

MR Imaging of Soft Tissue Masses of the Hand and Wrist: A Case Series

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Abstract:

Magnetic Resonance Imaging (MRI) plays a crucial role in the evaluation of soft tissue tumors of the hand and wrist. Given the intricate anatomy and a large variety of benign and malignant lesions that may arise in this region, accurate imaging is needed for diagnosis, surgical planning, and treatment guidance. MRI offers excellent soft tissue contrast and multiplanar capabilities, enabling detailed characterization of lesion size, location, tissue composition, and relationship to adjacent structures. Common benign tumors such as ganglion cysts, lipomas, and giant cell tumors of the tendon sheath, as well as less frequent malignant lesions, exhibit distinct MRI features that aid in differentiation. Advanced imaging techniques also assist in assessing vascularity, hemorrhagic components, and internal architecture. This abstract highlights the value of MRI in the comprehensive evaluation of soft tissue masses in the hand and wrist, emphasizing its utility in improving diagnostic confidence and optimizing clinical management.

Keywords: Ganglion Cysts, Lipomas, and Giant Cell Tumors of the Tendon Sheath.

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Introduction

Hand and wrist tumors can arise from various structures, including skin, fat, tendons, synovial sheaths, blood vessels, nerves, cartilage, and bone, comprising a notable percentage of soft tissue and bone tumors—approximately 15% and 6%, respectively [1,2].

The majority of these tumors are benign, particularly those not involving the skin, and are frequently identified early due to their superficial and easily palpable characteristics [3].

A precise preoperative diagnosis and understanding of the lesion's anatomical positioning in relation to adjacent structures is essential. This highlights the

necessity for a comprehensive knowledge of finger and hand anatomy in imaging, as well as familiarity with the radiologic characteristics of different pathological conditions. Recognizing the tissue of origin significantly assists in diagnosis, since lesions generally reflect the characteristics of their source tissue.

Case Series:

Case 1: Ganglion Cyst A 30 years old women presented with complains of painless focal swelling over the dorsum of left wrist for last 6 months.

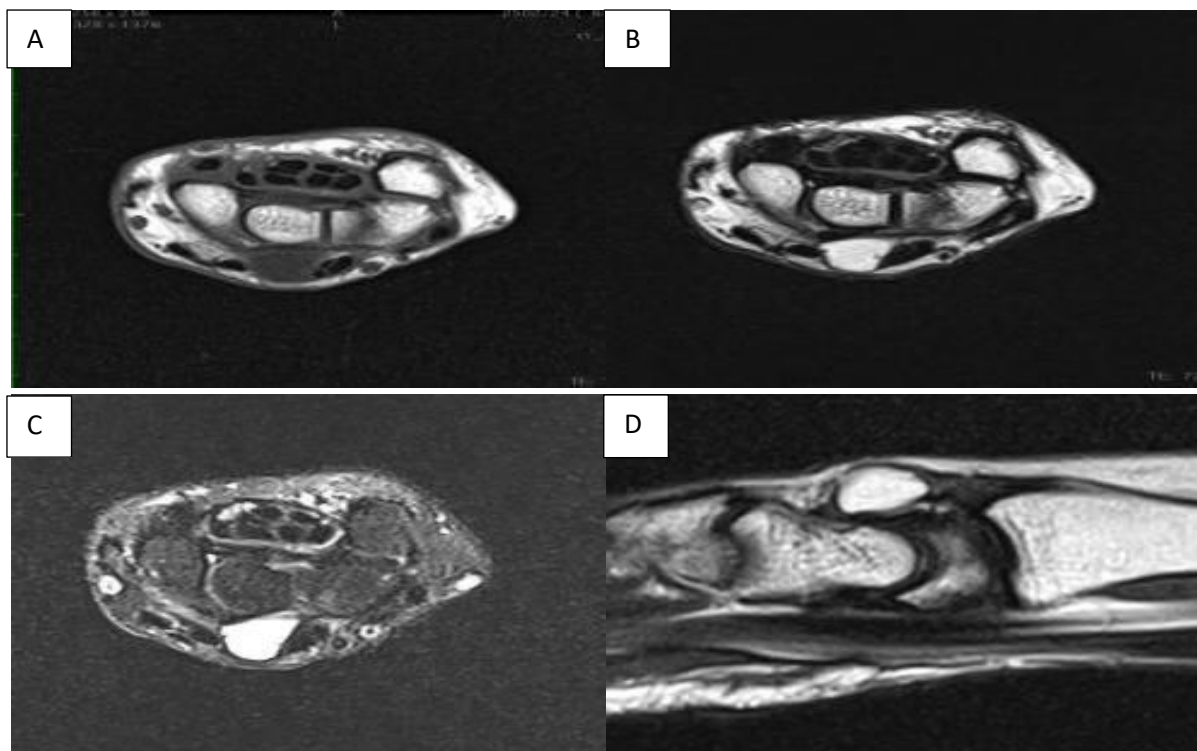


Figure 1: A,B,C and D are axial T1, T2 , STIR and sagittal T2WI respectively showing a well-defined oval shaped cystic lesion noted on the dorsum of wrist between the extensor digitorum and extensor pollicis longus tendons which is following fluid signal intensity on all the sequences.

