Tendinopathy

Understanding different clinical presentations

Jill Cook

Most tendons have a homogeneous presentation
- Age and sex
  - Young active men
    - Patellar tendon in jumping athletes
  - Adductor tendon in kicking athletes
  - Older sedentary women
    - Tibialis posterior
    - Supraspinatus
      - Both sexes

Young, high load athletes
- Middle aged, moderate load people
- Older, low load, post menopausal women (Maffulli et al)
- Sedentary people

Use this tendon to illustrate how intrinsic and extrinsic factors affects onset of tendinopathy

Achilles tendinopathy
- Heterogeneous in prevalence and onset
  - Presents across a range of ages and activity
  - 11% lifetime incidence (Kujala et al 07)
    - Young, high load athletes
    - Middle aged, moderate load people
    - Older, low load, post menopausal women (Maffulli et al)
    - Sedentary people
- Use this tendon to illustrate how intrinsic and extrinsic factors affects onset of tendinopathy

Questions
1. Is tendon pathology a homogeneous condition?
2. Does one type of load induce pathology?
3. What intrinsic factors predispose individuals to tendon pathology?
4. Are there new perspectives on treatments for tendinopathy?

Review of pathology?
- Metaplastic change to fibrocartilage
  - Cellularity proliferation
  - Rounder
  - Ground substance proliferation
  - Larger (compressive) proteoglycans
  - Collagen degradation
  - Loss of Type 1
  - Neurovascular proliferation

Pathology of tendinopathy
- Does a tendon go from normal to pathological in one step?
  - Evidence in animal and human studies that tendinopathy is a continuum

Number of tendons

<table>
<thead>
<tr>
<th>Metaplastic change</th>
<th>Cellularity proliferation</th>
<th>Rounder</th>
<th>Ground substance proliferation</th>
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</table>

Combination of histopathological changes

- Metaplastic change to fibrocartilage
- Cellularity proliferation
- Rounder
- Ground substance proliferation
- Larger (compressive) proteoglycans
- Collagen degradation
- Loss of Type 1
- Neurovascular proliferation
Normal tendon

Stress shielded

Optimised

Load

Strengthen

Normal or excessive load +/- individual factors

Excessive load + individual factors

Degenerative tendinopathy

Optimised

Load

Tendon dysrepair

Reactive tendinopathy

Normal tendon transition over one volleyball season

Start of season

Normal

Swollen (cell-PGs)

Degenerative (matrix-collagen)

Normal

228

58

5

.78

.2

02

Swollen

35

72

26

.26

54

2

Degenerative

4

25

129

.02

16

82

End of season

Malliaras et al unpublished

What about tendon load?

Positive

- Without load tendons lose function
- Tendon degradation in matrix and cell
- Functional and muscolotendinous deterioration in the individual

Negative

- Overload leads to tendinopathy
- Pathology and pain
  - Not necessarily together
- More load, more prevalent
- Young and past elite athletes (Sugiura et al 07)
- Aspects of load may be critical
  - Distance runners OR (frequency)
  - Sprinters OR (load)? (Sugiuara 06)

Types of tendon load

- Tensile
- Compressive
- Friction/shear

Tensile load thought to be the primary overload

Compression is implicated in many tendinopathies

Load may vary in different parts of the tendon

Model of tendinopathy

<table>
<thead>
<tr>
<th>Type of tendinopathy</th>
<th>Reactive (swollen)</th>
<th>Tendon dysrepair</th>
<th>Degenerative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tendon response</td>
<td>Active Adapted to load</td>
<td>Active Attempting to heal</td>
<td>Passive Gives up on healing</td>
</tr>
<tr>
<td>Tendon</td>
<td>Increased protein production</td>
<td>Continued protein production but fails to gain structure</td>
<td>Cells die, no protein production</td>
</tr>
<tr>
<td>Age/Load</td>
<td>Younger, short term load</td>
<td>Older and/or subject to ongoing strain</td>
<td>Older and/or subject to further strain</td>
</tr>
<tr>
<td>Capacity to repair</td>
<td>Full</td>
<td>Limited</td>
<td>None</td>
</tr>
<tr>
<td>Prevalence</td>
<td>Common, not seen</td>
<td>Less common presents clinically</td>
<td>Uncommon, presents clinically</td>
</tr>
<tr>
<td>Pain ???</td>
<td>If severe, very painful</td>
<td>Sometimes</td>
<td>Often grumbly</td>
</tr>
</tbody>
</table>

Question 1

Tendon pathology is NOT homogeneous
Is load homogeneous?
- Mid tendon
  - Achilles is the only tendon to fail in the midsubstance
  - Not hypovascular
- Tensile load
  - Insertion
    - Not commonly where tendon inserts, but just proximal to it
  - Compressive load
    - Posterior gliding membranes and anterior fat structures
      - Complex and multifunctional
      - Mechanoreceptive, nociceptive structures and macrophages (Shaw et al. 2007)
    - Friction

