Role of high frequency ultrasound in diagnosis of pathologies related to Thumb.

<table>
<thead>
<tr>
<th>Poster No.:</th>
<th>P-0043</th>
</tr>
</thead>
<tbody>
<tr>
<td>Congress:</td>
<td>ESSR 2016</td>
</tr>
<tr>
<td>Type:</td>
<td>Scientific Poster</td>
</tr>
<tr>
<td>Authors:</td>
<td>J. P. Singh, S. Kumar, K. Gupta, A. Jawed, V. Gupta; Gurgaon/IN</td>
</tr>
<tr>
<td>Keywords:</td>
<td>Musculoskeletal system, Ultrasound, Outcomes analysis, Outcomes</td>
</tr>
<tr>
<td>DOI:</td>
<td>10.1594/essr2016/P-0043</td>
</tr>
</tbody>
</table>

Any information contained in this pdf file is automatically generated from digital material submitted to EPOS by third parties in the form of scientific presentations. References to any names, marks, products, or services of third parties or hypertext links to third-party sites or information are provided solely as a convenience to you and do not in any way constitute or imply ECR's endorsement, sponsorship or recommendation of the third party, information, product or service. ECR is not responsible for the content of these pages and does not make any representations regarding the content or accuracy of material in this file.

As per copyright regulations, any unauthorised use of the material or parts thereof as well as commercial reproduction or multiple distribution by any traditional or electronically based reproduction/publication method is strictly prohibited.

You agree to defend, indemnify, and hold ECR harmless from and against any and all claims, damages, costs, and expenses, including attorneys' fees, arising from or related to your use of these pages.

Please note: Links to movies, ppt slideshows and any other multimedia files are not available in the pdf version of presentations.

www.myESR.org
Purpose

Ultrasound is ideally suited for the assessment of complex anatomy and pathologies of the thumb. Focused and dynamic ultrasound can provide a rapid real-time diagnosis, and can be used for guided treatment in certain clinical situations. The purpose of the study was to evaluate the role of high frequency ultrasound in diagnosis of pathologies related to thumb.
Methods and Materials

Prospective study of 94 patients referred to radiology department for pathologies related to thumb was performed using high frequency (14 MHz probe) ultrasound over a period of one year. Patients with past history of surgery, pediatric patients and those with orthopedic implants were excluded and the remaining 83 patients (18-76 years) were evaluated using ultrasound to assess its ability to diagnose the pathology and the need for further imaging with MRI was assessed.

Ultrasound Anatomy

Bones and joints: Ultrasound has intrinsic limitations in the assessment of bone. The bone cortex appears as a regular continuous bright echogenic line with strong posterior acoustic shadowing. Joint ultrasound reveals a homogenously hypoechoic smooth linear band due to hyaline cartilage with a linear continuous bright hyperechoic line of subchondral bone deep to it. The synovial membrane is too thin to be discriminable on normal ultrasound.

Muscles and tendons: Normal skeletal muscles echotexture consists of relatively hypoechoic background reflecting muscle fascicles and clearly demarcated linear hypoechoic strands related to fibroadipose septa. Tendon shows linear fibrillar pattern in long axis and bright stippled clustered dots in short axis. There are a total of 8 muscles and tendons involved in the movement of the thumb with their origin, insertion, function and nerve supply as given in table 1.

Arteries: They appear as pulsatile structure on short axis. The major palmer arterial supply to the thumb is from the princeps pollicis artery (principal artery of the thumb), which usually arises from the radial artery as it turns medially towards the deep part of the hand.

Nerve: Ultrasound demonstrates nerves as hypoechoic spots of fascicles embedded in hyperechoic background of interfascicular epineurium, on short axis and as linear hypoechoic fascicles separated by hyperechoic bands on long axis view. The motor nerve supply of muscles of the thumb is given in table 1.

Ligaments: At ultrasound the collateral ligaments appear as anisotropic bands crossing the joint line and intersecting on the boundaries of adjacent bones. The radial and ulnar collateral ligaments at MCP joint are important in retaining stability and restraining forces in both flexion and extension. There is a proper collateral ligament (PCL), one each on the radial and ulnar side of the MCP joint. These are orientated in the off-coronal plane with the distal attachment of the ligaments lying slightly more volar than the proximal attachment. In addition, there is an accessory collateral ligament (ACL) that lies volar
to the PCL and is attached, in part, with the PCL and the volar plate (Figure 1a and b). Aponeurosis of the adductor pollicis covers the UCL of the thumb superficially (Fig 1c).

**The pulley, volar plate and the sesamoid bone:** There are two main pulleys in the thumb A1 (just proximal to the metacarpophalangeal joint and A2 pulley just proximal to the interphalangeal joint (Figure1c and d), which keep the flexor pollicis tendon closely approximated to the bone. Attached to the base of the each phalanx is a fibrocartilaginous triangular structure, which is attached proximally by connective tissue struts. These are the volar or palmar plates (Figure 1a & b), whose role is to prevent hyperextension.

