A CLINICO-RADIOLOGICAL CORRELATION OF WRIST JOINT PAIN

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ABSTRACT

BACKGROUND

Wrist joint pain is one of the commonest conditions that are encountered in the orthopaedics. It is increasing because of repetitive stress injury caused by increased use of personal computers, laptops and mobile phones. Accurate diagnosis is made clinically and confirmed by imaging modalities before any treatment is undertaken. The imaging modalities used are x-ray and ultrasonography.

The objectives of this study is to evaluate a patient by ultrasonography as first line of imaging modality. To use US along with x-rays and clinical examination to aid in quick and decisive diagnosis, to delineate pitfalls during image interpretation and limitation of ultrasonography.

MATERIALS AND METHODS

Perspective analysis of 100 patients presenting with wrist pain were included in our study. All patients underwent thorough clinical examination followed by x-ray (PA and Lateral) of the affected wrist and ultrasonography of the affected wrist with comparison of opposite side.

RESULTS

We were able to find various conditions like synovitis, neurogenic masses, injuries, etc.

CONCLUSION

Ultrasonography examination can be used as the first line of imaging investigation for a case of wrist pain as it is inexpensive, real time and allows for comparison with the opposite side.

KEYWORDS

X-ray, Ultrasonography, Wrist Pain, Tenosynovitis.


BACKGROUND

Ultrasonography (USG) is an imaging modality that uses sound waves in the higher frequency range, which normally cannot be heard by human beings. It is ideal initial imaging device after plain radiograph; it provides economical and non-invasive imaging of tissue. Extended Field of View (EFOV) and Tissue Harmonic Imaging (THI) is a new USG technique that can potentially provide images of higher quality than conventional method. This allows for improved display of large lesions and visualisation of anatomic relationships. We also utilised colour Doppler to assess acute change and vascularity of the lesion. Plain film radiography is the most widely used imaging modality in the evaluation of the musculoskeletal system. Conventional radiographic studies are readily available, relatively inexpensive and non-invasive.

Anatomy of the hand and wrist is complex and the pathologic conditions encountered are diverse. We have evaluated 100 cases in this study and they were subjected to plain x-ray and USG. Main cases in our study were tenosynovitis, ganglion, cystic and solid masses and nerve tumours.

MATERIALS AND METHODS

In a study of 100 patients a detailed history, general physical and wrist joint examination was done followed by x-ray and USG. We included patients above 25 yrs with history of pain in either wrist joints. We have excluded patients of acute trauma or any congenital abnormalities. Plain film radiography is the most widely used, readily available, relatively inexpensive and non-invasive. It depends on the natural contrast between the five radiographic densities like air, fat, water, bone and metal. A basic premise in plain film evaluation is the necessity of having a minimum of two views, preferably perpendicular to each other, i.e. Antero-Posterior and Lateral. Key benefits are the demonstration of bony landmarks and the ability to assess contiguous structures over considerable length. Ultrasound travels as a longitudinal wave; higher frequencies are associated with improved spatial detail or better resolution. USG was done of the affected wrist and other healthy side was used as control. All scans were done on Voluson 730 using the high-frequency linear array probe 6 - 12 MHz (Million Hertz).
We utilised the USG to its fullest along with EFOV, TH1 and Colour Doppler. USG has many advantages. First - it shows the abnormality and appropriate landmarks such as joints, muscles or vessels remote from the lesion. Second - it is useful in comparing measurements at follow-up scanning. Thirdly - clinicians can readily see the abnormality as a result, be more willing to accept the less expensive, more readily available USG.(4) Portion of the tendon must be examined individually and integrity should be primarily determined during real-time scanning. The combination of high-resolution probes and the power Doppler allow clear depiction of even minimal increases of perfusion in several inflammatory conditions including tenosynovitis and enthesitis.(5) Ultrasound accurately characterises masses of the hand and wrist as cystic or solid and can be used to obtain specific diagnoses for the majority of these lesions.(2) Anatomy is the first thing to be considered for the wrist, because it is a complex and unusual joint. Normal function depends on the integrated action of a number of tissue structures including the carpal and forearm bones, the intrinsic and extrinsic ligaments, tendons and the components of the Triangular Fibrocartilage Complex (TFCC). We should have knowledge of these articulating surfaces, fibrous capsule, synovial membrane, vascular supply, innervations along with flexor retinaculum to understand it better. Sonographic technique and appearance - The patient is asked to expose both the wrist joints simultaneously and is made to sit on a stool close to and facing the US machine. Both static and dynamic examination of the wrist was assessed. Hand is placed in an appropriate position for imaging of the specific areas of interest. Transverse, longitudinal and extended-field-of-view images were obtained.

