Ultrasonography of degenerative tendon disorder

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Introduction

1. Standard nomenclature of tendon pathology
   - Tendinosis
   - Paratenonitis: inflammation of paratenon
   - Tenosynovitis: inflammation of tendon synovium
   - Partial or complete tear

2. Tendinosis
   - Intrasubstance degeneration may derive from overuse injuries
   - repetitive submaximal loading and/or eccentric mechanical forces
   - recurrent microtrauma with microfailure of collagen bundles especially in the vulnerable areas where tendons exhibit reduced blood flow
   - Intrasubdstance ruptures ← predisposing degenerative changes that weaken the strength of the tendinous structure

   - Supraspinatus, long head and distal biceps, extensor and flexor carpi tendons about the elbow, patellar and Achilles tendons, tibialis posterior and flexor hallucis longus

3. Age related change in tendon
   - Increased amount of insoluble collagen
   - Increased maturation of collagen cross-link
   - Increased Collagen fibril diameter
   - Reduced collagen turn over
   - Decreased proteoglycan and water content
   - Reduction in cellularity and vascularity
     → stiffer, lesser compliant, weaker tendon, diminished healing capacity
4. Overuse tendon injury
   - Repetitive strain $\rightarrow$ microscopic and/or macroscopic injury to collagen fibril, non-collagenous matrix, and the microvasculature $\rightarrow$ inflammation, edema, pain
   - Earliest pathophysiologic change: paratendon structure $\rightarrow$ peritendinitis or paratendonitis
   - If chronic overload (+) $\rightarrow$ fibrosis and thickening of the paratendon $\rightarrow$ chronic peritendinitis $\rightarrow$ eventually tendon degeneration
   - Result in decreased tensile strength, loss of functional fibers due to degeneration with diminished vascularity (cannot repair subclinical injury)

5. Tendinosis:
   - non-inflammatory, intra-tendinous degeneration
   - Pathology
     1) loss or disorientation of collagen continuity
     2) fiber separation by inc. mucoid ground substance
     3) focal necrosis and calcification
     4) inflammation is notably absent
     5) degenerative and reparative process coexist
   - ex) lateral epicondylitis, Achilles tendinitis, patellar tendinitis

6. Development of tendinosis

1) Intrinsic factors
   - Tissue hypoxia due to poor vascularity
     - impaired metabolic activity, oxygen free radical
     - temperature during exercise (43-45°)
       : fibroblast cell death around 42.5°
   - age, immobilization, hormone, drugs (steroid, fluoroquinolone)

2) Extrinsic factors
   - joint stability, direct compression, malalignment, muscle weakness & imbalance
   - Type, Pattern, Magnitude of loading

3) Development of tendinosis
   - Ischemia: critical zones of hypovascularity in tendons
   - deposition of large mucoid patches and vacuoles between the thinned degenerated fibers.
   - These two processes coexist and are associated with spontaneous tendon rupture
7. Tendinitis
   - Macroscopic
     : Symptomatic degeneration of the tendon with vascular disruption.
     : Inflammatory repair response
   - Pathology
     : Degenerative changes as noted above with superimposed evidence of inflammation, including fibroblastic & myofibroblastic proliferation, hemorrhage, & organizing granulation tissue.

Sonographic findings of the degenerative tendon (tendinosis)

1. focal (nodular) or diffuse tendon thickening,
2. intratendinous hypoechoic areas with loss of the fibrillar echoes
3. tendinosis related neovascularure (thickened part of tendon)
4. Tendon heterogeneity (partial tear?)
5. Calcification (relationship with tendon degeneration is unclear)

Table 1. US findings of lateral epicondylitis (Levin et al, radiology, 2005)

