ANOTHER ONE BITES THE DUST:
THE NON-SURGICAL MANAGEMENT OF
OVERUSE INJURIES

2017 Sports Medicine Symposium:
Return to Play
July 21, 2017

Stacy Majoras, DO, ATC
Bronson Sports Medicine Specialists
Western Michigan University Team Physician
Objectives

- Mechanism of overuse injury
- Pathophysiology of tendon injury
- Pathophysiology of bone injury
- Non surgical management of over use injuries
• Definition of tendinopathy
• Disease pathophysiology
• Common overuse injuries of tendon
  • Treatment overview
    – Eccentric exercises
    – Nitroglycerin
    – Shockwave
    – PRP
    – Others
• Definition of overuse bone injury
• Disease pathophysiology
• Treatment overview
• Return to play
• Closing remarks and questions
• Tendon – a flexible but inelastic cord of strong fibrous collagen tissue attaching muscle to bone, poor blood supply
• Pathology – science of the causes and effects of diseases
• Tendinopathy – disease of a tendon
What Causes the Pain?

- To understand pain we should understand pathology
- If pathology is not the problem why do we have pain?
- Biochemical substances
  - Catecholamines
  - Acetylcholine
  - Glutamate
  - Lactate
- Neurovascular infiltration (late dysrepair)
- Patients in all phases with and without pain
Pathogenesis

- Several opinions/theories: some proven and some based on theory
- Delicate balance between cell death and proliferation
- Normal tendon under stress
  - Increased cross-linkage and collagen deposits
- Inflammatory
- Overuse
- Continuum
- Degeneration
- Under use
- Chemical mediated – increased neurotransmitters sensitize pain response – lactate
Degenerative Pathology

- Types described in literature
  - Hypoxic degeneration
  - Hyaline degeneration
  - Mucoid degeneration
- Irreversible cellular changes
- Disintegration of matrix
- Usually associated with chronic overuse
  - Increased tension causes micro-tearing
  - Abnormal adaptation to micro-tears = tendinosis
  - Increasing muscle contractions lead to avascular environment for tendon – reperfusion injury
- Also related to underuse
  - Cell and matrix changes similar to that of overuse
  - Mostly reversible
- Decreased mechanical integrity leading to failure of the tendon
Is tendon pathology a continuum? A pathology model to explain the clinical presentation of load-induced tendinopathy

J L Cook,1 C R Purdam2

• Stage 1 – Reactive tendinopathy
• Stage 2 – Tendon disrepair
• Stage 3 – Degenerative tendinopathy
• Stage 4 – stage 2/3 + fibrosis, hard or soft calcification
• Is tendon rupture end-stage degenerative tendinopathy?
  – Kujala et al, 2005
Cumulative Incidence of Achilles Tendon Rupture and Tendinopathy in Male Former Elite Athletes

Urho M. Kujala, MD, PhD,* Seppo Sarna, PhD,† and Jaakko Kaprio, MD, PhD†

**TABLE 1.** Cumulative Incidence Before Age 45 and Lifetime Incidence of Achilles Tendon Injuries in Former Top-Level Athletes and Controls

<table>
<thead>
<tr>
<th>Sport</th>
<th>n</th>
<th>Median Age* (Range)</th>
<th>Cumulative Incidence of Achilles Tendon Pathology</th>
<th>Cumulative Incidence of Achilles Tendon Rupture</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>%† (n) &lt;45 y Lifetime</td>
<td>%† (n) &lt;45 y Lifetime</td>
</tr>
<tr>
<td>Short-distance running</td>
<td>94</td>
<td>69.5 (55.4–91.8)</td>
<td>31 (24) 36 (28)</td>
<td>17 (13) 18 (14)</td>
</tr>
<tr>
<td>Middle and long-distance running</td>
<td>99</td>
<td>69.9 (58.1–93.9)</td>
<td>42 (39) 52 (48)</td>
<td>3 (2) 5 (3)</td>
</tr>
<tr>
<td>Track and field, jumping</td>
<td>74</td>
<td>67.7 (55.5–89.7)</td>
<td>18 (11) 27 (17)</td>
<td>2 (1) 12 (7)</td>
</tr>
<tr>
<td>Track and field, throwing</td>
<td>60</td>
<td>67.7 (57.7–88.9)</td>
<td>7 (4) 17 (9)</td>
<td>2 (1) 2 (1)</td>
</tr>
<tr>
<td>Decathlon</td>
<td>17</td>
<td>67.2 (56.9–82.4)</td>
<td>15 (2) 23 (3)</td>
<td>17 (2) 17 (2)</td>
</tr>
<tr>
<td>Soccer</td>
<td>104</td>
<td>66.6 (54.9–87.9)</td>
<td>23 (20) 28 (24)</td>
<td>7 (6) 12 (10)</td>
</tr>
<tr>
<td>Boxing</td>
<td>66</td>
<td>66.7 (54.9–82.8)</td>
<td>5 (3) 9 (5)</td>
<td>2 (1) 4 (2)</td>
</tr>
<tr>
<td>Cross-country skiing</td>
<td>34</td>
<td>74.7 (63.1–96.7)</td>
<td>4 (1) 4 (1)</td>
<td>0 0</td>
</tr>
<tr>
<td>Ice hockey</td>
<td>73</td>
<td>65.3 (54.7–92.3)</td>
<td>8 (5) 17 (10)</td>
<td>7 (4) 9 (5)</td>
</tr>
<tr>
<td>Basketball</td>
<td>53</td>
<td>67.5 (53.9–75.5)</td>
<td>16 (7) 19 (8)</td>
<td>5 (2) 12 (5)</td>
</tr>
<tr>
<td>Wrestling</td>
<td>77</td>
<td>70.5 (57.0–87.0)</td>
<td>5 (3) 5 (3)</td>
<td>0 2 (1)</td>
</tr>
<tr>
<td>Weightlifting</td>
<td>34</td>
<td>73.3 (60.1–89.8)</td>
<td>4 (1) 8 (2)</td>
<td>4 (1) 4 (1)</td>
</tr>
<tr>
<td>All athletes</td>
<td>785</td>
<td>69.0 (53.9–96.7)</td>
<td>18.2 (120) 23.9 (158)</td>
<td>5.4 (33) 8.3 (51)</td>
</tr>
<tr>
<td>Controls</td>
<td>416</td>
<td>67.5 (55.5–94.3)</td>
<td>2.9 (10) 5.9 (20)</td>
<td>1.2 (4) 2.1 (7)</td>
</tr>
</tbody>
</table>