Normal tendon consists of fascicles of type I collagen and it is oriented mainly parallel to the long axis and is grouped together in bundles. On USG they are echogenic fibrillar structures that consists of multiple parallel lines in longitudinal planes and multiple dots like echoes in transverse planes. It is usually surrounded by the paratenon and epitendineum. Around it is synovial sheath and is depicted as a thin echogenic fluid-containing structure that surround the echogenic tendon fibres. The synovial fluid is usually but not always anechoic. A small amount of fluid is frequently seen within the extensor tendon sheaths of the wrist or hand in individuals with normal anatomy. Ligaments consist mainly of type I collagen fibres, typically oriented in sheets that may be grouped together in bundles. By USG they are seen as echogenic fibrillar structures. Nerves are composed of multiple axons that are bundled together in neuronal fascicles. They are depicted as multiple parallel hypoechoic areas (groups of fascicles) surrounded by echogenic perineurium and epineurium. Extensor surface of the wrist - The transducer is placed transversely across the wrist for the initial assessment. Two key structures define the sonographic anatomy of the extensor surface of the wrist. They are the extensor retinaculum and the dorsal tubercle of the radius (Lister tubercle).(6) Deep to the extensor retinaculum are six tunnels that are formed by its attachments to the radius and ulna. Each tunnel contains a single synovial sheath that surrounds one or more extensor tendons. There are six compartments around the wrist, which should be systematically evaluated while doing USG [Figure - 1, 2, 3]. Intrinsic ligaments of the wrist - The two most important are the scapholunate and lunotriquetral should be seen.

Triangular Fibrocartilage - It is seen as a homogeneously echogenic inverted triangular structure deep to the extensor carpi ulnaris tendon. Tears in this in the ulnar aspect of the cartilage also may be depicted at sonography [Figure 4]. Flexor surface of the wrist - Here flexor retinaculum is the key anatomic structure that defines the anatomy of the flexor surface of the wrist. There are eleven flexor tendons in number [Figure 5]. Median Nerve, Ulnar Nerve and Guyon’s Canal - The median nerve lying within the carpal tunnel is seen elliptic in outline and seems to become progressively flatter as it passes through the canal. A prominent median artery may accompany the median nerve. The ulnar nerve at the wrist lies within the Guyon’s canal. On transverse USG, ulnar nerve is seen as a rounded structure with a location medial to the ulnar artery. Both the median and the ulnar nerves may be involved in nerve entrapment syndromes (Carpal tunnel syndrome and Guyon’s canal syndrome, respectively) due to the strict confines of their fibro-osseous tunnels.

RESULTS
We have reviewed 100 cases. The age distribution reveals that 37% were between 25 - 34 years, 23% between 35 - 44 years, 23% were between 45 - 54 years and rest 17% were above 55 years of age. Our patients were equal in sex ratio. Socioeconomic status of study subjects concerned 74% of middle, 23% of lower and the rest 3% from high class. Chief complaints of patients 99% having pain, 30% had swelling, 4% with numbness of fingers and 2% had restriction of movements of wrist. Majority were having more than one symptom. About 33% were having it for 21 - 40 days, 26% for 41 - 60 days, 21% for 1 - 20 days and the rest of 20% were having it for a long time i.e. 61 - 80 days. Right wrist involvement in 53% and left in 47% cases. Nine had hypertension and 7 were diabetics. Our 32% of patients had swelling, 1% had abnormal position and 1% had deformity of the wrist. On palpation of wrist it was noted that 99% had tenderness, 32% with swelling and 1% had deformity. Types of movements of the wrist joint revealed that 73% had type B, 26% type D and rest 1% had type A. Analysis of x-ray findings shows that 95% were normal and remaining 5% had abnormal findings. By USG 10 had De Quervain’s tenosynovitis, 6 had flexor tenosynovitis, 6 with extensor tenosynovitis and 1 with tendon rupture [Table 1]. Ulnar nerve was seen in 3 and 2 had median nerve involvement. Only 1% had vascular pathology. Analysis of ultrasound showed 24% had focal, cystic in 21 (simple-12 and infected-9) and 3% had solid masses [Table 2]. Out of these 13 had flexor and 8 with extensor aspect involvement. Our 99% of patients had no joint involvement. The frequency of case detection from USG was more, 51 (51.0%) compared to x-ray 5 (5.0%), the difference was found to be statistically significant (χ2 52.5, P = 0.001) [Table 3].

