Tendinopathy of the Upper Extremity: Histopathology and Evidence Informed Practice

Jane Fedorczyk, PT, PhD, CHT
Center for Hand and Upper Limb Rehabilitation
Philadelphia, PA

Nomenclature Presents Challenges

- Tendonitis
- Tendinopathy
- Tendonopathy
- Tendinosis
- Tendinalgia
- Peritendinitis
- Enthesiopathy
- Elbow pain
- Tennis elbow
- Lateral Epicondylitis
- Lateral Epicondylitis
- Lateral Elbow Tendinopathy

The term tendinopathy eliminates the issue of tissue status related to degenerative v. inflammatory states.

Integrative Model of Lateral Epicondylalgia

Coombs, Bisset, Vincenzino, 2008

Strength Deficits & Imbalances;
Motor Control Issues; Upper Limb Use Changes

Tendon Pathology:
Tendinosis = Angiofibroblastic Hyperplasia

- Dense Population of Fibroblasts
- Vascular Hyperplasia
- Disorganized Collagen Fibers
- Incomplete/Immature Healing of Tendon which may lead to:
  - Fibrosis
  - Calcification
  - Rupture

Nirschl, 1972
Kraushaar & Nirschl, 1999

Tendon Structure

Collagen fiber = basic unit of tendon
Endotenon binds fibers to form bundles
Peritendon = epitenon + paratenon

Fedorczyk, 2006

Normal Tendon Histology

Fedorczyk, 2006, 2010
Morphologic Changes to Tendon with HRHF

Neovascularization

Neurochemicals Observed in Tendon in Patients with Chronic Tendinopathies
- Substance P or NK-1
- Glutamate or NMDAr1
- Calcitonin Gene-Related Peptide (CGRP)

Identified using microdialysis and immunohistochemistry at time of surgical procedure:
- ECRB (origin): Ljung, 1999; Alfredson, 2000
- Forearm Flexor (origin): Ljung, 2004
- Patellar (tendinosis): Alfredson, 2001; Lian 2006; Forsgren, 2005
- Achilles (tendinosis, nodules): Alfredson, '01; Bjur, '05; Forsgren, '05
- Subacromial Bursa: Gotoh, 1998

Associated with chronic pain mediation
Urban & Gebhart, 1999; Brain & Cox, 2006

Peripheral Sensitization >> Central Sensitization

- Pain mediation may occur in chronic tendinopathies via “neurogenic inflammation”
- Glutamate, SP, and CGRP are potent pain modulators within central sensitization

Urban and Gebhart, 1999
Tendinosis Phases of Pain (Nirschl)

Peripheral Sensitization

I: Mild pain after exercise activity; resolves in 24 hours
II: Pain after exercise, exceeds 48 hrs; resolves with warm-up
III: Pain with exercise activity that does not alter activity
IV: Pain with exercise activity that does alter activity

Central Sensitization

VI: Intermittent pain at rest that does not disturb sleep
VII: Pain caused by light activities of daily living; constant pain at rest; pain disturbs sleep

Motor System Impairments in Upper Limb

- Decreased grip strength due to pain
- Decreased wrist extension strength due to pain
- Decreased scapula stabilizer strength and endurance
  - Lucado, et al., 2012
  - Bhatt, et al., 2013
  - Day, et al., 2015

Location of Tendinosis

Enthesis = insertion/origin into bone = osteotendinous junction

- Tendon inserts into bone not covered by periosteum with hyaline cartilage interposed between bone and tendon
- Plantar fascitis, lateral and medial elbow tendinopathy are common enthesiopathies

Integrative Model of Lateral Epicondylalgia

Coombs, Bisset, Vincenzino, 2008
Location of Tendinosis

“Midsubstance” = musculotendinous junction or any where within the tendon just not the enthesis