*Age when responding to the questionnaire.
†Of those responding to the specific question.
Stage 1

- Reactive tendinopathy
  - Acute overload
  - Initial proliferative response
  - Homogeneous thickening of the tendon
  - No neurovascular changes
  - Collagen remains maintained
Stage 2

- Tendon disrepair
  - Body’s attempt at healing
  - Increase in number of cells – chondrocytes
  - Angiofibroblastic hyperplasia – a concentration of fibroblasts
  - Vascular hyperplasia
  - Disorganized collagen

Figure 1 Pathology continuum; this model embraces the transition from normal through to degenerative tendinopathy and highlights the potential for reversibility early in the continuum. Reversibility of pathology is unlikely in the degenerative stage.
Degenerative tendinopathy – Continued

- Accumulation of pathology causes structural failure of tendon
- Cell death – apoptosis
- Cell exhaustion
- Focal disarray amidst normal tendon

Stage 3

242 Pounds Lost in 18 months with Power 90 and P90X
• Stage 2/3 + fibrosis
  – hard or soft calcification
Common Overuse Injury

- Tendinopathies
  - Lateral epicondylitis
  - Patellar tendinitis
  - Quad tendinitis
  - Achilles tendinitis
  - Plantar fasciitis
  - Biceps tendinitis
  - Rotator cuff tendinitis
  - Hip flexor tendinitis
Outline

• Definition of tendinopathy
• Disease pathophysiology
• Common overuse injuries of tendon
• **Treatment overview**
  – Eccentric exercises
  – Nitroglycerin
  – Shockwave
  – PRP
  – Others
• Definition of overuse bone injury
• Disease pathophysiology
• Treatment overview
• Return to play
• Closing remarks and questions
• Goals
  – Relieve pain
  – Increase movement – preserve movement
  – Increase strength – preserve strength
  – Increase function – preserve function
  – Halt and/or reverse histologic deterioration

• Different treatments for different stages of pathology
  – ie: patient in acute phase doing overloading eccentric exercises may be more detrimental
  – Self-limiting: most likely will resolve with conservative measures or no interventions
Treatments

- Physical therapy – eccentric exercises
- Iontophoresis
- Custom vs OTC foot orthotics
- Bracing - Heel lifts, counterforce brace, wrist splints
- NSAIDS
- Corticosteroid injections
- Platelet Rich Plasma (PRP) injections
- Nitroglycerin patches
- Acupuncture
- Prolotherapy
- Tenotomy
- Tenex - percutaneous tenotomy
- Percutaneous radiofrequency micro-tenotomy
- Laser therapy
- Shock wave therapy
- Botulinum toxin
- Surgery

What Works?
NSAIDS

• If no inflammatory mechanism why use anti-inflammatories?
  – GOOD QUESTION
• Retard soft tissue healing
  – Ferry et al, 2007
  – Rat patellar tendons

Corticosteroids

• Strong anti-inflammatory
• Has been shown to decrease tendon size
• Linked to tendon rupture

<table>
<thead>
<tr>
<th>Drug</th>
<th>Failure</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>0</td>
<td>23</td>
</tr>
<tr>
<td>Ibuprofen</td>
<td>0</td>
<td>23</td>
</tr>
<tr>
<td>Acetaminophen</td>
<td>0</td>
<td>24</td>
</tr>
<tr>
<td>Naproxen</td>
<td>3</td>
<td>24</td>
</tr>
<tr>
<td>Piroxicam (feldene)</td>
<td>4</td>
<td>24</td>
</tr>
<tr>
<td>Celecoxib</td>
<td>6</td>
<td>22</td>
</tr>
<tr>
<td>Valdecoxib (Bextra)</td>
<td>10</td>
<td>24</td>
</tr>
</tbody>
</table>
Physical Therapy

• Eccentric exercises
  – Knee bent vs knee straight
  – Open chain vs closed chain
  – Use of extra weight
  – Stimulate cellular activity in the late disrepair phase
• Iontophoresis – electrical stimulation with anti-inflammatory
• Phonophoresis – use of ultrasound with anti-inflammatory
• Graston – mechanical deep tissue
Heavy-Load Eccentric Calf Muscle Training For the Treatment of Chronic Achilles Tendinosis

Håkan Alfredson, MD, Tom Pietilä, RPT, Per Jonsson, RPT, and Ronny Lorentzon,* MD, PhD

From the Sports Medicine Unit, Department of Orthopaedic Surgery, University Hospital of Northern Sweden, Umeå, Sweden

• 30 recreational athletes
  – 15 study group: eccentrics
  – 15 controls: no training regimen
• Tried and failed – rest, nsaid, orthotics, PT, change training
• Measured
  – Isokinetic calf strength
  – Peak torque
  – Total work
  – Pain score – VAS
Results

**TABLE 2**
Isokinetic Concentric and Eccentric Peak Torque (in Newton-meters) in 15 Patients with Chronic Achilles Tendinosis and Selected to Receive Surgical Treatment

<table>
<thead>
<tr>
<th>Test condition</th>
<th>Preoperative (Week 0)</th>
<th>Postoperative (Week 24)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Injured(^a)</td>
<td>Noninjured</td>
</tr>
<tr>
<td>Concentric plantar flexion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>90 deg/sec</td>
<td>70.8 ± 24.4</td>
<td>87.1 ± 21.6</td>
</tr>
<tr>
<td>225 deg/sec</td>
<td>34.4 ± 15.3</td>
<td>45.1 ± 12.3</td>
</tr>
<tr>
<td>Eccentric plantar flexion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>90 deg/sec</td>
<td>146.3 ± 56.3</td>
<td>169.4 ± 48.0</td>
</tr>
</tbody>
</table>

\(^a\) The injured side had significantly lower strength than the noninjured side for all test conditions \((P < 0.01)\).