![Figure 1. (a), (b) Photographs showing the Normal Position of the Wrist and the Transducer for Evaluation of Tendons of the Extensor Compartment. (c) Transverse USG Image shows Tendons Extenord Carpi Radialis Brevis (ECRB) and Longus (ECRL)](image)
Figure 2. Transverse USG Image shows Extensor Tendons - Extensor Carpi Radialis Longus and Brevis (ECRL and ERCB), Extensor Pollicis Longus (EPL), Compartment IV and Compartment V

Figure 3. Photographs showing the Normal Position of the Wrist and the Transducer for Evaluation of the Flexor Surface of the Wrist Joint

Figure 4. (a) Photographs showing the Normal Position of the Wrist and the Transducer for Evaluation of Triangular Fibrocartilage Complex (TFCC). (b) Longitudinal USG Image shows the Echogenic Triangular Fibrocartilage Deep to the Extensor Carpi Ulnaris (ECU) Tendon

Figure 5. Transverse USG Image shows Flexor Tendons

Figure 6. Extensor Ganglion Cyst with Low Level Echoes and Thin Septation

Figure 7. Carpal Tunnel Syndrome (a) Transverse (b) Longitudinal USG Images at the Level of Pisiform shows Abnormally Enlarged Median Nerve with Diameter of 14 mm and Increased Palmar Bowing of Flexor Retinaculum

Figure 8. De Quervain’s Disease (a) Transverse and (b) Longitudinal USG Image with Colour Doppler through the First Extensor Compartment showing Tendon Thickening and Hypoechoic Tendon Sheath Collection showing Increased Vascularity, (c) Longitudinal Extended FOV and (d) Doppler Image showing Hypoechoic Tendon Sheath
Figure 9. Extensor Tenosynovitis - (a) and (b) X-ray Wrist showing Soft Tissue Swelling. Transverse and Longitudinal USG Images with Doppler (c, d, e, f) showing Extensive Tendon Sheath Thickening involving all Extensor Tendons with Hypoechoic Tendon Sheath with Increased Vascularity

Figure 10. Flexor Tenosynovitis (a) Transverse USG Image with (b) Doppler showing sheath Thickening and Hypoechoic Tendon Sheath Collection with Increased Vascularity

Figure 11. Giant Cell Tumour of Tendon Sheath. Transverse (a) and Longitudinal, (b) USG Image showing a Heterogeneous Hypoechoic Mass Lesion Overlying the Tendon Sheath Partially surrounding the Tendon which was also Immobile

Table 1. Findings of Ultrasonographic Examination of Tendons

<table>
<thead>
<tr>
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<tr>
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<td></td>
</tr>
<tr>
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<tr>
<td>Total</td>
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</tr>
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</table>

Figure 12. a, b, c USG Images showing Vascular Malformation with Swelling and Doppler Signals

Figure 13a

Figure 13b

Figure 13. Nerve Sheath Tumour – Neurofibroma. PA Projection of Wrist Joint shows Soft Tissue Swelling Transverse USG Image showing a Lobulated Heterogeneous Soft Tissue Mass Lesion with Few Areas of Cystic Degeneration with Colour Doppler showing Increased Vascularity within the Lesion
DISCUSSION

Ultrasound was first utilised for nautical purposes after the sinking of the Titanic in 1912. This ‘echolocation’ technology was used to detect icebergs, which later expanded during WW I and WW II to identify submarines. The first medical ultrasound was used in 1942. The use of ultrasound in musculoskeletal system started in 1958. In 1978, ultrasound technology started to be used to demonstrate synovitis in rheumatoid arthritis patients. In the present study, majority of the patients had swelling and all had tenderness. About movements, majority had type B - 73%, i.e. mild pain with no restriction, type D - 26% i.e. pain with restriction. One patient had type A, i.e. no pain with no restriction. Type C is no pain with restriction. Causes of wrist pain with salient clinical and USG features of few diseases –

(1) Ganglion Cyst - It is usually diagnosed clinically. It is a fibrous swelling often multilobular, arising near a joint or tendon sheath and containing a clear mucinous fluid. It is seen between 33 and 70% cases of swellings of the wrist. Peak incidence between 10 and 40 years. Basic elements are main cyst, stalk or pedicle, capsular cysts and the attachment to the joint or tendon sheath.(7) Most common symptoms are pain, swelling and weakness. They are most commonly (60% - 70%) found dorsally over the scapholunate ligament followed by a volar location adjacent to the flexor carpi radialis and radial artery.(8) They are 1 - 2 cm cystic structures may cause paraesthesia from compression of the ulnar or median nerves.(9) USG sensitivity is 90%, they are typically anechoic with well-defined walls, some cases a tortuous neck and folds or septations is seen [Figure 6]. Small ganglion cysts (< 10 mm) are hypoechoic, larger are anechoic with posterior acoustic enhancement.(8) Most are complex larger, well-defined, thick walls, locules, acoustic enhancement with some has blood flow and internal reflectors. Solid-appearing ganglia, although unusual may mimic a benign neoplasm or synovitis.(10) In addition to diagnosis ultrasound can be used to guide aspiration and the injection of steroids into ganglia.(11)