- Nodules may be present
- Achilles, Patellar, Rotator Cuff

Collagen Type Varies by Location

<table>
<thead>
<tr>
<th>Location</th>
<th>Collagen Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tendon</td>
<td>I</td>
</tr>
<tr>
<td>Myotendinous Junction</td>
<td>I, III, IV, V</td>
</tr>
<tr>
<td>Enthesis</td>
<td>II</td>
</tr>
</tbody>
</table>

ECRB Most Commonly Implicated Tendon

CET slides against capitellum during elbow motion
ECRB vulnerable (Erak, 2004)
Limited vascular supply to under surface of ECRB

Stages of Tendinosis

described by Kraushaar and Nirschl, JBJS, 1999

- Stage 1: Peritendinous inflammation
  - Not really tendinosis, but what clinicians typically think of as tendinitis; inflammation of connective tissues that surround tendon not enclosed in sheath
- Stage 2: Angioblastic Degeneration
- Stage 3: Further Degeneration/Rupture
- Stage 4: Fibrosis and Calcification
**Suggested Time Course**
Scott, et al. JOSPT, Nov. 15, p. 834

- Acute, less than 4 wk
- Subacute, 5 to 12 wk
- Chronic, greater than 12 wk
- Acute on chronic

"rooted in evidence, but not validated"

---

**Co-Morbidities**

- Inflammatory Diseases
- Rheumatologic Disorders
- Diabetes Mellitus and other Metabolic Disorders
- Smoking
- Obesity
- Medications
  - Statins, Corticosteroids, Fluoroquinolones
- Cervical Radiculopathy

Scott, et al. JOSPT, Nov. 15

---

**Physical Load Factors**

- Repetitive Forceful Gripping or Elbow Motion
- Constrained position of upper limb
- Cold Temperatures
- Equipment changes
- Poor technique

Scott, et al. JOSPT, Nov. 15

---

**Intrinsic Factors**

Individual characteristics:
- Age
- Muscle Flexibility, Strength or Imbalances
- Changes in practice (loading tendon)

Scott, et al. JOSPT, Nov. 15

---

**Incidence**

- Annual incidence 1-3% of general population
- About 5% tennis players
- 5 to 8 per 1000 patients per year
- 12 -13 per 1000 patients per year for people between 40 to 50 years


---

**Clinical Challenges**

- Pathoanatomical Features
  - limited clinical utility
- Co-morbidities
- Time Course
- Risk Factors
- Prevalence/Incidence

Scott, et al. JOSPT, Nov. 15, p. 834
Autologous Blood Injections

- Regenerative Medicine
- Whole Blood vs. Plate-Rich Plasma (PRP)

Platelet-Rich Plasma

- Concentrated source of growth factors and cytokines that facilitate tissue healing.
- Few clinical studies in humans show the effectiveness of PRP treatment.
- Anti-inflammatory medicines should be stopped before and after PRP treatment is given.

Examination

Painful Conditions of the Elbow

Lateral
- LET
- Radial Tunnel
- LCL Injury (PLRI)
- PL Plica Syndrome

Medial
- Medial Epicondylitis
- Cubital Tunnel
- MCL or UCL Injury
- “Unhappy Triad”

Generalized
- “Little Leaguers Elbow”
- Osteochondritis Dissecans
- Arthritis (OA or RA)

Localize Source of Pain and Dysfunction

- Most structures in the elbow have nerve root innervation from C5-C8.
- Perform an upper quarter screening examination for potential nerve root pathology.
- Rule out shoulder and wrist pathology.
Primary Differential Diagnosis

- Radial Tunnel Syndrome
- C5/C6 Cervical Radiculopathy
- Proximal Neurovascular Entrapment
- Injury or Degenerative Changes to the Radiohumeral Joint
- Posterolateral Rotary Instability (PLRI)
- Posterolateral Plica Syndrome
- Triceps Tendinopathy

LET: Clinical Presentation

- ECRB most common musculotendinous unit involved
- Age of onset is 35-50
- Pain on or near the lateral epicondyle
- Aggravated by repetitive forceful gripping activities

Pain is Primary Complaint

- Degrees of pain and tenderness LE
- Pain limits grip
- Pain limits ability to accept load with elbow extended