**TABLE 3**
Isokinetic Concentric and Eccentric Peak Torque (in Newton-meters) in 15 Patients with Chronic Achilles Tendinosis Who Underwent a 12-Week Calf Muscle Strengthening Regimen

<table>
<thead>
<tr>
<th>Test condition</th>
<th>Week 0</th>
<th>Week 12</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Injured</td>
<td>Noninjured</td>
</tr>
<tr>
<td>Concentric plantar flexion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>90 deg/sec</td>
<td>69.1 ± 24.6(^a)</td>
<td>78.6 ± 20.8</td>
</tr>
<tr>
<td>225 deg/sec</td>
<td>30.9 ± 10.4(^a)</td>
<td>37.7 ± 10.3</td>
</tr>
<tr>
<td>Eccentric plantar flexion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>90 deg/sec</td>
<td>152.0 ± 57.4(^c)</td>
<td>171.1 ± 48.6</td>
</tr>
</tbody>
</table>

\(^a\) The injured side had significantly lower strength than the noninjured side for all test conditions \((P < 0.01)\).
New regimen for eccentric calf-muscle training in patients with chronic insertional Achilles tendinopathy: results of a pilot study

P Jonsson,¹ H Alfredson,¹ K Sunding,² M Fahlström,³ J Cook⁴

Table 2  Characteristics of 34 tendons in 27 subjects with chronic insertional Achilles tendinopathy: comparison between subjects who were satisfied and not satisfied with treatment

<table>
<thead>
<tr>
<th>Variable</th>
<th>Satisfied (n = 23)</th>
<th>Not satisfied (n = 11)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>15/23</td>
<td>3/11</td>
<td>0.336</td>
</tr>
<tr>
<td>Age</td>
<td>54.9 (14.7)</td>
<td>50.3 (7.8)</td>
<td></td>
</tr>
<tr>
<td>Height (cm)</td>
<td>171.1 (9.3)</td>
<td>176.1 (7.1)</td>
<td>0.130</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>86.7 (19.8)</td>
<td>83.0 (14.0)</td>
<td>0.584</td>
</tr>
<tr>
<td>BMI</td>
<td>29.7 (7.0)</td>
<td>26.7 (3.9)</td>
<td>0.206</td>
</tr>
<tr>
<td>Duration of symptoms (months)</td>
<td>23.3 (22.6)</td>
<td>33.4 (16.3)</td>
<td>0.196</td>
</tr>
<tr>
<td>Haglund's deformity</td>
<td>18/23</td>
<td>9/11</td>
<td>0.813</td>
</tr>
<tr>
<td>Bursitis</td>
<td>17/23</td>
<td>5/11</td>
<td>0.110</td>
</tr>
<tr>
<td>Bone spurs</td>
<td>20/23</td>
<td>5/11</td>
<td>0.373</td>
</tr>
<tr>
<td>Baseline VAS</td>
<td>69.9 (18.9)</td>
<td>77.5 (8.6)</td>
<td>0.115</td>
</tr>
<tr>
<td>Follow-up VAS</td>
<td>21.0 (20.6)</td>
<td>58.1 (14.8)</td>
<td>&lt;0.001*</td>
</tr>
</tbody>
</table>

Results expressed as mean, standard deviation and p value.

*Significant p value <0.05.
Chronic Achilles tendon pain treated with eccentric calf-muscle training

Martin Fahlström
Per Jonsson
Ronny Lorentzon
Håkan Alfredson

Table 2 Basic characteristics and results after the eccentric training regimen in 132 Achilles tendons in 108 patients with chronic Achilles tendon pain – a comparison between the tendons with good and poor results

<table>
<thead>
<tr>
<th>Variable</th>
<th>Chronic painful mid-portion tendinosis</th>
<th>Chronic insertional tendon pain</th>
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<tbody>
<tr>
<td></td>
<td>Good results ($n=90$)</td>
<td>Poor results ($n=11$)</td>
</tr>
<tr>
<td>Patient age in years (mean±SD)</td>
<td>46.0±9.6</td>
<td>47.2±9.2</td>
</tr>
<tr>
<td>Male/female (%)</td>
<td>72/28</td>
<td>27/73</td>
</tr>
<tr>
<td>Body mass index – BMI (mean±SD)</td>
<td>25.7±3.6</td>
<td>27.9±2.5</td>
</tr>
<tr>
<td>Duration of symptoms in months (mean±SD)</td>
<td>19.8±29.9</td>
<td>15.1±12.7</td>
</tr>
<tr>
<td>VAS during activity week 0 (mean±SD)</td>
<td>66.8±19.4</td>
<td>74.0±18.9</td>
</tr>
<tr>
<td>VAS during activity week 12 (mean±SD)</td>
<td>10.2±13.7</td>
<td>64.9±26.4</td>
</tr>
<tr>
<td>Estimated subjective recovery in % (mean±SD)</td>
<td>83.3±17.3</td>
<td>12.9±23.7</td>
</tr>
</tbody>
</table>
Eccentric training in patients with chronic Achilles tendinosis: normalised tendon structure and decreased thickness at follow up