(2) Entrapment Neuropathy - They are more common Carpal Tunnel Syndrome (CTS) and the rarer Guyon’s Canal Syndrome (GCS).(12)

A) Carpal Tunnel Syndrome (CTS) - It is the most well-known, frequent and accounts for 90% of all entrapment neuropathies. It was first reported by Phalen in 1950.(13) In this decreased function of the median nerve is seen; it is present in 3.8% of the general population. Symptoms are pain, numbness and tingling sensation. In the distal distribution of the median nerve (thumb, index, middle finger and the radial side of the ring finger) and a reduction of the grip strength and function of the affected hand. Symptoms tend to be worst at night and clumsiness is reported during the day with activities requiring wrist flexion. Patients often describe a phenomenon termed the “flick sign” in which shaking or flicking their wrists relieves symptoms. CTS classified on the basis of symptoms and signs into three stages. It is being diagnosed with increasing frequency in patients with occupations like typists, transcriptionists, musicians, jackhammer operators, carpenters, broom stick labourers, software professionals, personnel using personal computers, laptops, mobile phones and other devices.(1) USG is a valuable tool, because it enables one to detect changes in nerve shape. CTS is typically associated with a notch sign or an inverted notch sign and it manifests as an abrupt change in median nerve calibre in the carpal tunnel.(15) The cross-sectional area of the median nerve has been used in US to classify the severity of CTS as normal, mild, moderate and severe.(16) The cut-off values of Cross-Sectional Area (CSA) above which the diagnosis of CTS is made ranges from 9 to 12 mm.(3) In addition, secondary signs such as contour deformities e.g. notch sign identified as dilation proximal to carpal ligament with sharp anterior calibre change and flattening within the carpal tunnel, palmar bowing or the flexor retinaculum of 2.5 mm may be helpful.(17) USG has advantage over x-ray to see nerve involvement [Figure 7].

B) Guyon’s canal syndrome (GCS) - Guyon canal is another fibro-osseous passageway in the antero-medial aspect of the wrist, through which the ulnar nerve, artery and vein traverse. The floor is formed by flexor retinaculum, roof by palmar carpal ligament, lateral and medial walls by the hook of hamate and pisiform. It is rare caused by chronic repeated external pressure, space-occupying lesions or as a sequel of fractures.(12) In the majority it is idiopathic, causes include thrombosis of ulnar artery, synovitis, prominent hook of the hamate, schwannoma.(17) USG can detect it easily by identifying nerve and vessels and their pressure effects.

(3) De Quervain’s tenosynovitis - It is a stenosing tenosynovitis of the first dorsal compartment wrist, which contains the abductor pollicis longus and extensor pollicis brevis tendons. Increased prevalence is seen in those using hands in repetitive fashion (repetitive microtrauma) or post isolated acute injury with increased incidence in women, especially in pregnancy and the postpartum period and in Rheumatoid Arthritis (RA). (17) First described by de Quervain clinical symptoms of this entity include pain at the end of the distal radius radiating to the forearm or thumb, moderate swelling, sensitivity to pressure and crepitation. Pathologic findings include thickening of the retinaculum and tendovaginal chamber as well as the tendons. Radiographic findings typically are negative.(16) Patients are in their fourth to sixth decades with females presenting 10 times more frequently than males. Clinically, there is pain around the radial styloid process exacerbated by movement of the thumb and by Finkelstein’s test, i.e. passive ulnar deviation of the wrist with the thumb flexed.(19) It causes pain, tenderness and swelling around or just proximal or distal to the radial styloid at the point where the abductor pollicis longus tendon runs over the radial styloid and under the extensor retinaculum.(20) On USG tendon thickening and sheath, effusion are apparent. The synovial sheath may be thickened in a lobulated fashion and the retinaculum also may appear increased in size.(18) An

<table>
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<th>Ultrasound</th>
<th>X²</th>
<th>P</th>
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<tr>
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<td>49 (49.0)</td>
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<tr>
<td>Abnormal</td>
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<td>51 (51.0)</td>
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<td>Total</td>
<td>100 (100.0)</td>
<td>100 (100.0)</td>
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Table 3. Comparison of Findings of X-Rays and Ultrasoundography

