of the middle phalanx. Surrounding thin rim of fluid is seen 2mm on the dorsal and volar aspects of the middle phalanx. Mild tenosynovitis of the flexor tendons of the 3rd and 4th digits was noted. Diffuse subcutaneous oedema is seen in the third digit and at the dorsal and volar aspects of the hand.]

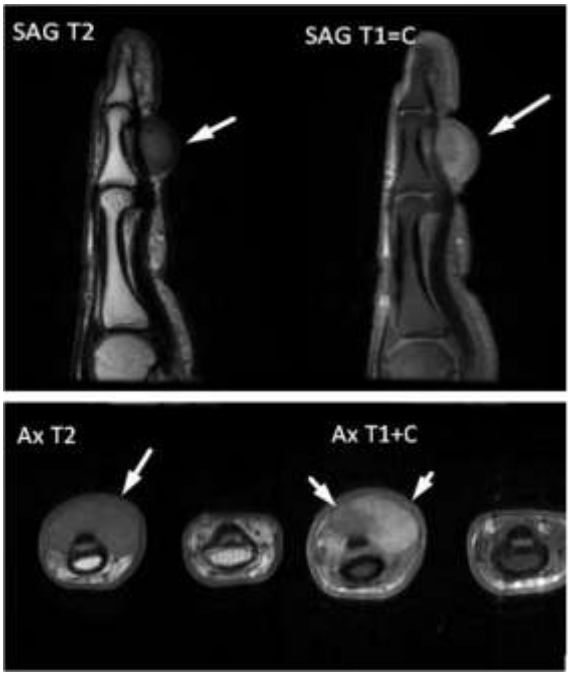

Figure 7: Tenosynovial giant cell tumour. [Case: 16-year-old male c/o right middle finger pain x 1 month following trauma while playing cricket. MRI findings: Proximal Interphalangeal joint: PDFS hyperintense signal noted within the ulnar collateral ligament– May represent sprain with grade I-2 tear. Oedema is also seen in the collateral bands of the extensor tendon, suggesting a sprain. Minimal effusion is seen in the PIP joint, with adjacent fluid in the volar plate region. Surrounding subcutaneous oedema noted.]

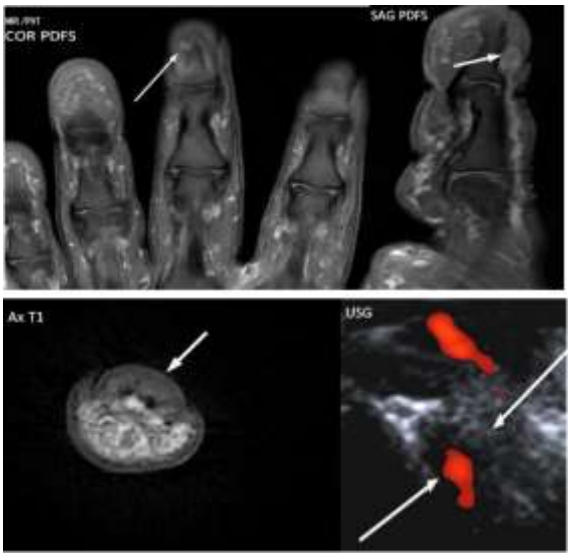

Figure 8: Glomus Tumour. [Case: 54-year-old male came with pain in the middle finger for 2 years. MRI findings: Well-circumscribed lesion, appearing hyperintense on PDFS sequence, is seen in the dorsal aspect of the right middle finger, in the subungual region on the radial aspect. The lesion is seen deep to the muscle plane and about the distal phalanx. On Ultrasound correlation: A well-circumscribed hypoechoic lesion with an adjacent feeding vessel is noted.]