L Öhberg, R Lorentzon, H Alfredson

Table 2 Details on the tendons of 25 patients with Achilles tendinosis

<table>
<thead>
<tr>
<th>Sex/age</th>
<th>Thickness (mm)</th>
<th>Structure</th>
<th>Follow up (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Before</td>
<td>After</td>
<td>Before</td>
</tr>
<tr>
<td>Female/58</td>
<td>11.0</td>
<td>11.5</td>
<td>x</td>
</tr>
<tr>
<td>Male/54</td>
<td>4.0</td>
<td>6.4</td>
<td>x</td>
</tr>
<tr>
<td>Male/50</td>
<td>6.3</td>
<td>6.1</td>
<td>x</td>
</tr>
<tr>
<td>Female/51</td>
<td>12.0</td>
<td>10.0</td>
<td>x</td>
</tr>
<tr>
<td>Male/45</td>
<td>18.2</td>
<td>14.7</td>
<td>x</td>
</tr>
<tr>
<td>Male/54</td>
<td>9.2</td>
<td>7.3</td>
<td>x</td>
</tr>
<tr>
<td>Female/59</td>
<td>7.5</td>
<td>6.1</td>
<td>x</td>
</tr>
<tr>
<td>Male/47</td>
<td>7.1</td>
<td>6.4</td>
<td>x</td>
</tr>
<tr>
<td>Male/51</td>
<td>7.2</td>
<td>5.7</td>
<td>x</td>
</tr>
<tr>
<td>Male/41</td>
<td>6.7</td>
<td>6.5</td>
<td>x</td>
</tr>
<tr>
<td>Male/47</td>
<td>14.2</td>
<td>13.2</td>
<td>x</td>
</tr>
<tr>
<td>Male/55</td>
<td>7.3</td>
<td>7.5</td>
<td>x</td>
</tr>
<tr>
<td>Male/47</td>
<td>9.1</td>
<td>7.4</td>
<td>x</td>
</tr>
<tr>
<td>Male/50</td>
<td>9.5</td>
<td>7.2</td>
<td>x</td>
</tr>
<tr>
<td>Female/56</td>
<td>5.6</td>
<td>6.3</td>
<td>x</td>
</tr>
<tr>
<td>Male/55</td>
<td>8.7</td>
<td>6.0</td>
<td>x</td>
</tr>
<tr>
<td>Male/45</td>
<td>6.7</td>
<td>7.3</td>
<td>x</td>
</tr>
<tr>
<td>Female/62</td>
<td>10.2</td>
<td>7.0</td>
<td>x</td>
</tr>
<tr>
<td>Male/36</td>
<td>6.6</td>
<td>5.3</td>
<td>x</td>
</tr>
<tr>
<td>Male/36</td>
<td>6.8</td>
<td>5.3</td>
<td>x</td>
</tr>
<tr>
<td>Male/56</td>
<td>11.2</td>
<td>9.0</td>
<td>x</td>
</tr>
<tr>
<td>Female/54</td>
<td>8.6</td>
<td>6.6</td>
<td>x</td>
</tr>
<tr>
<td>Male/47</td>
<td>6.1</td>
<td>6.3</td>
<td>x</td>
</tr>
<tr>
<td>Male/63</td>
<td>10.3</td>
<td>7.2</td>
<td>x</td>
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<tr>
<td>Male/57</td>
<td>7.0</td>
<td>7.2</td>
<td>x</td>
</tr>
<tr>
<td>Male/73</td>
<td>12.0</td>
<td>8.0</td>
<td>x</td>
</tr>
</tbody>
</table>

Figure 1 An Achilles tendon with chronic tendinosis shown by ultrasonography before treatment with eccentric calf muscle training. The typical findings are a localised thickening, focal hypoechoic areas, and an irregular tendon fibre structure.

Figure 2 Ultrasonographic image of an Achilles tendon after treatment with eccentric calf muscle training. The typical findings are a decrease in tendon thickness, no hypoechoic areas, and a regular tendon fibre structure.
Nitroglycerin

- Nitroglycerin – potent vasodilator
  - Side effects: headache, flushing
- Theory – Nitric oxide synthase stimulates collagen synthesis through wound fibroblasts
  - Inhibit nitric oxide synthase leads to decrease CSA and load failure of the tendon during healing
  - Suggests Nitric oxide is important for modulating tendon healing

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\text{N}^+ \\
\text{O} \\
\end{array}}
\]
Topical glucosamine treatment of chronic patellar tendinopathy: a placebo-controlled double-blind randomized trial

Mirjam Steenbergen
Inge van der Linden

- Reviewed 7 articles
- Split between acute/subacute vs chronic

Acute/Subacute phase
- 2 articles
  - Berrazueta et al – 100% improved compared to Placebo
  - Pons et al – 42% improvement vs 87% improvement in corticosteroids

Chronic phase
- 5 articles
  - Paoloni et al – 81% pain excellent vs 60% in placebo; improved work
  - Paoloni et al – 78% pain excellent vs 49% in placebo; improved work; night pain; hop test
  - Paoloni et al – pain at rest, at night, with activity, PROM, Work
  - Paoloni et al – Decreased pain at 8 weeks for the 0.72mg/24 hrs
  - Kane et al – no significant decrease in pain at 6 months
Topical glyceryl trinitrate treatment of chronic patellar tendinopathy: a randomised, double-blind, placebo-controlled clinical trial

Mirjam Steunebrink, Johannes Zwerver, Ruben Brandsema, Petra Groenenboom, Inge van den Akker-Scheek, Adam Weir

<table>
<thead>
<tr>
<th></th>
<th>VISA-P Baseline (mean (SD))</th>
<th>VISA-P 6 weeks (mean (SD))</th>
<th>VISA-P 12 weeks (mean (SD))</th>
<th>VISA-P 24 weeks (mean (SD))</th>
<th>VISA-P Difference (95% CI) 6 weeks</th>
<th>VISA-P Difference (95% CI) 12 weeks</th>
<th>VISA-P Difference (95% CI) 24 weeks</th>
</tr>
</thead>
<tbody>
<tr>
<td>GTN (n=16)</td>
<td>63 (16.4)</td>
<td>64 (21.8)</td>
<td>73 (15.3)</td>
<td>75 (16.2)</td>
<td>1.1 (−10.5 to 12.7)</td>
<td>4.2 (−7.9 to 16.2)</td>
<td>−1.2 (−12.5 to 10)</td>
</tr>
<tr>
<td>Placebo (n=17)</td>
<td>67.8 (10.9)</td>
<td>67.7 (15.6)</td>
<td>73.7 (20.7)</td>
<td>80.7 (22.1)</td>
<td>2.3 (−0.7 to 5.3)</td>
<td>1.8 (−0.8 to 4.2)</td>
<td>0.4 (−2 to 2.8)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>VAS Baseline (0−10)</th>
<th>VAS 6 weeks (0−10)</th>
<th>VAS 12 weeks (0−10)</th>
<th>VAS 24 weeks (0−10)</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>GTN (n=16)</td>
<td>4.1 (2.9)</td>
<td>5.9 (3.1)</td>
<td>6.6 (2)</td>
<td>6.6 (3)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Placebo (n=17)</td>
<td>5.8 (3)</td>
<td>5.4 (3.3)</td>
<td>6.6 (3.7)</td>
<td>7.8 (3.1)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Shockwave