Table 2. Ultrasonographic Examination of Focal Masses

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<th>Focal Masses</th>
<th>Frequency</th>
<th>Percent</th>
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<tbody>
<tr>
<td>Cystic</td>
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<td>50.0</td>
</tr>
<tr>
<td>Solid</td>
<td>3</td>
<td>12.5</td>
</tr>
<tr>
<td>Infected</td>
<td>9</td>
<td>37.5</td>
</tr>
<tr>
<td>Total</td>
<td>24</td>
<td>100.0</td>
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hypoechoic or anechoic ring surrounds the hyperechoic tendon in peritendineal effusion of tenosynovitis giving the appearance of a "target sign" (Figure 8) (21). USG can be used to see postoperative complications like volar subluxation of the tendons due to excessive release of the retinaculum. (17) Doppler shows marked hypervascularity. (5) A steroid injection is often curative, but surgical decompression or the first extensor compartment may be required in resistant cases. (22)

(4) Tenosynovitis refers to inflammation of the tendon sheath and can be caused by trauma, foreign bodies, infection and arthritis. (23) Rheumatoid arthritis, diabetes mellitus, calcium pyrophosphate deposition disease, gout, hypothyroidism, tuberculosis, fungal infections and collagen vascular disease predispose to work-related tenosynovitis. (1) By USG there is fluid distending the tendon sheath or thickening. The fluid is usually anechoic, although complicated tenosynovitis (infectious or haemorrhagic) may have fluid with low-level echoes. Tendon sheath thickening may be diffuse and smooth or eccentric and nodular. With active inflammation, there is usually a detectable hypervascularity on Doppler. In most cases it is possible to determine the cause based on the ultrasound findings, clinical history and associated laboratory findings [Figures 9]. When necessary, ultrasonound-guided aspiration and biopsy can also be performed to establish the diagnosis. (1) USG hyperechoic fibrillar appearance is disrupted in the setting of tendonitis. The affected tendon may often be enlarged and has increased blood flow visible by Doppler. Partial tearing of the tendon may be seen. Tendonitis and tenosynovitis are not exclusively linked with each other and often are seen independently. (19) Almost all had tenosynovitis in our study.

(A) Flexor Tenosynovitis - Inflammation of tendon sheaths in the hand causes stiffness and pain of one or more fingers usually worse in the morning. Thickening of the affected tendon sheaths in the palm is diagnostic. Swelling may be mainly just proximal to the wrist or over the proximal phalanges and into the palm. Typically, the affected finger cannot be fully extended and active flexion is more limited than passive flexion. The flexor carpi ulnaris or radialis or digital flexor tendons are most commonly involved [Figures 10]. (1)

(B) Dorsal Tenosynovitis - Inflammation of the extensor tendon sheath generally reflects an underlying inflammatory arthritis. The swelling bulges to either side of the extensor retinaculum of the wrist to produce an hourglass swelling. (20) It may occur in any of the six extensor compartments. (1)

(5) Rheumatoid Arthritis (RhA) - It is a systemic disorder characterised by chronic synovitis leading to articular cartilage and bone destruction. Despite advances in the treatment of this disease, it is associated with significant morbidity, mortality and healthcare costs. Radiography of the hands and wrist has long been the standard imaging modality for the diagnosis, grading and assessment of disease progression in rheumatoid arthritis. By USG we can directly visualise the articular and periarthritic pathology in rheumatoid arthritis and can also detect the early inflammatory changes such as synovitis, bone erosions and to a lesser extent cartilage loss. It is now used as an indicator for disease activity, especially with Doppler to diagnose subclinical cases of arthritis and evaluate treatment response. (12) Doppler has been shown to depict hyperaemia in inflammatory diseases. (24) Pannus is seen as hypoechoic soft tissue in continuation with the hypertrophic synovium at the articular margins with hypervascularity. (12) X-ray findings include osteoporosis, joint space changes, alignment deformities, periostitis, erosions, secondary osteoarthritis and soft tissue changes.