Tensile load
- Maximal load is energy storage and release
- Force increased with load at length
- Long thin springs are vulnerable to overload in the middle
- Sustained in the midtendon
- Shorter tendons may be more vulnerable at the insertions

Compressive load
- Enthesis adapts to the strains on the tissue
  - The bone, bursa and cartilage changes are dependent on
    - The inherent characteristics
- Primarily compressive pathology proximal to the insertion

Achilles tendon
- Achilles insertions therefore don’t like to be stretched
  - That’s why they like heel inserts
  - That’s why they don’t respond to the Alfredson program
    - Remember, only 30% improved with standard Achilles program

Achilles insertion
- 27 participants (34 tendons)
  - Chronic Achilles insertional tendinopathy
  - Mean 26 months
- Eccentric program to flat
  - i.e. eccentrics with reduced compression
  - VAS 72 at baseline
- VAS decreased to 21
  - 19 participants (23 tendons satisfied)
  - 9 (11 tendons not satisfied)
  - VAS significantly improved (58) but not back to previous levels of activity
  - Outcome not influenced by bone spurs, Haglund’s or bursal pathology (Jonsson et al. BJSM 2008)

Does compression explain some mid tendon Achilles tendinopathy?
- Loading a spring causes thinning in the midtendon, therefore internal compression
  - Midtendon is made up of fibres from soleus and gastroc
  - Internal interface between soleus and gastrocnemius (Bojsen-Moller et al. 2004)
Question 2

Tendon load is NOT homogeneous
(even in one tendon)

So........

- Type of load explain Achilles tendinopathy in
  - Elite athletes in the mid tendon
  - Repeated energy storage
  - Insertional tendinopathy
  - Compressive load
- What about the other presentations?
  - Middle aged recreational athlete
  - Older woman
  - Sedentary people
- There are a range of other factors that influence the onset and type of tendinopathy

Genes

- Blood group
  - Yes (Kannus et al 91, Jarvinen 92)
  - No (Maffulli)
- Tendinopathy in systemic disease
  - Diabetes, arthritis
  - Collagen diseases
  - Marfan’s, Ehlers-Danlos
- Specific polymorphisms for type V collagen and tenasin-C gene are more common in those with chronic Achilles tendon pain
  - No difference Type I collagen

Body composition

- BMI in subjects that failed the Achilles eccentric program higher (>28) than in responders (Alfredson et al)
- BMI correlated with pathology score (Mokone et al)
- BMI over 35 increased risk of shoulder tendon surgery by more than 3 times (Wendleboe et al 04)

Body composition

- BMI as a RISK factor for upper extremity tendinitis
- Cohort study in 500 workers over 5 years
  - No baseline symptoms
  - Clinical diagnosis of wrist, elbow or shoulder tendinopathy
  - Aside from symptoms and history of other conditions (CTS), BMI was the ONLY significant factor
    - 29.5 UET, 27.7 no UET (no variance reported)
    - Age, sex, job, exercise, smoking, support, stress, disease all not significant
  - Werner et al 05

Systematic review identified 41 studies that examined tendons and body fat

- 19 found a significant association (Gaida et al, submitted)
- Trends in same direction for all but two of the remaining studies
**Waist and pathology**

<table>
<thead>
<tr>
<th>Waist girth (cm)</th>
<th>110</th>
<th>100</th>
<th>90</th>
<th>80</th>
<th>70</th>
<th>60</th>
<th>50</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sagittal depth (mm)</td>
<td>14</td>
<td>12</td>
<td>10</td>
<td>8</td>
<td>6</td>
<td>4</td>
<td>2</td>
</tr>
</tbody>
</table>

**Tendon abnormality**

- Abnormal
- Normal

Malliaras et al 06

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**Dyslipidaemia**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Achilles</th>
<th>Control</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chol (mmol/L)</td>
<td>5.47 (1.02)</td>
<td>5.18 (1.08)</td>
<td>0.094</td>
</tr>
<tr>
<td>TG (mmol/L)</td>
<td>1.22 (0.77)</td>
<td>0.96 (0.47)</td>
<td>0.038</td>
</tr>
<tr>
<td>HDL (mmol/L)</td>
<td>1.44 (0.39)</td>
<td>1.53 (0.48)</td>
<td>0.027</td>
</tr>
<tr>
<td>%HDL</td>
<td>27.6 (8.5)</td>
<td>31.9 (10.3)</td>
<td>0.016</td>
</tr>
<tr>
<td>LDL (mmol/L)</td>
<td>3.27 (0.50)</td>
<td>3.14 (0.95)</td>
<td>0.186</td>
</tr>
<tr>
<td>LDL/HDL</td>
<td>2.23 (0.56)</td>
<td>2.18 (0.92)</td>
<td>0.192</td>
</tr>
<tr>
<td>TG/HDL</td>
<td>0.941 (0.746)</td>
<td>0.691 (0.445)</td>
<td>0.036</td>
</tr>
<tr>
<td>ApoB (mg/L)</td>
<td>1005 (230)</td>
<td>896 (231)</td>
<td>0.017</td>
</tr>
</tbody>
</table>