Case 2: Giant Cell Tumor of the Tendon Sheath: A 35-year-old man presented with a gradually enlarging, painless swelling on the volar side of the right middle finger, present for the past five years.

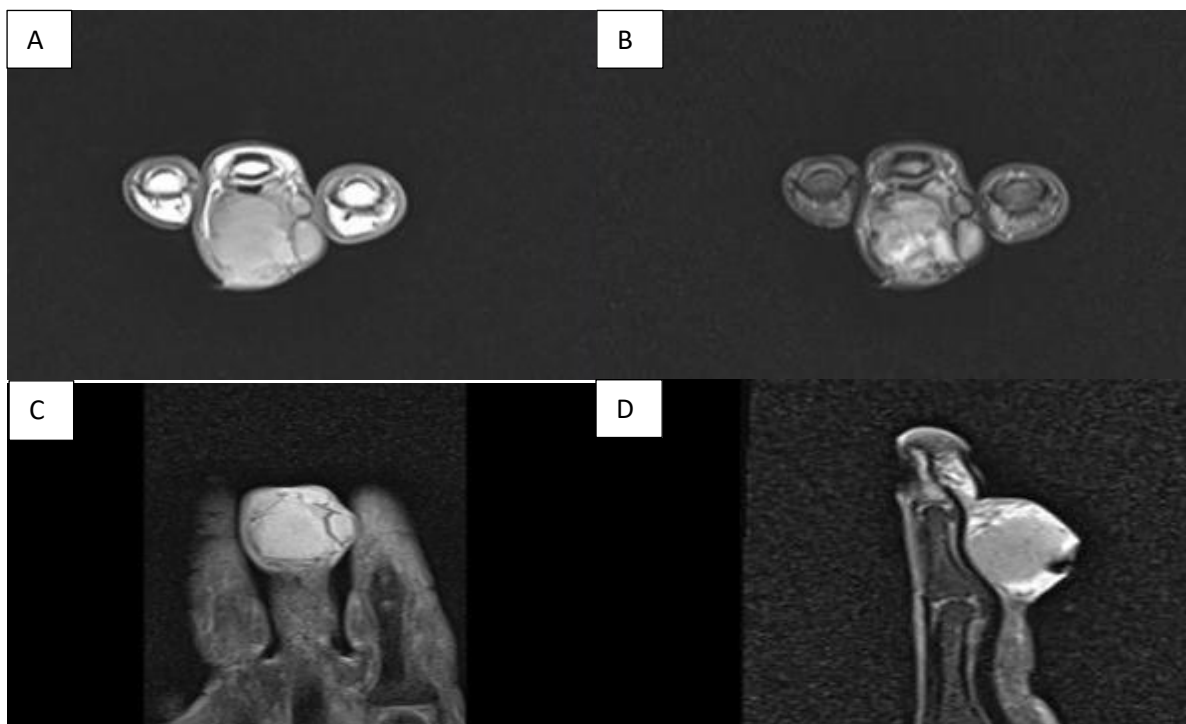


Figure 2: A, Fig. B, Fig C and Fig D are axial T1WI, axial STIR, coronal T1 fat sat and sagittal T1 post contrast images respectively shows a well-defined T1 low signal intense and STIR heterogenous signal intense round shaped lesion involving the ventral aspect of middle phalanx, arising from the tendon sheath with heterogenous enhancement on post contrast images.

Case 3: Peripheral Nerve Sheath Tumor: A 40-year-old female patient presented to our department with painless swelling over the radial aspect of left wrist for last 2 years.