There are two sesamoid bones in the palmer aspect of the thumb embedded in the palmer plate close to the MCP joint. The ulnar sesamoid provides attachment point for adductor pollicis and the radial sesamoid provides attachment to the short head of FPB.

Table 1: Muscles and tendons involved in the movement of the thumb.

<table>
<thead>
<tr>
<th></th>
<th>Muscles</th>
<th>Function</th>
<th>Origin</th>
<th>Insertion</th>
<th>Nerve supply</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Flexor pollicis longus (FPL)</td>
<td>Flexion of thumb primarily at IP and weakly at MCP joint</td>
<td>Middle half of volar surface of radius, adjacent interosseous membrane, medial border of coronoid process of the ulna</td>
<td>Palmer surface of the distal phalanx of thumb</td>
<td>Anterior interosseous branch of median nerve (C8,T1)</td>
</tr>
<tr>
<td>2.</td>
<td>Extensor pollicis longus (EPL)</td>
<td>Extension of thumb at carpometacarpal, MCP and IP joint</td>
<td>Middle third of posterior surface of ulna and interosseous membrane</td>
<td>Dorsal surface of base of distal phalanx of thumb</td>
<td>Posterior interosseous nervea deep branch of radial nerve (C7,C8)</td>
</tr>
<tr>
<td>3.</td>
<td>Extensor pollicis brevis (EPB)</td>
<td>Extension of thumb a carpometacarpal and MCP joint</td>
<td>Radius and interosseous membrane</td>
<td>Base of proximal phalanx of thumb</td>
<td>Posterior interosseous nerve (C7,C8)</td>
</tr>
<tr>
<td>No.</td>
<td>Muscle Name</td>
<td>Function</td>
<td>Innervation</td>
<td>Nerve Branch</td>
<td></td>
</tr>
<tr>
<td>-----</td>
<td>-----------------------------</td>
<td>----------------------------------------</td>
<td>--------------------------------------------------</td>
<td>-------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Abductor pollicis longus (APL)</td>
<td>Abducts the thumb and extends it at carpometacarpal joint</td>
<td>Post surface of radius, ulna, and interosseous membrane</td>
<td>Base of 1st metacarpal</td>
<td>Posterior interosseous nerve (C7, C8)</td>
</tr>
<tr>
<td>5.</td>
<td>Abductor pollicis brevis (APB)</td>
<td>Abducts thumb at first MCP joint.</td>
<td>Tubercles of scaphoid and trapezium and adjacent flexor</td>
<td>Proximal phalanx and extensor hood of thumb</td>
<td>Recurrent branch of median nerve [C8, T1]</td>
</tr>
<tr>
<td>6.</td>
<td>Opponens pollicis</td>
<td>Medially rotates thumb</td>
<td>Tubercle of trapezium and flexor retinaculum</td>
<td>Lateral margin and adjacent palmar surface of 1st metacarpal</td>
<td>Recurrent branch of median nerve [C8, T1]</td>
</tr>
<tr>
<td>7.</td>
<td>Flexor pollicis brevis (FPB)</td>
<td>Flexion at first MCP joint</td>
<td>Tubercle of the trapezium and flexor retinaculum</td>
<td>Base of proximal phalanx of the thumb along the radial aspect and radial sesmoid</td>
<td>Recurrent branch of median nerve [C8, T1]</td>
</tr>
<tr>
<td>8.</td>
<td>Adductor pollicis (AP)</td>
<td>Adducts thumb</td>
<td>Transverse head of third metacarpal; oblique head-capitate and bases of second and third metacarpals</td>
<td>Base of proximal phalanx, ulnar sesmoid bone and extensor hood of thumb</td>
<td>Deep branch of ulnar nerve [C8, T1]</td>
</tr>
</tbody>
</table>
Images for this section:

**Fig. 1**: Lateral schematic diagrams shows first MCP joint in flexion (a) and extension (b) with parts of the UCL [PCL (1), ACL (2)] and the volar or palmer plate (black arrow). The frontal schematic diagram of the thumb (c) shows adductor pollicis aponeurosis (black arrow) covering the UCL (open black arrow). Lateral (d) schematic diagram shows the flexor pollicis longus tendon (red arrow) passing underneath the A1 and A2 pulley. (PCL - Primary collateral ligament. ACL - Accessory collateral ligament.)