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**How does fat affect tendons?**

- Cytokines
  - Visceral fat excretes pro-inflammatory cytokines
  - IL-6, IL-1
  - Also factors known to be associated with bone-tendon junction pathology
  - TNF-a

- Lipid deposition
  - In arteries
    - Vascular compromise
  - In tendons
    - Tendolipomatosis
    - Seen in familial hypercholesterolaemia
    - Cholesterol levels linked to Achilles tendinopathy
    - 70% of those examined had elevated cholesterol levels (Jones et al under review)

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**Clinical application**

- If you exercise (increased load)
  - With a genetic predisposition to tendon disease and/or central fat storage
  - AND you are fat
  - You may have a series of factors that leave you vulnerable to tendon disease

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**Factors that affect the Achilles**

- So how might fat explain other populations with tendinopathy?
  - Sedentary people might have higher fat mass
    - Surgery in athletic and not athletic populations
      - NA were shorter, heavier (higher BMI), higher subcutaneous fat
        - 25/48 good result of 32/45, VISA 88 of 74
      - Suffered more wound infection and sensitivity, more hypertrophic scarring, more repeat surgery
    - Maffulli et al 07
  - Middle aged men have higher visceral fat levels
  - Post menopausal women change fat deposition from subcutaneous to visceral

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**Factors that affect the Achilles tendon**

- Compression in Achilles tendinopathy
  - The posterior retinaculum that prevents bowstringing in plantar flexion may compress the tendon in this position
  - Sedentary people may spend time in plantar flexion
  - 44% of sedentary people failed to improve with eccentric (tensile) loading
  - Sayana et al 07
Factors that affect the Achilles

- Sex
  - Women get less Achilles mid-tendinopathy than men
  - Is oestrogen a factor?
- Female hormones may be protective of tendons
  - Non-load related tendinopathy in post-menopausal women
  - Increased incidence in rupture post menopause

Role of female hormones in Achilles tendinopathy

- 95 post-menopausal women
  - Achilles tendon US
  - VISA-A score
  - Golfers and controls
  - Current and never HRT
  - Results
    - Positive effect from HRT
    - Negative effect from golf
    - More pathology
    - Larger tendons

Question 3

Many factors must be taken into account when assessing an individual with tendinopathy

Treating tendinopathy

- Have there been any advances in treating tendons?
  - Pain
    - Essential during exercise as part of the Alfredson program
    - Pain during activity in rehabilitation may not affect outcome
      - VISA in active group 57-85, rest group 57-91 (Silbernagel et al)

Linking load, pathology and pain - patellar tendon

- Loading not good for pathology
  - 25%
- Pathology & pain
  - 4%
- Supports the model
- Loading not detrimental for pain
  - 1%
- Pathology & pain
  - 21%
- Loading good for pain

Eccentric exercise compared to stretching

- Achilles RCT, n=45
- Eccentric vs 30 s stretch both bent and straight knee
- No difference (?) in outcome at 3 and 12 months
- Issues
  - Follow up
  - Outcome measures
    - US, palpation and unvalidated questionnaires
      - Norregaard et al 07
Eccentric exercise in season

- Unsuccessful in patellar tendon
  - Visnes, Fredberg
- Soccer players
  - Randomised to intervention or control
    - Intervention stretching and eccentric exercise
      - 25 times each leg, 3 sets, 3 times a week
  - No difference in outcome
    - 9% of normals developed US changes both groups
    - RR of developing symptoms 2.8 (1.6,4.9) in both groups if US abnormal at baseline
- Eccentrics have never been shown to have a preventative role
  - In-season loads are high

Treating tendinopathy

- Identify if you think compression is a factor
  - If so, limit the compression on the tendon
- Identify factors that might influence outcome
  - Fat is easy
  - Genes, sex a bit harder
- Identify if they are in a population that responds to an eccentric program
  - Middle ages recreational athletes
    - If so, start with that
  - Otherwise consider other factors that might impact on outcome

Question 4

There are more treatment options than standard eccentric exercise programs

Summary

- Tendinopathy has a range of factors that contribute to it
- Occurs in tendons with a variety of loads
  - The pathology is likely the same
  - The aetiology is likely different
- Understanding and addressing the factors associated with the condition may improve outcomes