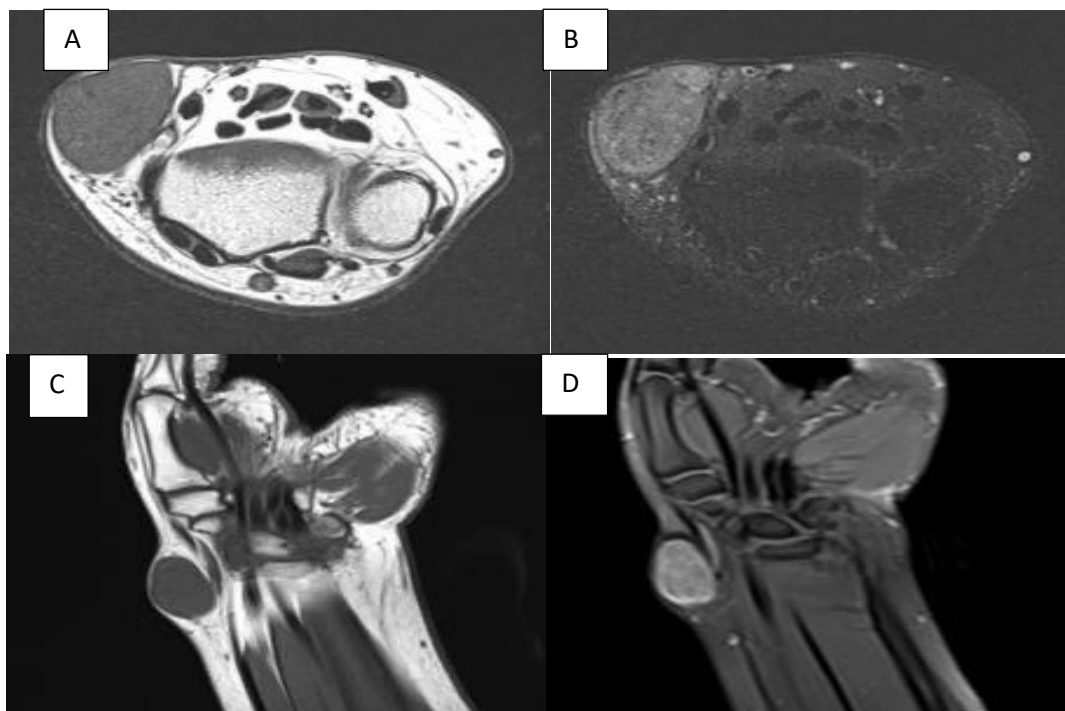


Figure 3: A well-circumscribed, oval shaped mass is noted in the course of the radial nerve, showing homogenous T1 hypointensity (Fig A and C) and heterogenous T2 hyperintensity (Fig B) and heterogenous enhancement on post contrast study (Fig D). On coronal T1WI (Fig C) the lesion shows a fine rind of fat around it suggesting split fat sign.

Case 4: Haemangioma: A girl aged 16years presented with complaints of soft tissue swelling over his left palm for last 2yrs. No history of trauma was given.

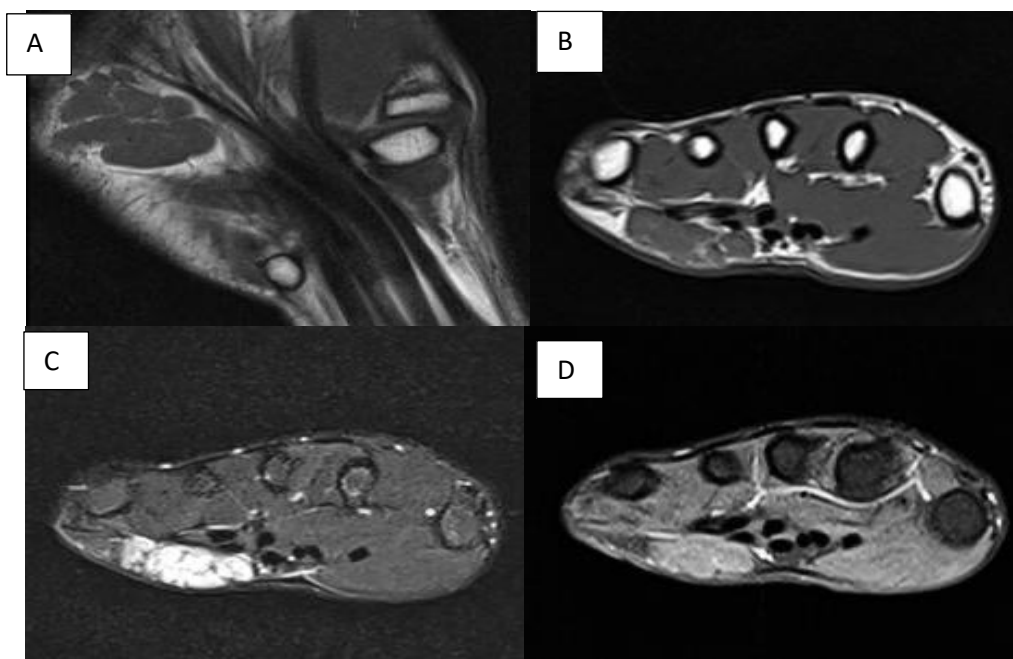


Figure 4: A well encapsulated lobulated soft tissue mass lesion is noted over the hypothenar aspect of palm in the subcutaneous plane. It is hypointense on T1WI (Fig A and Fig B) and is hyperintense on STIR sequence (Fig C) and is showing homogenous enhancement on post contrast sequence (Fig D).

Case 5: Arterio-Venous Malformation: A 48-year-old woman came with complaints of soft tissue swelling over her left forearm, wrist, and palm. The swelling has increased in size over the past 1 year.