Posterolateral Rotary Instability (PLRI)

- LUCL attaches to lateral epicondyle
- 25% of failed tennis elbow surgical cases develop PLRI (Singleton, 2004)
- PLRI with Tennis Elbow; insidious onset
  - Kalainov and Cohen, 2005 suggest that corticosteroids may contribute to degeneration of lateral stabilizing tissues

Posterolateral Plica Syndrome

Ruch, 2006

Characteristic findings include:

- Painful click or snap with terminal extension and supination in the absence of gross instability.
- Maximal tenderness posterior to lateral epicondyle and centered at posterior radiocapitellar joint.
- Symptoms mimic lateral epicondylitis
- Repetitive microtrauma related to the thickening/fibrosis of plica.
- Instability of the elbow may exacerbate the inflammation, leading to snapping.
- Arthroscopic management may provide a successful treatment option

Triceps Tendinopathy
Tennis Elbow Examination

Patient History
- Patient Age
- Duration of Symptoms
- Number of Recurrences
- Mechanism of Injury
- Nature and Location of Pain

Symptomatic Tendinosis (JF)
Duration of Sx’s >3 months
Recurrent Problem
Age-related= older = tendinosis
Risk factor exposure

Tests and Measures
- ROM
- Muscle Length – Mills
- Accessory Movement
  - A/P radial head (PRUJ); Lateral Glide
- Muscle Performance
  - Grip Strength, Total Arm, Scapula Stabilizers
- Self-Report Measure
  - PRTEE, PSFS, DASH
- Special Tests
  - Rule out or Confirm
  - Problem – they can all hurt!

Grip Strength
- Maximum vs. Pain-free
- Standard testing position except elbow is extended; 3 trials
- PF = squeeze and stop when feel onset of pain
- Ratio may inform CDM on irritability
**Tennis Elbow Tests**

- Resisted Middle Finger Extension
- Cozen’s Test (Tennis Elbow Test)
- Mill’s Tennis Elbow Test
- Nirschl’s Hand Shake Test

No psychometric data such as specificity, sensitivity, likelihood ratios

Roles and Maudsley, 1972

---

**Cozen’s Test or Tennis Elbow Test**

Magge, 2014

- Elbow is stabilized by examiner’s thumb on the lateral epicondyle.
- Patient actively makes a fist, pronates and extends the wrist with radial deviation while the examiner resists the motion

Positive: Sudden severe pain in the area of the lateral epicondyle

---

**Mills Tennis Elbow Test**

Mills, Br Med J, 1937

- Patient’s elbow is fully extended with forearm pronated and wrist fully flexed.
- Can be performed actively by the patient or passively by the examiner.
- May be used as a manipulation technique to rupture adhesions or as a non-traumatic test to provoke pain around the lateral epicondyle.

**Handshake Test**

Kraushaar and Nirschl, 1999

- Firm handshake with elbow extended; supinates against the examiner’s resistance.
- The elbow is then flexed and the same maneuver is performed.
- Nirschl feels that this is a good indicator of prognosis

---

**Clinical Commentary**

Outcome Evaluation in Tendinopathy: Foundations of Assessment and a Summary of Selected Measures
Treatment-based classification

Management of Lateral Elbow Tendinopathy: One Size Does Not Fit All

Integrative Model of Lateral Epicondylalgia
Coombs, Bisset, Vincenzino, 2008

Rehabilitation Guidelines

- Must reduce overload forces; modify aggravating activities
  - Ergonomic Considerations
  - Sports-Related Modifications
- Manage pain and/or tissue healing
  - *abate acute symptoms*
- Promote scapular stability and total arm strength
  - *if weakness determined*
- Promote progressive forearm activity
  - flexibility, strength, and endurance of extensors
- Patient Education

Evidence-Informed Interventions

- Rest from aggravating activities, not from movement
- Activity Modification
  - Self selected
  - Patient Education
  - Secondary to orthotic intervention or limb positioning

"The consensus is that management of tendinopathy should optimally involve addressing loading of the tendon."
Bill Vicenzino, JOSPT, Nov. 15, p. 816
Relative REST

- Not always easy to do!
- Orthotic Intervention may help

Borkholder, et.al. SR, 2004
- One level 1b and 10 Level 2b studies that offer evidence for orthotic intervention efficacy; however all are low quality studies

Wait and See?