• Basics
  – Use of high frequency acoustic pulses focused to area of greatest pain
  – Same as lithotripsy
• Late tendon disrepair stage
• Mechanical loading increases growth factors
  – Cytokines
  – IGF-1
  – TGF-β1
  – Interleukin – 6
• Increase new vessel development at the insertion site
• Block gate control mechanism
A systematic review of shockwave therapies in soft tissue conditions: focusing on the evidence

Cathy Speed

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Ref</th>
<th>Study design</th>
<th>System type</th>
<th>N</th>
<th>Regime</th>
<th>Significant benefit at 12 weeks (or other time frame as stated)?</th>
</tr>
</thead>
<tbody>
<tr>
<td>F-ESWT low to high as tolerated</td>
<td>21</td>
<td>DB-RCT</td>
<td>EH</td>
<td>172</td>
<td>1 session, 3800 pulses, starting at low dose, increasing to high as tolerated*</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>22</td>
<td>DB-RCT</td>
<td>EM</td>
<td>178</td>
<td>3 once weekly sessions, 2000–2500 shocks from 0.02 mJ/mm² increasing as tolerated*</td>
<td>No</td>
</tr>
<tr>
<td>F-ESWT low</td>
<td>23</td>
<td>DB RCT</td>
<td>EM</td>
<td>227</td>
<td>3 once weekly sessions, 4000 shocks, 0.08 mJ/mm²</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>13</td>
<td>DB RCT</td>
<td>EM</td>
<td>88</td>
<td>3 once monthly sessions, 1500 shocks, 0.12 mJ/mm²</td>
<td>No</td>
</tr>
<tr>
<td>F-ESWT high</td>
<td>24</td>
<td>DB RCT</td>
<td>EH</td>
<td>293</td>
<td>100 shocks @ 0.12, 1400@0.22 mJ/mm²</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>25</td>
<td>DB-RCT</td>
<td>EM</td>
<td>150</td>
<td>3800 shocks (3500 shocks @ 0.36 mJ/mm²)</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>26</td>
<td>DB RCT</td>
<td>EM</td>
<td>40</td>
<td>3 once weekly sessions, 2000 @ 0.25 mJ/mm²</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>27</td>
<td>DB-RCT</td>
<td>EM</td>
<td>114</td>
<td>1 session, 3800 shocks @ 0.34 mJ/mm² (implied)</td>
<td>Yes</td>
</tr>
<tr>
<td>RPT</td>
<td>28</td>
<td>DB-RCT</td>
<td>RPT</td>
<td>245</td>
<td>3 sessions once every 2 weeks of 2000 pulses @ 0.16 mJ/mm²</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>29</td>
<td>DB-RCT</td>
<td></td>
<td>50</td>
<td>2 sessions, 1 week apart, of 2000 shocks @ 0.16 mJ/mm²</td>
<td>Yes</td>
</tr>
</tbody>
</table>
# A systematic review of shockwave therapies in soft tissue conditions: focusing on the evidence

Cathy Speed

## Table 3  Studies of ESWT and RPT in chronic recalcitrant mid portion Achilles tendinosis

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Ref</th>
<th>Study design</th>
<th>System type</th>
<th>N</th>
<th>Regime</th>
<th>Significant benefit at 12 weeks (or other time frame as stated)?</th>
</tr>
</thead>
<tbody>
<tr>
<td>F-ESWT low</td>
<td>31</td>
<td>DB-RCT</td>
<td>EM</td>
<td>49</td>
<td>Once monthly, 1500 up to max 0.20 mJ</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>depending on tolerance</td>
<td></td>
</tr>
<tr>
<td>F-ESWT high</td>
<td>32</td>
<td>DB-RCT</td>
<td>Not stated</td>
<td>48</td>
<td>2000 shocks @ 0.12–0.51 mJ/mm²</td>
<td>Yes; Mean (SD) AOFs scale pain, function, alignment: 70 (6.8) to</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>88 (12) vs 74 (12) to 81 (16)</td>
</tr>
</tbody>
</table>

## Table 4  Studies of ESWT and RPT in chronic recalcitrant insertional Achilles tendinopathy

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Ref</th>
<th>Study design</th>
<th>System type</th>
<th>N</th>
<th>Regime</th>
<th>Significant benefit at 12 weeks (or other time frame as stated)?</th>
</tr>
</thead>
<tbody>
<tr>
<td>F-ESWT high</td>
<td>30</td>
<td>RCT</td>
<td>EM</td>
<td>68</td>
<td>1 session 3000 @ 0.21 ml/mm²</td>
<td>Yes; benefit at 3 and 12 months. Mean (SD) VAS pain TG: 7.9(2) to 2.9 (2.1) p&lt;0.001 vs CG: 8.6 (1.1) to 7.2 (1.3) p&gt;0.05</td>
</tr>
</tbody>
</table>
A systematic review of shockwave therapies in soft tissue conditions: focusing on the evidence

Cathy Speed

Table 6  Studies of F-ESWT in recalcitrant non-calcific rotator cuff tendinopathy