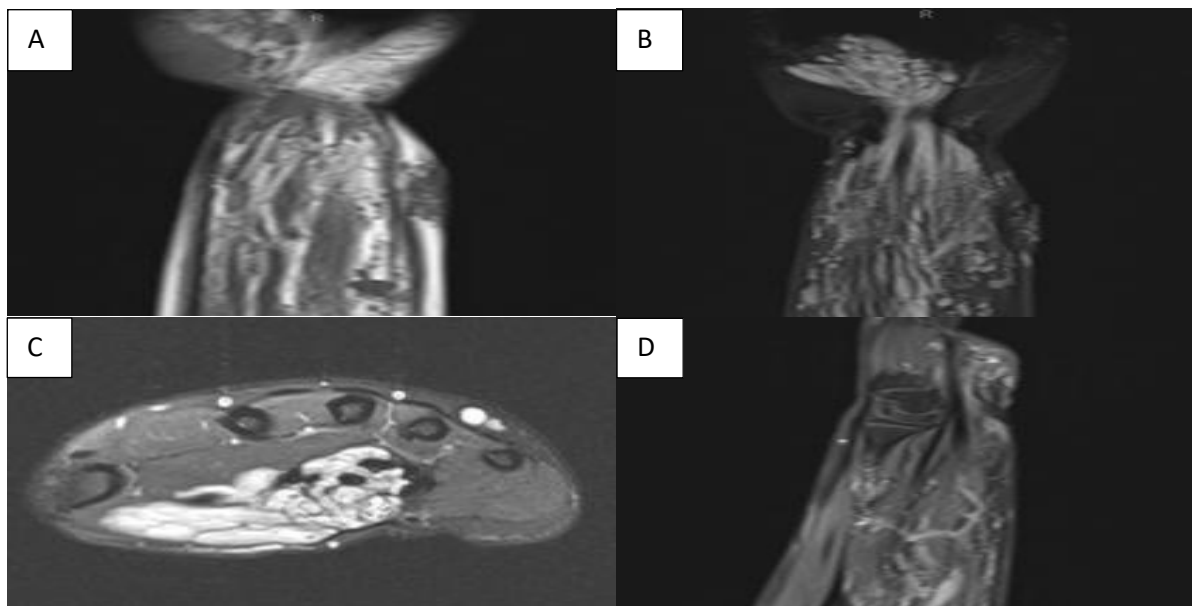


Figure 5: Fig A,B,C, and D are coronal T1, STIR , axial STIR and sagittal T1C+ images respectively showing multiple serpiginous tubular structures which are STIR hyperintense showing enhancement on post contrast study in the subcutaneous plane over the volar aspect of the left forearm ,wrist and palm.

Case 6: Fibrolipomatous Hamartoma of Median Nerve: A 28-year-old woman presented with a gradually enlarging mass on the volar side of the wrist, first noticed at the age of 2, which was initially painless. She now reports mild pain and a tingling sensation in the wrist and hand.

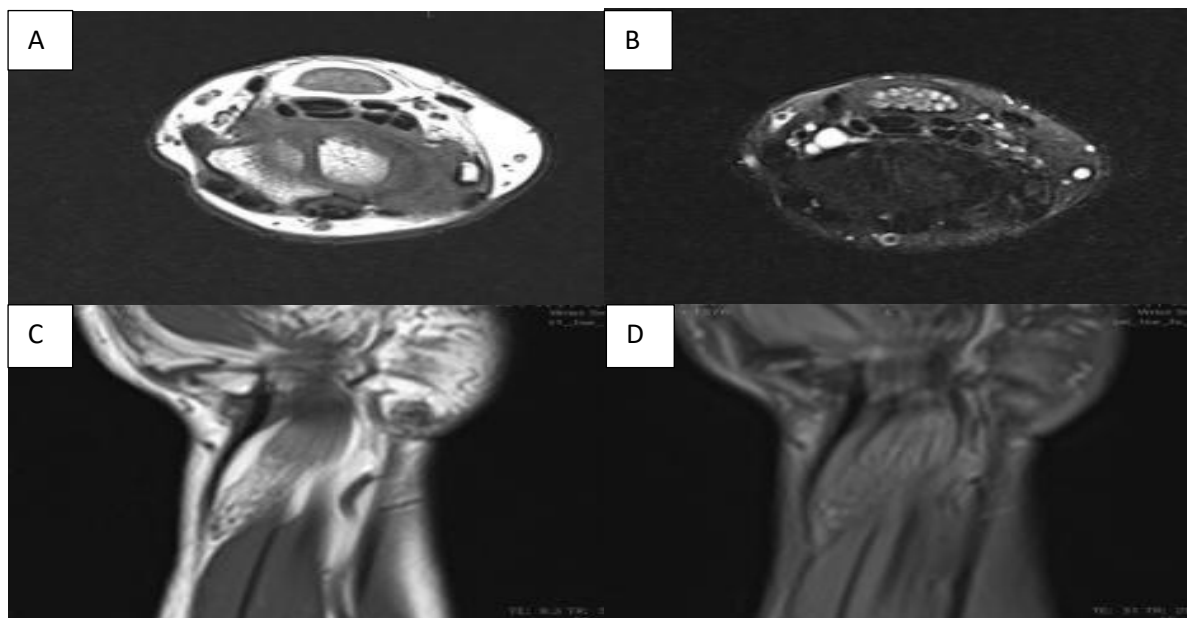


Figure 6: This is a case of fibrolipomatous hamartoma of median nerve. The involved nerve is grossly thickened with lipomatous tissue interdigitating between the prominent fascicles giving a coaxial cable like appearance in the axial sequence (Fig A and B) (4). The nerve is causing bowing and convexity of the overlying carpal tunnel retinacular sheath. There is homogenous suppression on the STIR sequence (Fig B and D).