(6) Gout - It is one of the commonest forms of inflammatory arthritis, mediated by the deposition of monosodium urate crystals in the superficial portions of the articular cartilage resulting in an inflammatory response. X-ray findings may be bilateral or unilateral and symmetric or asymmetric. Involvement of several joints in a single digit with soft tissue swelling produces what appears clinically as a "sausage digit." The bone proliferation produces an irregular and indistinct appearance to the marginal bone about the involved joint, characterised as a "fuzzy" appearance or "whiskering." USG shows the "double contour" sign with a superficial hyperechoic band over the articular cartilage, hypoechoic to hyperechoic tophi surrounded by an anechoic rim and erosions adjacent to the tophi. (12)

Mycobacterial tuberculous tenosynovitis - Radiographic features of tuberculous infection of the wrist may include localised osteoporosis, bone erosion or cavitation, gross destruction and eventually joint ankylosis. (25) Both typical and atypical mycobacterium tuberculous tenosynovitis may be associated with rice body formation. The rice bodies are small ultrasounds may reveal low-level internal echoes, but may fail to resolve individual rice bodies. Whenever the possibility of an infective tenosynovitis exists and a tendon sheath effusion is visible, ultrasound-guided aspiration of tendon sheath fluid is helpful in differentiating infective from non-infectious causes of tenosynovitis. If moderate-to-severe tendon sheath thickening is present, percutaneous biopsy may be undertaken. (26)

Infective Tenosynovitis - Tendon sheath thickening is usually hypoechoic and as such may resemble viscous fluid. Doppler is helpful in this instance allowing one to differentiate synovial sheath thickening from a synovial sheath effusion. This distinction is important as the demonstration of an effusion allows one to consider diagnostic aspiration (for culture and sensitivity) and may also influence decision making as to whether urgent surgery should be undertaken. Surgery may potentially be less beneficial in those patients without visible tendon sheath effusion. Unequivocal tendon sheath effusions are usually not a dominant feature, though small pools of fluid may be present with more pronounced fluid accumulation being a feature of severe acute suppurative tenosynovitis. Occasionally, infection can spread from the tendon sheath into the peritendinous tissues. (26)

Ultrasound may help to (1) Differentiate acute or chronic infection from tumours or non-infective inflammatory conditions with a similar clinical presentation. (2) Localise the site and extent of infection (e.g. subcutaneous, muscle, bursa, tendon sheath and joint). (3) Ascertain the form of infection (e.g. cellulitis, pre- abscess, abscess). (4) Identify precipitating factors (e.g. foreign bodies, fistula) and (5) Provide guidance for diagnostic or therapeutic aspiration, drainage or biopsy. (26) Tendon diseases like tendinosis and ruptures –

(A) Tendinosis - The tendon and adjacent structures can react in a number of ways to (repetitive) trauma. Repetitive injury and a high level of athletic activity lead to degeneration or tendinosis of the tendon. Loss of cross linking between collagen fibres, oedema, myxoid degeneration, vascular
proliferation (angio-fibroblastic hyperplasia) and reparative phenomenon (collagenous type 3 matrix production) are seen on histologic examination. Neovascularity is a specific sign of disease and attempted repair. This is associated in growths of nerve endings that explain the increased pain in most of these patients.

Rarely calcium deposits may occur within the tendons as a result of hypoxia. These histological changes will result in changes in morphology and internal architecture on imaging. They will be exhibited as swelling due to oedema and matrix production. Hypochoogenicity on USG with raised signal loss of fibrillar structure and calcium deposits. In tendinosis US show an enlarged tendon with internal irregularities of the normal internal structure, focal hypoechoic areas and hyperechoic regions with posterior shadowing. Histological examination showed that intratendinous hypoechogenic areas correlate with fibromyxoid degeneration, while hyperechoic images correlate with calcification.