Corticosteroid Injection

**Therapy:** pulsed US, DFM, exercise (9 visits, 30min)

**Wait and See:** patient education about aggravating activities

- 6 week follow up 92% > 47% > 32%
- 1 year follow up 69% > 91% > 83%

Sleeping Positions

- Avoid tension EDC and ECRB if resting pain present

Ergonomics

- Paucity of evidence found pertaining specifically to LET.
- Clinicians may consider the use of ergonomic instructions, frequent work breaks, and work station modifications to reduce stresses on the lateral elbow.

Strong Evidence

- All types of resistance training for forearm extensors
- No optimal type of resistance
- No parameters for optimal dosage
- Raman, 2012 recommends 3 sets of 15, eccentric


- I have no specific recommendation

Very little written on exercise prescription for any kind of exercise
Eccentric Strengthening
Exercise or Loading
Commonly use with Achilles Tendinopathies
- reduces neovascularization
  (Alfredson et al., 2003 – 2005)
  3 sets of 15, 2x/day, 7d/wk, 12 wks; painful
  - Unclear if needs to be painful
  - Unclear if area of tendinopathy matters
  - Unclear if dosage is appropriate for UE

Tim Tyler’s Flex bar Study, 2010

Weak Evidence
- Taping
- Electroanalgesia
- Iontophoresis
- Dry Needling
- Total Arm & Scapula Stabilizers Strengthening

Conflicting Evidence
- Acupuncture
- Low-level laser
- Phonophoresis
- Orthoses
- Manual Therapy
  - Soft tissue
  - Wrist, Cervical, Thoracic
  - Lateral glide
  - Vincenzino et al., 2009

Clinical Practice Guideline for LET

Purpose
- Describe evidence-informed PT practice for LET
  - diagnosis, prognosis, intervention, and assessment of outcome
- Identify interventions supported by current best evidence to address
  - impairments, activity limitations, and participation restrictions
- Create reference for best practice for educators, policy makers, payers, and clinicians

Jane Fedorczyk PT, PhD, CHT
Thomas Jefferson University

Ann Lucado PT, PhD, CHT
Mercer University

Joy MacDermid PT, PhD, CHT
Western Ontario University
MacMasters University

Joshua Vincent, PT, PhD
Roth/McFarlane Hand and Upper Limb Centre, London, Ontario

Matt Day, PT, PhD, OCS, CIMT
University of Southern Alabama

orthopt.org
handpt.org

Lateral Elbow Tendinopathy
Non-Op Management of Carpal Tunnel Syndrome
Distal Radius Fractures
Challenges

• Variety of nomenclature
  – -itis, -osis, -algia, tendinopathy, enthesis, common extensor tendon, lateral elbow pain
• No well developed operational definitions for time course
• Extensive amount of articles available for LET
• Variability in levels of evidence
  – Scientific commentary to systematic reviews

Summary: No Magic Bullet for Tx

• Multiple interventions have been investigated for the treatment of lateral elbow tendinopathy.
• Despite multiple randomized control trials, systematic reviews and meta-analyses of this literature, there is not one intervention that stands out as superior to others.
• The need for multiple interventions seems to reflect the multifactorial etiology of the condition.

Summary

• Clinical syndrome
• No psychometric data for special tests
• Imaging results may not correlate with clinical presentation
• Is it a self limiting condition?

“Compelling evidence that joint mobilizations have a positive effect on both pain and/or functional grip scores across all time frames compared to control groups in the management of LET”

Orthotic fabrication for 6-10 weeks recommended.
Therapists should use a valid functional outcome measure in the future — most studies used pain and triggering symptoms.
More RCTs needed.