Case 7: Macrodystrophia Lipomatosa of Index Finger: A 28-year-old man presented with gradually increasing soft tissue overgrowth and cosmetic deformity of the right index finger. There was no history of trauma.

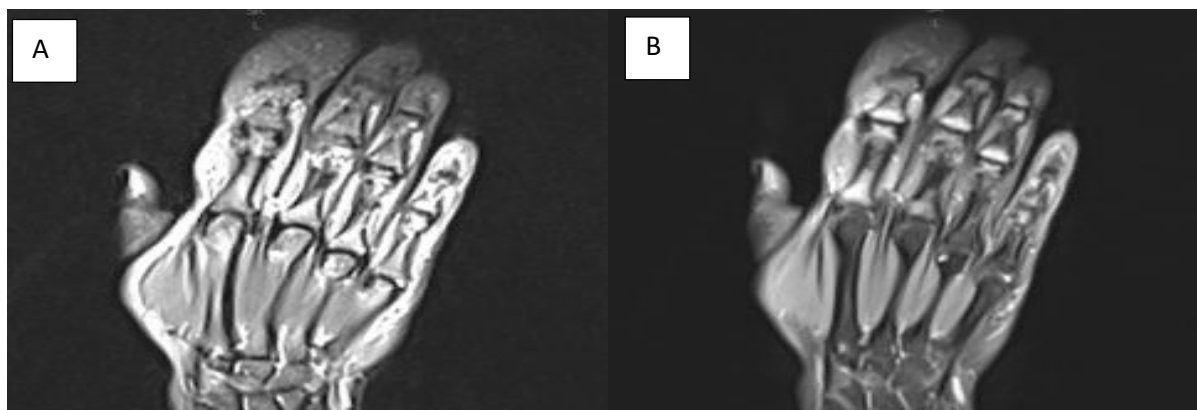


Figure 7: Fig A and B are the T1 and PDFS coronal sequences of the right hand showing fibrofatty soft tissue hypertrophy of the index finger.

Case 8: Glomus Tumor: A 40-year-old female came to our department with complaints of a red-blue nodular soft tissue swelling under the nailbed of the left index finger for last 2 years which was painful and sensitive to cold temperature and touch.