(B) Tendon rupture - May be spontaneous in the setting of rheumatoid arthritis or chronic tenosynovitis, but it may also be caused by trauma. In the flexor tendons, traumatic avulsion occurs when there is sudden forced extension of the finger during maximum contraction of the flexor digitorum profundus muscle. In partial tear, there is a localised disrupion of some tendon fibres. Since this is almost always associated with changes related to tendinosis, the US distinction between tendon degeneration and small tears is often not feasible. US can easily differentiate partial from complete tears and help in clinical decision-making, particularly in acute cases in which local oedema and pain limit a proper physical examination. In full-thickness rupture, a complete disruption of the tendon causes a retraction or the proximal torn edge due to the muscle action. In recent lesions a hypoechogenic haematomata fills the tendon gap, whereas granulation tissue can be demonstrated in chronic cases. One or the main applications of US in evaluation of complete tears is detection of the retraction site of the proximal tendon end, which can help in choosing the extent of the surgical incision. In chronic tendinitis, it may have a bumpy appearance or intratendinous calcification may be seen. In our study, only one had tendon rupture. Wrist ligament and cartilage abnormalities - Any component may be the site of pathology, but the TFCC is the commonest to demonstrate abnormalities. The patient may present with ulnar side pain, a clicking sensation or a decreased range of motion. Clinical examination may demonstrate a positive load test or direct tenderness, which may also represent ulnar abutment or chondromalacia of the hamate. Palmar classification for TFCC tears divides into traumatic and degenerative with subdivision by location. In general TFCC traumatic tears, if peripheral have a good blood supply and can be repaired. The central avascular region requires debridement. Pathology affecting it includes triangle fibrocartilage partial or full thickness tears. Detachment and degeneration of extensor carpi ulnaris tenosynovitis, subluxation ulnar collateral and radioulnar ligament tears. TFC tears appear as loss of the homogeneous echotexture and triangular structural appearance, absence of a portion of the structure, hypoechogenic defts or linear clefts or cysts. Thickness measurements of TFC have been proposed for detecting tears; however, this is unreliable. US have high specificity for detecting TFC tears, the sensitivity is low. Radial sided tears are difficult to visualise on US. Scapholunate Ligament (SLL) Tear - It is diagnosed on US as ligament becomes hypoechogenic, discontinuous, absent, presence of concurrent fluid or associated ganglion. Lunotriquetral Ligament (LTL) Tear - Injury of the LTL is uncommon compared with scapholunate instability. In our study by USG 24 patients had focal masses, 21 cystic i.e. 87.5% and 3 had solid masses i.e. 12.5% (Table 2). Out of cystic masses 12 were simple and 9 had infected cysts. Among these 13 i.e. 61% showed on the flexor and 8 i.e. 39% on the extensor aspect of the wrist. The wrist is a complex structure with an extensive differential diagnosis for a presenting mass. However, the vast majority of hand and wrist masses are benign and many of these have a distinctive radiographic appearance. The three most common hand and wrist lesions include ganglion cysts, giant cell tumours of the tendon sheath and haemangiomas. Others include lipomas, neural sheath tumours, infection, inflammation and variant soft tissue or bony structures.

(A) Giant Cell Tumour of Tendon Sheath (GCTTS) - Are benign proliferative lesions of synovial origin. After ganglion they represent the most common cause of a mass in the hand. They are commonly seen in patients in their third to fifth decade of life more in females. It is the most common mesenchymal tumour in this location. They are more common in the fingers than in the wrist and palm, can be seen in any hand. They are well-circumscribed, firm, grow slowly and are relatively painless. If near a joint, they may result in decreased joint motion. The pathogenesis remains unclear, but lesion is a product of a reactive inflammatory process. It is a localised extra-articular form of pigmented villonodular synovitis. It can arise from tendon sheaths, joint capsules, bursae, fascial planes or ligaments. Histologically, they are composed of histiocytes, macrophages, multinucleated giant cells and hemosiderin. Radiographs often appear normal (20%) or reveal a subtle soft-tissue mass (50%). Of all lesions 20% demonstrate adjacent osseous changes including erosions or periosteal reaction, a reactive inflammatory process. By USG it is solid, homogeneous, hypoechogenic masses located adjacent to tendons [Figure 11]. Large may partially surround the tendon; however, because they arise from the sheath and not the tendon, they do not move with the tendon when the finger is flexed and extended. Approximately, 10% will produce pressure erosion on the adjacent bone. Colour Doppler will generally show detectable internal blood flow and in some cases the mass will appear quite vascular. The treatment of choice is surgical resection. Approximately, 20% will recur after surgery.

(B) Haemangioma - Are common benign soft-tissue tumours. They account for approximately 5% to 10% of benign hand tumours. They are most common in patients between 20 and 40 years and are seen with equal frequency in men and women. They are vascular masses with variable amounts of nonvascular elements including thrombus, fat, fibrous and muscular tissue. They are classified by the vessel size as cavernous, capillary, venous or mixed. Most are asymptomatic, but they may present at an early age secondary to cosmetic deformity or pain. Frequently, there is an overlying skin discoloration or a visible vascular anomaly. On x-rays, they appear as inhomogeneous soft-tissue masses of varying size. Typically, the lesion margins are poorly defined and have calcifications (phleboliths). Less often the calcifications may be amorphous or metaplastic. Adjacent osseous remodelling
can occur including erosion, overgrowth, peristeal reaction and osteoporosis. By USG intramuscular features show a combination of echo rich and echo poor foci with ill-defined margins. Cystic foci are also known to occur. Presence of phleboliths helps in establishing the diagnosis. Colour Doppler is of great help to see vascularity of these in neonates is striking, but as age advances the vascularity is less marked. Flow is usually of low velocity. In such cases, compression and occlusion of the lesion proximally and releasing suddenly will result in increased vascularity. The vascularity is complex, the tumour size, growth rate and necrosis all affect the vascularity [Figures 12].