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Ref</th>
<th>Design</th>
<th>System type</th>
<th>N</th>
<th>Dose regime</th>
<th>Significant benefit at 12 weeks (or other time frame as stated)?</th>
</tr>
</thead>
<tbody>
<tr>
<td>F-ESWT low energy</td>
<td>11</td>
<td>DB-RCT</td>
<td>EM</td>
<td>74</td>
<td>1500 shocks @ 0.12 mJ/mm² once monthly×3</td>
<td>No. Mean (SD) SPADI TG: 53.6 (20.2) to 34.7 (26.6) vs CG: 59.5 (16.1) to 39.7 (27.7)</td>
</tr>
<tr>
<td></td>
<td>38</td>
<td>DB-RCT</td>
<td>EM</td>
<td>40</td>
<td>2000 shocks @ 0.11 mJ/mm² once weekly×3</td>
<td>No. Mean (SD) CMS: 42.2(13.04) to 64.39 (32.68) vs CG: 40.7 (13.29) to 66.5(37.92)</td>
</tr>
<tr>
<td>F-ESWT high energy</td>
<td>39</td>
<td>DB-RT</td>
<td>EM</td>
<td>40</td>
<td>6000 shocks @ 0.78 mJ/mm² versus 6000@0.33 mJ/mm²</td>
<td>No. Mean (SD) CMS: 46.37 (22.47) to 79.77(35.47) vs CG: 49.06 (20.52) to 67.89(32.94)</td>
</tr>
</tbody>
</table>

Table 5  Studies of F-ESWT in the treatment of calcific rotator cuff tendinopathy

<table>
<thead>
<tr>
<th>Ref</th>
<th>Design</th>
<th>System type</th>
<th>N</th>
<th>Regime</th>
<th>Significant benefit at 12 weeks (or other time frame as stated)?</th>
</tr>
</thead>
<tbody>
<tr>
<td>33</td>
<td>Single-blind RCT</td>
<td>EH</td>
<td>70</td>
<td>4 sessions: 1 using 12 shocks, 0.03 to 0.28 mJ, 3 sessions of 1200 shocks at 0.28 mJ (4–7-day interval)</td>
<td>Loss of 2/3 control patients to follow-up at 24 weeks. At 4 weeks: CMS TG: 45–74 at 4 weeks and 76 at 12 weeks; CG: 48–46 at 4 weeks</td>
</tr>
<tr>
<td>34</td>
<td>Single-blind RCT</td>
<td>EM</td>
<td>80</td>
<td>2 sessions at 2 week interval 2500 shocks @ up to 0.45 mJ/mm²</td>
<td>Yes. Benefit at mean follow-up 110 days (note significant range; 41–255 days). CMS: TG: 50.7 (33.7–70.2) to 63.2 (23.8–90), p&lt;0.0001 vs CG: 50.3(28.2–83.8) to 54.8 (19.9–86.8), p=0.061</td>
</tr>
<tr>
<td>35</td>
<td>Multicentre RCT. High vs low vs sham</td>
<td>Not stated</td>
<td>144</td>
<td>Two sessions, interval 12–16 days. 1500 shocks @ 0.32 mJ/mm² vs 6000 shocks @0.08 mJ/mm² vs sham</td>
<td>Yes. Benefit in both treatment groups at 6 and 12 months, superior in high-dose. Change in CMS at 6 months in control, low, high-dose groups: 6.6 (1.4–11.8), 15 (10.2–19.8), 31 (26.7–35.3) p&lt;0.001 between control and each treatment group and between high and low energy</td>
</tr>
</tbody>
</table>
A systematic review of shockwave therapies in soft tissue conditions: focusing on the evidence
Cathy Speed

Table 7  F-ESWT in the management of chronic recalcitrant common extensor tendinopathy

<table>
<thead>
<tr>
<th>Treatment*</th>
<th>Ref</th>
<th>Study type</th>
<th>System type</th>
<th>N</th>
<th>Regime</th>
<th>Significant benefit at 12 weeks (or other time frame as stated)?</th>
</tr>
</thead>
<tbody>
<tr>
<td>F-ESWT low</td>
<td>40</td>
<td>DB-RCT</td>
<td>EM</td>
<td>271</td>
<td>3, once weekly sessions 2000 shocks @ 0.07–0.09 mJ/mm²</td>
<td>No. Mean (SD) pain 65.9(19.4) to 38.3 vs CG: 60.6(25.5) to 50.4 (29.4)</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>DB-RCT</td>
<td>EM</td>
<td>75</td>
<td>1500 shocks @ 0.12 mJ/mm² once monthly×3</td>
<td>No. ‘Success’ TG: 25.8% vs CG: 25.4%</td>
</tr>
<tr>
<td></td>
<td>41</td>
<td>DB-RCT</td>
<td>EM</td>
<td>78</td>
<td>3, once weekly sessions 2000 shocks 0.09 mJ/mm² (NB Tennis players only)</td>
<td>Yes. Significantly higher improvement in pain during resisted wrist extension in TG: 3.5 (2.0) vs CG: 2.0 (1.9); p=.65% &gt;50% reduction of pain in 65% (TG) vs 28% (CG)</td>
</tr>
<tr>
<td></td>
<td>42</td>
<td>DB-RCT</td>
<td>EM</td>
<td>114</td>
<td>3, once weekly sessions 2000 shocks @ 0.06 mJ/mm²</td>
<td>Yes. Significant difference in pain reduction at 12 weeks: improvement of pain score by &gt;50% seen in 61% TG vs 29% CG Success rate &gt;50% improvement 39% TG vs 31% CG</td>
</tr>
<tr>
<td></td>
<td>43</td>
<td>DB-RCT</td>
<td>EM</td>
<td>60</td>
<td>3, once weekly sessions, 2000 shocks @ 0.03–0.17 mJ/mm² (NB No previous treatments)</td>
<td></td>
</tr>
</tbody>
</table>
Platelet Rich Plasma

• Basics
  – Autologous blood centrifuged to concentrate platelets in a serum

• Theory
  – Introduce autologous growth factors to site of injury to promote a “new start” to the healing cascade
    – TGF – β
    – FGF-2
    – PDGF-AB
    – IGF-1
    – EGF
    – HGF
    – VEGF-A
Variety
- 1 step vs 2 step process
- Centrifuge time and speed
- Leukocyte rich vs Leukocyte poor
- Platelet concentration
- Activation vs no activation
- Buffered vs not buffered