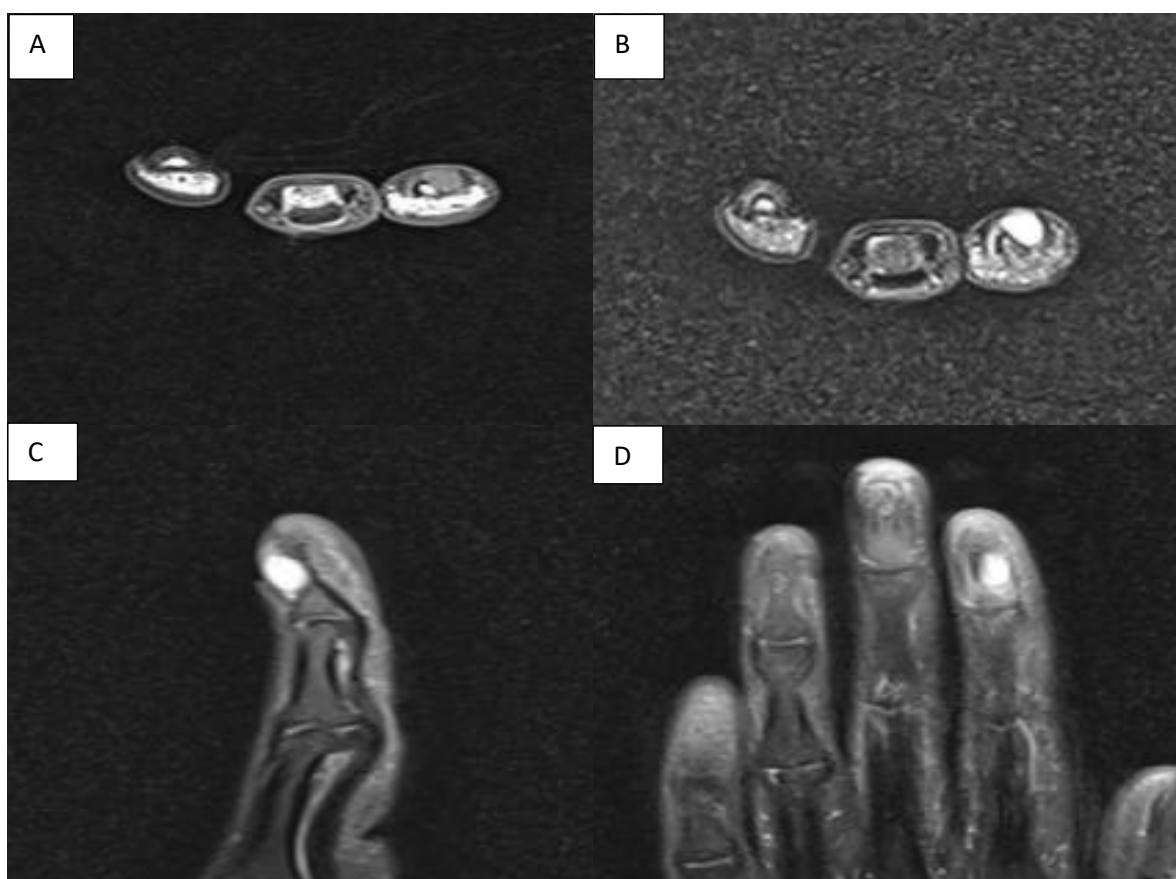


Figure 8: A well-defined homogenous soft tissue mass lesion noted over the dorsum of the distal phalanx. Fig A displays low signal on axial T1WI, Fig B and C displays high signal on axial (T2FS) and sagittal (PDFS) and Fig D (T1C+) displays avid post contrast enhancement.

Case 9: Lipoma: A 62-year-old woman presented to our department with a history of painless swelling over the ventral aspect of the proximal phalanx of the ring finger for last 5 years.

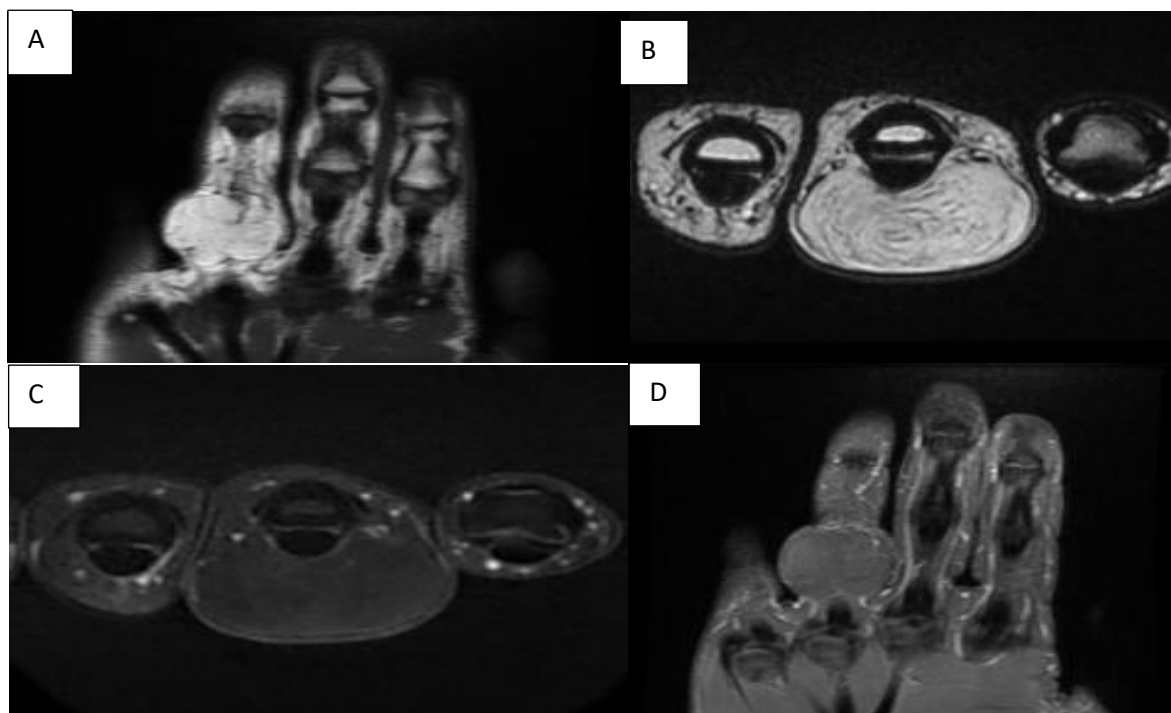


Figure 9: A well encapsulated lobulated soft tissue mass lesion is noted over the ventral aspect of the proximal phalanx of the ring finger. It is hyperintense on T1 and T2 WI (Fig A and B), shows suppression on STIR sequence (Fig C), not enhancing on post contrast sequence (Fig D).