© Radiology, Medanta-The Medicity - Gurgaon/IN
Results

There was a wide spectrum of pathologies that were seen using ultrasound. The common ones were de quervain tenosynovitis (15) [Figure-2], ulnar collateral ligament tear (15) [Figure-3, 4 nd 5] and carpometacarpal (CMC) degenerative joint disease (10) [Figure-6]. Some of the less common ones were flexor pollicis longus tear (5), trigger thumb/stenosing tenosynovitis (4) [Figure-7, 8], extensor pollicis longus (EPL) tenosynovitis (4), giant cell tumour of the tendon sheath (4) [Figure-9], intersection syndromes (4) [Figure-10], EPL tear (2) and extensor carpi radialis tenosynovitis (3) [Figure-11]. There were some rare and interesting cases like synovial sarcoma, digital neuroma [Figure-12], volar plate complex injury, neuroma of superficial branch of radial nerve, radial artery occlusion [Figure-13], radial sesamoid fracture [Figure-14], subluxation CMC [Figure-15], EPL avulsion [Figure-16], abductor pollicis calcific tendinitis, foreign body, lipoma [Figure-17], hemangioma [Figure-18], anterior interosseous nerve syndrome [Figure-19] and radial nerve compressive neuropathy.

In 77 (92.8%) patient's ultrasound was sufficient to make the diagnosis. However, in 6 patients (7.2%) MRI was required. MRI was required in synovial sarcoma, giant cell tumour of the tendon sheath and lipoma of thumb in order to look at the extent of the disease and osseous extension, prior to surgical resection. In patients with anterior interosseous nerve syndrome and radial nerve compressive neuropathy, MRI helped in making the diagnosis by identifying denervation edema. MRI was also considered for hemangioma of thumb in order to identify any arterial feeder, prior to surgical resection.
Fig. 1: Lateral schematic diagrams shows first MCP joint in flexion (a) and extension (b) with parts of the UCL [PCL (1), ACL (2)] and the volar or palmer plate (black arrow). The frontal schematic diagram of the thumb (c) shows adductor pollicis aponeurosis (black arrow) covering the UCL (open black arrow). Lateral (d) schematic diagram shows the flexor pollicis longus tendon (red arrow) passing underneath the A1 and A2 pulley. (PCL - Primary collateral ligament. ACL - Accessory collateral ligament.)

© Radiology, Medanta-The Medicity - Gurgaon/IN
Fig. 2: De Quervain's tenosynovitis (a-d). (a) shows thickened extensor retinaculum (in purple) around the 1st extensor tendons. Short (a) and long axis (c) ultrasound show thickened extensor retinaculum (white arrow) with swollen 1st compartment tendons (red arrow). Short axis ultrasound image (c) shows increased retinaculum vascularity (white arrow) and multiple 1st extensor compartment tendon slips (yellow arrow).

© Radiology, Medanta-The Medicity - Gurgaon/IN
Fig. 3: Ulnar collateral ligament tear (a-b). Long axis ultrasound (a) show intra-substance tear of the ulnar collateral ligament (white arrow) with normally positioned adductor pollicis aponeurosis (red arrow). Long axis ultrasound (b) show avulsed ulnar collateral ligament with bony fragment (white arrow) and normally positioned adductor pollicis aponeurosis (red arrow).

© Radiology, Medanta-The Medicity - Gurgaon/IN
**Fig. 6:** Degenerative joint disease of bilateral first CMC (a-c) and STT joint (d-e). 46 year old female patient presented with left thumb pain. AP Oblique radiographs of the thumb (b) shows degenerative changes in the right first CMC joint (white arrow) with no radiographic abnormality in the left first CMC joint (red arrow). Ultrasound of the first CMC right joint (c) shows synovial hypertrophy with osteophytes (white arrow) with milder changes in the left first CMC joint (a) (red arrow). Radiograph (d) of both wrist joint shows degenerative changes in the right STT joint (white arrow) with long axis ultrasound (e) of the right STT joint showing osteophytes (yellow arrow) and synovial hypertrophy (blue arrow). (Radius - R, Scaphoid - S, 1st metacarpal-M and trapezium - T).

© Radiology, Medanta-The Medicity - Gurgaon/IN
Fig. 4: Ulnar collateral ligament tear with Stener's lesion. Long axis ultrasound shows torn proximally retracted balled-up ulnar collateral ligament (white arrow) with distally interposed adductor pollicis aponeurosis (red arrow).

© Radiology, Medanta-The Medicity - Gurgaon/IN

Fig. 15: Subluxation with early degeneration of the first right CMC joint with partial tear of the dorsal intermetacarpal ligament (a-c). AP radiograph (a) of both the wrists show subluxed right first metacarpal at the CMC joint (arrow) with normal alignment of the left CMC joint (yellow arrow). Long axis ultrasound images of the right (b) and left (c) first CMC joint shows thickened hypoechoic dorsal intermetacarpal ligament (open arrow), synovial hypertrophy and articular surface irregularity (red arrow) with normal left carpometacarpal joint (yellow arrow).