Widely used commercial products
- Arthrex – lower platelets and lower leukocytes
  - 1500 rpm for 5 min (10ml → 3ml)
- Biomet (GPSIII) – higher platelets and higher leukocytes
  - 3200 rpm for 15 min (27ml → 3ml)
- Cascade – pure platelet rich fibrin
  - 6 min (18ml)
- Magellan – platelet leukocyte rich plasma
  - 17 min (26ml)
- Smart PReP – platelet leukocyte rich plasma
  - 16 min (60ml)
- Symphony II – platelet leukocyte rich plasma
  - 5min (54ml)
- Double spin – lit based, 1500 rpm for 5 min then top layer centrifuged again 6300 rpm for 20 min
Platelet-Rich Plasma Differs According to Preparation Method and Human Variability

Augustus D. Mazzocca, MS, MD, Mary Beth R. McCarthy, BS, David M. Chowaniec, BS, Mark P. Cote, DPT, Anthony A. Romeo, MD, James P. Bradley, MD, Robert A. Arciero, MD, and Knut Beitzel, MD

TABLE I: Concentration of White Blood Cells

<table>
<thead>
<tr>
<th>Blood</th>
<th>PRP_L</th>
<th>PRP_H</th>
<th>PRP_D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Draw 1</td>
<td>0.07</td>
<td>0.02 ± 0.01</td>
<td>0.35 ± 0.08</td>
</tr>
<tr>
<td>PRP_L</td>
<td>0.00</td>
<td>0.01 ± 0.0</td>
<td>0.06 ± 0.04</td>
</tr>
<tr>
<td>PRP_H</td>
<td>0.18</td>
<td>0.90 ± 2.94</td>
<td>1.66 ± 0.97</td>
</tr>
<tr>
<td>PRP_D</td>
<td>0.00</td>
<td>0.01 ± 0.01</td>
<td>0.05 ± 0.04</td>
</tr>
</tbody>
</table>

*The platelet-rich plasma prepared with single-spin method resulting in lower number of white blood cells and platelets.*

TABLE III: Growth Factor Concentration Compared Between Separation Methods

<table>
<thead>
<tr>
<th>Growth Factor*</th>
<th>PRP_Lp (pg/mL)</th>
<th>PRP_HP (pg/mL)</th>
<th>PRP_DS (pg/mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EGF</td>
<td>659.8 ± 35.9</td>
<td>2639.5 ± 197.7</td>
<td>670.7 ± 185.1</td>
</tr>
<tr>
<td>FGF-2</td>
<td>15.6 ± 2.4</td>
<td>75.2 ± 21.4</td>
<td>15.2 ± 3.4</td>
</tr>
<tr>
<td>HGF</td>
<td>645.2 ± 72.1</td>
<td>4277.3 ± 1508.2</td>
<td>581.7 ± 43.2</td>
</tr>
<tr>
<td>IGF</td>
<td>64.8 ± 55.4</td>
<td>672.9 ± 378.4</td>
<td>45.1 ± 60.7</td>
</tr>
<tr>
<td>PDGF</td>
<td>16,668.1 ± 5512.3</td>
<td>42,273.9 ± 2902.4</td>
<td>12,263.7 ± 3632.7</td>
</tr>
<tr>
<td>TGF-β</td>
<td>66,246.2 ± 7620.4</td>
<td>141,286.9 ± 12,576.1</td>
<td>83,011.7 ± 14,129.8</td>
</tr>
<tr>
<td>VEGF</td>
<td>138.7 ± 11.2</td>
<td>142.9 ± 12.5</td>
<td>138.7 ± 9.1</td>
</tr>
</tbody>
</table>

*EGF = epidermal growth factor, FGF-2 = fibroblast growth factor, HGF = hepatocyte growth factor, IGF = insulin-like growth factor, TGF-β = transforming growth factor-beta, and VEGF = vascular endothelial growth factor. †The values are given as the mean and the standard deviation. PRP_Lp = platelet-rich plasma prepared with single-spin method resulting in lower number of white blood cells and platelets, PRP_HP = alternative method resulting in a high amount of white blood cells and platelets, and PRP_DS = double-spin method.*
### Systemic Effects of PRP