Discussion

Ganglion Cyst

Ganglion cysts are the most commonly observed palpable masses in the wrist and hand, accounting for approximately 65% of all such lesions [5]. They are especially prevalent among younger individuals, who may seek medical attention due to discomfort or cosmetic concerns. While the exact cause remains uncertain, females are affected nearly three times more frequently than males [6]. These cysts are most often found on the dorsal side of the wrist, particularly in the region of the scapholunate ligament, with the volar wrist being the next most common site. Although their origin is usually idiopathic, studies have shown that around 10% of patients recall a traumatic incident prior to cyst formation [7]. This supports the widely held theory that repetitive stress or stretching of joint capsules and ligaments may stimulate local fibroblasts to produce hyaluronic acid, contributing to cyst development [8].

MRI Features – It appears round or lobulated, unilocular or multiloculated lesion with homogeneous signal characteristics on MR images. It is usually hyperintense on T1-weighted images and hyperintense on T2-weighted images due to its fluid content. The size can vary, and a connection to the joint capsule is often seen as a narrow stalk or tail. In cases where there is internal hemorrhage or proteinaceous debris, the signal becomes more complex with mixed intensity on both T1- and T2-weighted sequences [4,9]. While contrast administration is generally unneces-

sary, a thin rim of peripheral enhancement is common [10]. However, a thick or irregular enhancing wall may indicate inflammation or infection, and any solid enhancement should prompt consideration of other pathologies.

Giant Cell Tumor of the Tendon Sheath

Tenosynovial giant cell tumors (TGCTs) are the second most frequent type of hand mass after ganglion cyst. They commonly occur in individuals between 30 and 50 years of age, with a median age of approximately 47 [11,12]. Clinically, they may present as a solitary nodule (localized form), multiple nodules along the tendon sheath, or as joint pain and swelling when located intra-articularly. These tumors are most often found on the volar aspect of the radial three digits, particularly near the distal interphalangeal joints [13].

As a slow-growing benign lesion, TGCTs originate from the tendon sheath and are the most prevalent solid tumors seen in the hand and wrist. They typically arise between the third and fifth decades of life and are slightly more common in women. The tumor represents a localized proliferative process of the synovium within the tendon sheath and is considered the localized counterpart of pigmented villonodular synovitis (PVNS) [14]. These masses are most frequently located on the palmar side of the fingers, followed by the wrist, and are often painless—sometimes identified only due to visible swelling or incidentally during imaging or examination.

MRI Characteristics – Giant cell tumor of the tendon sheath (GCTTS) appears well-circumscribed and closely related to an adjacent tendon. On MRI, it shows low signal intensity on both T1- and T2-weighted images with moderate enhancement after contrast administration. Susceptibility artifacts and blooming effects, often due to hemosiderin deposits, are commonly observed [15].

Peripheral Nerve Sheath Tumors

Peripheral Nerve Sheath Tumors (PNSTs) originate from Schwann cells—either surrounding the nerve (as in schwannomas) or from cells within the nerve fascicles (as seen in neurofibromas). Together, these tumors make up about 5% of all benign soft tissue masses [16]. These tumors most commonly affect adults aged 20 to 50, with no notable difference in incidence between genders [17]. They are typically found along the volar aspect of the hand and wrist and are often linked to larger nerves, such as the ulnar nerve [4,17]. Patients usually present with a gradually enlarging, painless mass. However, applying pressure to the mass may produce paresthesia due to its neural origin.

MRI Characteristics - PNSTs generally appear as well-defined, spindle-shaped lesions. A notable imaging feature is the “split fat sign,” where surrounding fat separates around the traversing nerve fascicles. Schwannomas are typically positioned eccentrically in relation to the involved nerve—especially evident when larger nerves are affected. Neurofibromas, on the other hand, tend to be centrally located within the nerve and closely intertwined with the fascicles [4]. On MRI, PNSTs are characteristically hypointense on T1-weighted images and hyperintense on T2-weighted sequences. A “target sign” may be seen, especially in neurofibromas, consisting of a hyperintense peripheral rim with a central area of low signal on T2-weighted images—although this feature can also be occasionally observed in schwannomas [18,19]. Cystic degeneration, more frequently found in schwannomas and malignant PNSTs, can lead to a heterogeneous enhancement post contrast study [20]. In contrast, smaller PNSTs often exhibit uniform post-contrast enhancement.

Vascular Lesions

The most frequently encountered vascular anomalies in the upper limb are hemangiomas and vascular malformations, both of which are typically recognized during childhood. Hemangiomas are more prevalent and show a marked female predominance, with a female-to-male ratio of approximately 5:1 [21].

Hemangiomas generally undergo a phase of rapid growth (proliferation), followed by spontaneous regression. Around 90% of these lesions resolve by the age of nine, although some may persist into adulthood. Diagnosis is primarily clinical; however, MRI

can be helpful in confirming the diagnosis. On MRI, hemangiomas typically appear hyperintense on T2-weighted images and enhance following gadolinium administration. The enhancement may appear heterogeneous due to the presence of both high-flow and low-flow vascular components.