RESULTS

Table 1 shows that 21.7%, 41.7%, 28.3%, and 8.3% of study participants were in the 0–19, 20–39, 40–59, and ≥60 years age groups, respectively. Mean age was 36.6 years with 16.2 SD. Almost 56.9% of study participants were male, and 43.1% were female. Presenting complaints like pain, swelling, deformity, restriction of movement (ROM), and trauma were noted in 73.7%, 70.49%, 9.8%, 13.11%, and 21.3% of study participants, respectively. Almost 80% of cases involved a single finger, and 20% involved multiple fingers. 48.3% of cases were noted with right-sided finger involvement, and 51.7% with left-sided finger involvement. Among the cases with right-side finger involvement, 34.5%, 24.1%, 17.2%, 6.9%, and 17.2% cases were noted with Middle, Index, Ring, Little, and Multiple finger involvement, respectively. Among the cases with left-side finger involvement, 19.3%, 9.6%, 25.8%, 22.6%, and 22.6% cases noted with Middle, Index, Ring, Little, and Multiple finger involvement, respectively.

Table 1: Socio-clinical parameters of study participants [N=60]

Parameter	Number	%
Age Group (in years)		
0-19	13	21.7
20-39	25	41.7
40-59	17	28.3
≥60	5	8.3
Mean ± SD (in years)	36.6 ± 16.2	
Gender		
Male	34	56.9
Female	26	43.1
Presenting Complaints		
Pain	45	73.7
Swelling	43	70.49
Deformity	6	9.8
ROM	8	13.11
Trauma	13	21.3
Number of fingers involved		
Single	48	80
Multiple	12	20
Side and Type of finger involved		
Right finger		
Middle	10	34.5
Index	7	24.1
Ring	5	17.2
Little	2	6.9
Multiple	5	17.2
Left finger		
Middle	6	19.3
Index	3	9.6
Ring	8	25.8
Little	7	22.6
Multiple	7	22.6

Table 2 and Figure 2 show the ROC analysis of MRI diagnosis with final diagnosis results. It found that the AUC for MRI diagnosis was 0.62, and the association between MRI diagnosis and final diagnosis was statistically significant ($p<0.05$). The sensitivity, positive predictive value, and accuracy of the MRI method of diagnosing finger pathology compared to the final diagnosis were 91.6%, 91.6%, and 95.0%, respectively.

Table 2: ROC and AUC of MRI diagnosis Vs final diagnosis [N=60]

		AUC	95% CI	P value
MRI Diagnosis		0.62	0.58 – 0.87	**0.04**

AUC = Area under the curve
CI = Confidence interval

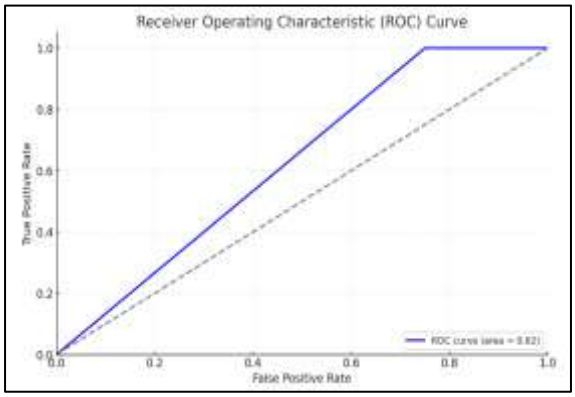

Figure 2: ROC Curve and Analysis

DISCUSSION

The present study found that the third decade (20-29 years) age group, representing 30.0% of the total participants, was followed by the second decade (10-19 years) at 20.0%. Individuals aged in their fifth decade account for 17.5% of the cases, while those aged in their fourth decade account for 12.5%. The male: female ratio was 1:0.8.

Our study revealed a distinct distribution of symptoms. Pain emerged as the most common complaint, reported in 73.77% of cases, followed by swelling or lesions at 70.49%. Deformity was relatively rare, reported in only 9.84% of cases, while restricted range of motion (ROM) and trauma are less commonly reported at 13.11% and 21.31%, respectively. These findings revealed the prominence of pain and swelling/lesions as primary concerns within the dataset, suggesting their paramount importance in patient presentation.