(C) Neural Tumours - Neurofibroma and Schwannoma are among the most common benign neural tumours of the upper extremity. Most Schwannomas arise from the larger and deeper peripheral nerves. They are painless seen between the ages 30 and 60 years. They often occur along the flexor surface of the forearm and hand. They arise from Schwann cells at the periphery of nerves and are eccentric to the nerve. Neurofibromas however arise from the central nerve fascicles. They tend to involve the smaller cutaneous nerves and occur in a young group of patients. Neuromas are a proliferative response to nerve injury and are not considered to be true nerve tumours. By USG, they are homogeneous and hypoechoic and may demonstrate posterior enhancement. Doppler typically show hypervascularity. Schwannomas may show cystic areas due to degeneration and hyperechoic foci due to collagen within [Figure 13]. The nerve passes through the centre of the mass in neurofibromas, whereas it is related to the periphery of the mass in Schwannomas. When seen an echogenic ring in the mass is confirmative of a nerve sheath tumour. They are well encapsulated. Malignancy should be strongly suspected when US shows indistinct margins and adhesions to the surrounding structures.

(D) Lipomas - Are the commonest masses encountered, they are subcutaneous, though intramuscular and intermuscular locations are infrequent. On radiographs larger lipomas present as radiolucent masses accompanied infrequently by punctuate calcification and rarely osseous thickening. On US, they are usually hyperechoic or isoechoic when in the subcutaneous tissues. A hypoechoic pattern is less common. The margins are well defined, it is non-compressible and is vascular on Doppler. Postoperative recurrence of a lipoma is known and is usually due to microscopic infiltration of the surrounding tissues.

Malignant tumours - Malignant soft tissue tumours of the hard and wrist are relatively rare. Given the abundant synovial tissue in the many joints and tendon sheaths of the hand and wrist, it is not surprising that the most common is synovial cell sarcoma. Other rare tumours include malignant fibrous histiocytoma, fibrosarcoma, liposarcoma, neurosarcoma and angiosarcoma. The only role of US in malignant tumours is to define the extent and relationship of the mass with the surrounding structures. Power Doppler may help in monitoring the baseline to chemotherapy and persistence of low resistance flow indicates low response to therapy.

Foreign Bodies - They are a common problem after penetrating injuries of the hand and wrist. If not detected and removed they can be a source of persistent pain, soft tissue infection and abscess. In most cases successful surgical removal depends on accurate localisation via imaging. Many foreign bodies such as metal cat be detected and localised radiographically. However, some foreign bodies such as glass, wood and vegetable matter are radiolucent and are not detectable with radiographs. USG is an excellent means of detecting radiolucent foreign bodies in the hand and wrist. It is also helpful in precisely localising radio-opaque bodies that were initially detected with radiographs. It is seen as hyperechoic structure; acoustic shadowing is present when it is big enough. Abscess formation will appear as a complex fluid collection. In many cases, Doppler will show an inflammatory hyperaemia surrounding the foreign body.

Ultrasound Guided Procedures - It is a useful clinical application of guided percutaneous tendon sheath, bursal and joint injections with corticosteroids and local anaesthetic. Due to the ability for real-time assessment accurate needle placement and observed delivery of the therapeutic agents can be made. In carpal tunnel syndrome, compressive symptoms may also be relieved by ultrasound-guided percutaneous injection of anti-inflammatory agents, usually in the space between the flexor carpi radialis tendon and the median nerve. Ultrasound guided percutaneous synovial biopsy of the wrist joint is another useful procedure that is usually performed in cases of arthritis of uncertain aetiology. This is performed using a side-notch cutting needle inserted into the joint space. In our study of comparison of findings, 5 had abnormal x-ray as compared to 51 subjects by USG. The difference was found to be statistically significant (x2 = 52.5, P = 0.00 1). The wide variety of pathologies that we have encountered and diagnosed in our study was shown to be reliably diagnosed with ultrasound. In conclusion, we would like to say that USG has proved its superiority over plain x-ray findings in evaluating wrist pain. X-rays are invasive and ionising. Advantages of USG are many, i.e. non-invasive, non-ionizing, real time and multplanar. It can be done rapidly without any patient preparation. It is ideally available and at a low cost. It has high spatial resolution. Main disadvantages of USG are limited assessment capability of internal structures of the joints, bone and bone marrow. However, introduction of the extended-field-of-view technology has allowed imaging of larger segments and has made their interpretation by the referring physician easier. Musculoskeletal radiology has been affected by the explosive technological developments that have taken place during the last few decades with ultrasonography as the front runner.

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REFERENCES