<table>
<thead>
<tr>
<th>US Finding</th>
<th>Odds Ratio</th>
<th>Session 1</th>
<th>Session 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linear intrasubstance tears</td>
<td>6.8 (0.8, 59.4)*</td>
<td>8.3 (1, 70.2)*</td>
<td></td>
</tr>
<tr>
<td>Thickening of common extensor tendon</td>
<td>6.7 (3.3, 13.6)</td>
<td>2.9 (1.5, 5.5)</td>
<td></td>
</tr>
<tr>
<td>Intratendinous calcification</td>
<td>6.2 (2.2, 17.5)</td>
<td>7.8 (2.2, 27.9)</td>
<td></td>
</tr>
<tr>
<td>Adjacent bone irregularity</td>
<td>4.8 (1.5, 15.5)</td>
<td>4.0 (1.2, 13.0)</td>
<td></td>
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<tr>
<td>Focal hypoechoic regions</td>
<td>4.0 (1.6, 10.2)</td>
<td>4.0 (1.2, 13.0)</td>
<td></td>
</tr>
<tr>
<td>Enthesophytes at common extensor tendon insertion site</td>
<td>2.7 (1.2, 6.3)</td>
<td>2.3 (0.9, 5.9)*</td>
<td></td>
</tr>
<tr>
<td>Diffuse heterogeneity</td>
<td>3.0 (1.6, 5.5)</td>
<td>2.4 (1.3, 4.4)</td>
<td></td>
</tr>
<tr>
<td>Peritendinous fluid</td>
<td>1.8 (0.7, 5.0)*</td>
<td>0.8 (0.4, 1.9)*</td>
<td></td>
</tr>
</tbody>
</table>

Note.—Numbers in parentheses are 95% CIs. * Odds ratio is not statistically significant (P > .05).

Tendon and hypervascularity

- Abnormally thickened tendons with altered echotexture (focal hypoechoic areas) and hypervascular pattern at color and power Doppler imaging
- Related neovascularure is typically appreciated in relation to the thickened part of the tendon, both inside and outside
- Painful tendinosis typically appears more hypervascular than of asymptomatic tendinosis, no correlation between microvascular response and duration of symptoms
- hypervascular pattern is not an unfavorable sign for the prognosis
Tendinosis and interstitial tear
- abrupt demarcation between degeneration, microtears, and interstitial tears is misleading: a continuum of the same disease process and coexist
- interstitial tears: in areas of tendon degeneration as thin hypoechoic clefts oriented along the long axis of the tendon

Partial tear
- Partial tears occur in the longitudinal orientation (longitudinal splits, fissurations) or in the transverse direction,
- macroscopically produce discontinuities in individual portions of complex tendons
- US demonstrates both the intact and the retracted ruptured portions of tendon in association with a hematoma

Complete tear
- help to avoid delayed diagnosis of complete tear (retraction!!)
- allows a precise assessment of the severity and extent of tendon injury
- distinguishing tendinosis and partial tears from a complete tendon rupture is of the utmost Importance
- acute complete rupture: as focal defect created by a variable degree of retraction of the torn tendon edges
- posterior acoustic shadowing at the site of tendon tear or behind the retracted tendon may be an associated finding as a result of sound-beam refraction at the frayed tendon ends
- defect created by the tear is usually filled with anechoic or hypoechoic fluid from local hematoma.
- Subacute to chronic tearing, the absence of fresh hemorrhagic fluid and the organized hematoma which fills the defect with echogenic material can be misleading, mimicking tendon integrity
- gentle passive assisted movements can be helpful to enhance the separation of the tendon ends during stretching

Sonographic findings in individual tendon

1) Common extensor tendon
- reported sensitivity of approximately 80% and specificity of approximately 50%
- Tendinosis appears as tendon enlargement and heterogeneity
- lateral epicondylitis:
  tendinosis (tendinitis?)
  partial tear
  complete tear
2) Achilles tendon
   - typical sonographic findings in patients with clinical signs and symptoms
     Enlarged tendons showing spindle shape/fusiform thickening
     Hypoechoic lesions within the tendons
     Doppler-proven neovascularisation

3) Rotator cuff

4) Patellar tendon

Reference