The present study observed greater involvement of conditions in the middle and ring fingers of both hands, with the little and index fingers less frequently affected. The 'multiple' category highlights broader issues impacting more than one finger.

To provide a comprehensive understanding of finger pathology, it is crucial to analyse the extent of finger involvement in affected patients. The analysis of finger involvement in our study revealed that most cases involved a single finger (80.0%), while multiple fingers were involved in 20.0% of cases. This distribution indicated that single-finger involvement is significantly more common than multiple-finger involvement.

MRI analysis revealed a diverse spectrum of musculoskeletal and soft-tissue abnormalities. Tumour and cystic lesions emerge as the most common diagnosis, comprising 28 (46.67%) of the total cases, followed by traumatic conditions at 8 (13.33%). Vascular and inflammatory lesions were observed in 7 (11.67%) cases, while infections were observed in 6 (10.00%) cases. Additionally, calcific tendinitis, normal findings, and congenital lesions were seen in 1 case each (representing 1.67% per condition). This distribution underscores MRI's comprehensive assessment, capturing various pathological entities affecting the fingers in the dataset.

The final diagnosis correlated with MRI findings in 55(91.7%) of the 60 cases. Tumour and cystic lesions are the most common, accounting for 23 cases (38.33% of the total), which correlates with the final diagnosis. Vascular lesions were observed in 10 cases (16.67%), of which seven correlated with the final diagnosis; the remaining 25 cases showed a positive correlation.

The analysis of MRI observations and their correlation with final findings showed high accuracy, particularly in diagnosing non-tumoral conditions, with all cases matching the final findings. For tumour and cystic lesions, although there were some discrepancies, the overall accuracy remained substantial, with 82.17% of cases matching the final findings. Notably, fibroma, lipoma, tenosynovial giant cell tumour, and exostosis showed the highest accuracy, each at 100%, followed by glomus tumours at 84.62%. However, nerve sheath tumours and ganglion cysts exhibited lower accuracy rates, with only 33.33% and 50.00% of cases matched, respectively. This analysis demonstrates MRI's reliability in diagnosing various musculoskeletal conditions, underscoring its effectiveness in clinical practice.

A study by Tamai M et al,[14] found that the severity of MRI-proven joint injury statistically significantly correlated strongly with that of joint injury on physical examination, underscoring MRI's accuracy in reflecting joint injury in early-stage RA patients. Serhal A et al,[15] have provided further support for these findings. Gombos Z et al,[16] reported a case series in which glomus tumours were often misidentified as AVMs on MRI. They noted that the overlapping imaging features, particularly in small lesions, contributed to the diagnostic confusion. The

results are supported by the findings of Sawani et al,[17] Glomus tumour was diagnosed in a 45-year-old male on MRI. However, the final diagnosis after surgery and HPE was capillary venous malformations. Glomus tumours exhibit high vascularity and can present with MRI characteristics similar to those of other tumours. The distinction is particularly challenging in superficial, small lesions, where detailed vascular architecture is difficult to visualise. Santoshi JA et al,[18] highlighted the difficulty in differentiating between glomus tumours and capillary venous malformations on MRI, due to similar signal intensities and enhancement patterns on post-contrast imaging. Glazebrook KN et al,[19] documented misdiagnoses between these entities, stressing the importance of detailed imaging protocols and, when necessary, adjunctive diagnostic techniques such as Doppler ultrasound. A study by Desai S et al,[20] concluded that 3T-MRI can be used for accurate diagnosis, to establish the extent, and to grade pulley injuries for appropriate patient management.

This study emphasizes the crucial role of 3T MRI in evaluating finger pathologies, showing a strong correlation with final clinical diagnoses. The results affirm the reliability and diagnostic accuracy of 3T MRI in detecting a wide range of musculoskeletal and vascular abnormalities affecting the fingers, thereby facilitating precise and effective treatment planning. Although minor limitations in specificity exist, 3T MRI remains an essential modality for the accurate diagnosis and management of finger disorders.

CONCLUSION

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Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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