In contrast, vascular malformations do not regress over time and tend to enlarge in proportion to the child’s growth [21]. These anomalies are categorized based on flow dynamics into low-flow types such as venous and lymphatic malformations and high-flow types such as arteriovenous malformations. MRI of AVMs typically reveals lesions that are isointense on T1-weighted sequences and hyperintense on T2-weighted images [22].

Fibrolipomatous Hamartoma

These are benign, slow-growing lesion probably originate from hypertrophied mature adipocytes and fibroblasts within the epineurium of nerves [22]. Dense fibrofatty tissue infiltrates the endoneurium, perineurium, and epineurium; however, the nerve fascicles themselves remain structurally preserved and unaffected. It typically affects children or young adults and is most commonly found on the flexor aspect of the forearm, wrist and hand, with the median nerve involved in approximately 85% of cases [22]. Clinically, it may manifest as pain, swelling, or paresthesia due to its compressive effects. It can also be associated with macrodactyly, a condition referred to as macrodystrophia lipomatosa [4,22].

MRI Characteristics - The lesion displays a characteristic appearance on imaging, with fusiform enlargement along the nerve’s path and displacement of adjacent anatomical structures. On T1- and T2-weighted MRI, it appears as hypointense cylindrical structures—representing nerve fascicles—encased by areas of fat signal intensity [5,10]. This characteristic appearance has been likened to 'spaghetti' on coronal images and a 'coaxial cable' on axial views [4].

Glomus Tumor

Glomus tumors are rare perivascular growths originating from the glomus body, typically found in the distal phalanx or beneath the fingernail. While the majority are benign, some may exhibit malignant features and behave aggressively. The glomus body, located under the nail or within the finger pulp, is a neurovascular structure involved in temperature regulation. These tumors represent approximately 1–5% of all hand tumors and are most commonly diagnosed between the fourth and sixth decades of life [23]. Solitary glomus tumors show a slight predominance in females. Although their exact cause often remains unknown, many cases exhibit genetic alterations such as NOTCH gene fusions, and a smaller portion show BRAF mutations [24, 25].

Glomus tumors in the subungual and phalangeal regions are usually under 1 cm in size and often present with a characteristic triad: localized tenderness, heightened pain when exposed to cold, and intense discomfort after minor trauma [26]. Due to their small size and uncommon nature, diagnosis is frequently delayed—on average by about seven years [27].

When the tumor involves the area beneath the nail, it can result in nail plate discoloration or deformation. While glomus tumors affect both sexes equally overall, subungual lesions are more frequently observed in females. These tumors generally present in the fourth or fifth decade of life and are characterized by intense pain that is often aggravated by temperature fluctuations [14]. They may be palpable and are usually highly tender.

MRI Characteristics – MRI plays a crucial role in diagnosing glomus tumors, identifying multiple lesions if present, and precisely localizing the tumor before surgery—especially since these lesions are often very small and difficult to detect intraoperatively. On imaging, glomus tumors typically appear hypo- to isointense on T1-weighted images, hyperintense on T2-weighted images, and exhibit uniform enhancement after administration of gadolinium-based contrast.

LIPOMAS

Lipomas are relatively rare benign soft tissue tumors in the hand and wrist, though they are commonly found throughout the body. Typically, they present as painless, slow-growing masses and only become symptomatic when they compress nearby nerves or tendons [5,11]. These tumors can develop in either subcutaneous or intramuscular compartments and can vary in size, though they infrequently exceed 10 cm [28,29]. Compared to other body regions, lipomas in the hand and wrist are usually located more deeply. On conventional radiographs, a lipoma may exhibit the “Bufalini sign” [30].

MRI Features – Lipomas typically appear as hyperintense on T1-weighted images due to their fatty composition, with complete signal suppression on fat-saturated sequences [3]. They may contain thin internal septations that show minimal enhancement.

However, the detection of thickened or irregularly enhancing septa should prompt consideration of a potential liposarcoma or atypical lipomatous tumor, the latter being equivalent to a well-differentiated liposarcoma in the extremities [30]. Hemorrhage within the lesion may alter the imaging appearance and mimic malignancy [9]. Management includes either observation or marginal surgical excision, with recurrence being uncommon.

Conclusion

MRI serves as a highly effective, non-invasive imaging modality for the evaluation of soft tissue tumors in the hand and wrist. Its excellent soft tissue contrast, precise visualization of anatomical structures, and ability to assess lesion composition make it an essential tool for differentiating benign from malignant masses, guiding biopsy procedures, and aiding in surgical planning. Understanding the typical MRI appearances of various soft tissue masses, along with their clinical and pathological correlations, enhances diagnostic accuracy and helps avoid unnecessary procedures. Incorporating MRI into routine evaluation significantly improves clinical decision-making and contributes to better patient outcomes.

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