© Radiology, Medanta-The Medicity - Gurgaon/IN
**Fig. 11:** Extensor carpi radialis longus acute tenosynovitis (a-f). Schematic diagram shows the extensor carpi radialis longus tendon with the most common site of tenosynovitis marked with circle in image (a) and thickening of the tendon sheath in image b (black arrow). Long (c and d) and short axis (e and f) ultrasound views of the tendon shows thickened tendon sheath (white arrow) with increased vascularity (red arrow).

© Radiology, Medanta-The Medicity - Gurgaon/IN

**Fig. 10:** Distal intersection syndrome. Short axis ultrasound at the level of distal intersection point showing the EPL tendon (white arrow) crossing over the 2nd compartment tendons (red arrow) associated with tendon sheath thickening (blue arrow).
Fig. 13: Radial artery occlusion in a 48-year-old female presenting with thumb pain following accidental intra-arterial injection of antibiotic (a-b). Long (a) and short (b) axis ultrasound shows thrombosis of radial artery (white arrow) with colour filling of the adjacent veins.
Fig. 19: Anterior interosseous nerve syndrome in a 31 year-old female who presented with inability to flex the thumb (a-c). Long axis ultrasound of the thumb (a) shows normal FPL tendon (white arrow). Axial T2 images of the forearm show oedema within the radial half of flexor digitorum profundus (green arrow), FPL muscle (red arrow) and pronator quadratus muscle (blue arrow). The median nerve on both ultrasound and MRI was unremarkable in this patient (image not shown).

© Radiology, Medanta-The Medicity - Gurgaon/IN
**Fig. 14:** Radial sesmoid fracture of the thumb (a-b). Long (a) and short (b) axis ultrasound images show displaced fractured bony fragment (white arrow) from the radial sesmoid bone (red arrow). (FPL - F and medial sesmoid - MS)

© Radiology, Medanta-The Medicity - Gurgaon/IN
Fig. 12: Neuroma of the digital radial nerve of the thumb (a-b) in a patient with cut injury. Long (a) and short (b) axis ultrasound views show the digital radial nerve of the thumb (white arrow) with neuroma (blue arrow) and the adjoining cut site (red arrow).

© Radiology, Medanta-The Medicity - Gurgaon/IN
Fig. 18: Hemangioma of thumb (a-f). Patient photograph (a) shows swelling along the dorsal aspect of IP joint of the thumb. Long axis ultrasound (b) image shows a hypoechoic solid lesion (white arrow) with mild vascularity on Doppler. MRI images show the lesion (white arrow) to be hyperintense on PD fat-sat axial (c), hypointense on T1 axial (d) and showing intense contrast enhancement on sagittal T1 post contrast image (e). MIP angiographic image (f) in the arterial phase does not reveal any prominent arterial feeder at the location of the lesion (red arrow).

© Radiology, Medanta-The Medicity - Gurgaon/IN
**Fig. 5:** UCL tear

© Radiology, Medanta-The Medicity - Gurgaon/IN

**Fig. 16:** EPL avulsion: Mallet thumb with avulsed base of distal phalanx of thumb with the EPL tendon attached to the avulsed fragment.
**Fig. 8:** Stenosing tenosynovitis: Lack of tendon translation across the thickened A1 pulley with folding of the FPL tendon on thumb flexion.
**Fig. 7:** Trigger Thumb: Thickened portion of the FPL tendon seen triggering over A1 pulley

© Radiology, Medanta-The Medicity - Gurgaon/IN

**Fig. 17:** Lipoma of thumb (a-b). Short axis (a) ultrasound image shows a hyperechoic in the region of the base of the thumb (red arrow). Axial T2 MRI images (b) of the lesion showing the lesion (red arrow) having the same signal intensity as the subcutaneous fat.

© Radiology, Medanta-The Medicity - Gurgaon/IN
Fig. 9: Giant cell tumor (a-d). Short (a and b) axis ultrasound images along the dorsal aspect of the base of thumb shows a hypoechoic mass (red arrow) lying deep to extensor pollicis longus (EPL) tendon (blue arrow) and the superficial radial nerve (yellow arrow). MRI images shows a relatively well-defined lobulated mass lesion (red arrow) appearing hypointense on coronal T2 (c) weighted image showing focal areas of blooming (green arrow) on the gradient echo sequence (d).

© Radiology, Medanta-The Medicity - Gurgaon/IN
Conclusion

Ultrasound should be used as the primary investigation of choice for pathologies of thumb because of its dynamic nature, better resolution for smaller structures, low cost and ease of use in trained hands. In larger lesions where deep extent needs to be assessed for surgical planning or for identification of denervation edema in nerve pathologies, MRI was found useful.