#### TABLE 3
Data Summary for All Time Points and Growth Factors

<table>
<thead>
<tr>
<th>Time After PRP Injection, h</th>
<th>0.25</th>
<th>3</th>
<th>24</th>
<th>48</th>
<th>72</th>
<th>96</th>
</tr>
</thead>
<tbody>
<tr>
<td>(−5.961 to 39.264)</td>
<td>(−1.820 to 11.626)</td>
<td>(−3.107 to 29.433)</td>
<td>(0.046 to 4.506)</td>
<td>(−0.761 to 6.313)</td>
<td>(−0.418 to 11.612)</td>
<td></td>
</tr>
<tr>
<td>IGF-1</td>
<td>0.974 ± 0.109</td>
<td>1.027 ± 0.197</td>
<td>1.078 ± 0.165</td>
<td>1.072 ± 0.163</td>
<td>1.092 ± 0.229</td>
<td>1.063 ± 0.155</td>
</tr>
<tr>
<td>(0.929 to 1.019)</td>
<td>(0.944 to 1.110)</td>
<td>(1.009 to 1.148)</td>
<td>(1.002 to 1.143)</td>
<td>(0.995 to 1.188)</td>
<td>(0.998 to 1.128)</td>
<td></td>
</tr>
<tr>
<td>IGFBP-3</td>
<td>1.185 ± 0.906</td>
<td>1.191 ± 0.749</td>
<td>1.149 ± 0.539</td>
<td>1.094 ± 0.478</td>
<td>1.090 ± 0.455</td>
<td>1.258 ± 0.414</td>
</tr>
<tr>
<td>(0.811 to 1.559)</td>
<td>(0.874 to 1.507)</td>
<td>(0.921 to 1.377)</td>
<td>(0.888 to 1.301)</td>
<td>(0.898 to 1.282)</td>
<td>(0.895 to 1.282)</td>
<td></td>
</tr>
<tr>
<td>bFGF</td>
<td>1.573 ± 1.644</td>
<td>1.409 ± 1.574</td>
<td>2.105 ± 2.825</td>
<td>2.287 ± 3.826</td>
<td>1.611 ± 1.391</td>
<td>2.284 ± 2.877</td>
</tr>
<tr>
<td>(0.894 to 2.251)</td>
<td>(0.744 to 2.074)</td>
<td>(0.912 to 3.298)</td>
<td>(0.632 to 3.941)</td>
<td>(1.024 to 2.198)</td>
<td>(1.069 to 3.498)</td>
<td></td>
</tr>
<tr>
<td>VEGF</td>
<td>1.065 ± 0.277</td>
<td>1.537 ± 0.898</td>
<td>1.413 ± 0.563</td>
<td>1.317 ± 0.449</td>
<td>1.497 ± 0.776</td>
<td>1.420 ± 0.517</td>
</tr>
<tr>
<td>(0.948 to 1.182)</td>
<td>(1.139 to 1.935)</td>
<td>(1.170 to 1.657)</td>
<td>(1.118 to 1.842)</td>
<td>(1.153 to 1.842)</td>
<td>(1.191 to 1.649)</td>
<td></td>
</tr>
<tr>
<td>PDGF-BB</td>
<td>1.258 ± 0.854</td>
<td>1.043 ± 1.112</td>
<td>0.884 ± 0.949</td>
<td>1.067 ± 1.022</td>
<td>1.550 ± 2.204</td>
<td>1.202 ± 1.003</td>
</tr>
<tr>
<td>(0.906 to 1.610)</td>
<td>(0.573 to 1.513)</td>
<td>(0.483 to 1.284)</td>
<td>(0.625 to 1.509)</td>
<td>(0.620 to 2.481)</td>
<td>(0.779 to 1.626)</td>
<td></td>
</tr>
<tr>
<td>IGF-1:IGFBP-3</td>
<td>0.980 ± 0.288</td>
<td>1.060 ± 0.500</td>
<td>1.113 ± 0.602</td>
<td>1.101 ± 0.378</td>
<td>1.165 ± 0.599</td>
<td>0.929 ± 0.337</td>
</tr>
<tr>
<td>(0.861 to 1.099)</td>
<td>(0.849 to 1.271)</td>
<td>(0.859 to 1.367)</td>
<td>(0.937 to 1.264)</td>
<td>(0.912 to 1.418)</td>
<td>(0.786 to 1.071)</td>
<td></td>
</tr>
<tr>
<td>IGF-1 × IGFBP-3</td>
<td>1.170 ± 0.963</td>
<td>1.270 ± 1.013</td>
<td>1.253 ± 0.680</td>
<td>1.198 ± 0.575</td>
<td>1.222 ± 0.760</td>
<td>1.346 ± 0.493</td>
</tr>
<tr>
<td>(0.772 to 1.567)</td>
<td>(0.843 to 1.548)</td>
<td>(0.966 to 1.540)</td>
<td>(0.949 to 1.446)</td>
<td>(0.901 to 1.543)</td>
<td>(1.138 to 1.554)</td>
<td></td>
</tr>
</tbody>
</table>

*Values are expressed as mean ± SD (95% CI). Statistically significant data are in boldface. PRP, platelet-rich plasma; hGH, human growth hormone; IGF-1, insulin-like growth factor–1; IGFBP-3, insulin-like growth factor binding protein–3; bFGF, basic fibroblast growth factor; VEGF, vascular endothelial growth factor; PDGF-BB, platelet-derived growth factor–BB.*
<table>
<thead>
<tr>
<th>Article</th>
<th>Tendon</th>
<th>PRP</th>
<th>Control</th>
<th>US</th>
<th>Results</th>
</tr>
</thead>
</table>
| Mishra et al 2006 | Flexor or extensor of the elbow | Leuk rich Buffered Anesthesia No activation | Yes – not blinded       | No                    | 0, 4, 8 wks, 6 months  
VAS: PRP 80.3 - 5.7 vs Control 86 - 72  
Mayo elbow scores: PRP 50.3 - 86.3 vs control 50-56.5 |
| Filardo et al 2009 | Patella                | Leuk rich Activated | Yes – physiotherapy      | no                    | 0, 15, 30 days, 6 mo (no stat diff)  
VAS: PRP 52.7-36 vs control 50.73.5  
0-10 scale: PRP 6.6-3.1 vs control 6.7-3.7  
Tegner: 3.7-6.6 vs 5.3-6.8 |
| Peerbooms et al 2010 | Common extensor of the elbow | Leuk rich Buffered No activation | Yes – cortisone Double blind | No                    | 0, 4, 8, 12, 26, 52 wks  
VAS: PRP 70.1-25.3 vs Control 65.8-50.1  
DASH: 161.3-54.7 vs 131.2-108.4  
Initially steroid was better then PRP |
| Gaweda et al 2010 | Achilles Non insertional | Leuk rich            | No                       | Yes                   | 6wks, 3, 6, 18 mo  
AOFAS:55-96  
VISA-A:24-96  
Tendon thickening: 15/15 – 1/15 |
| Gosens et al 2012 | Patellar                | Leuk rich Buffered No activation | No                       | No                    | (1)14 post surg/(1)22 non surg  
VISA-P: (1) 41.8-56.3  
(2) 39.1-58.6 |
• Volume of injection
• Most effective preparation
• Buffering or activation
• Injection technique
• Single vs multiple doses
• Timing of injection in relation to initial injury
• Most effective post injection treatments
Hypertonic Dextrose and Morrhuate Sodium Injections (Prolotherapy) for Lateral Epicondylitis (Tennis Elbow)

### TABLE 4 Grip strength for the participants in the PrT-D (n = 10), PrT-DM (n = 10), and wait-and-see control (n = 12) groups

<table>
<thead>
<tr>
<th>Measure</th>
<th>Baseline</th>
<th>Week 8</th>
<th>Week 16</th>
<th>Week 32</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grip strength, mean (SE), N</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PrT-D</td>
<td>299.4 (61.7)</td>
<td>348.6 (56.8)^b,c</td>
<td>364.4 (50.3)^a,b,c</td>
<td>368.9 (49.9)^a</td>
</tr>
<tr>
<td>PrT-DM</td>
<td>201.3 (29.9)</td>
<td>208.4 (23.9)</td>
<td>202.2 (21.5)</td>
<td>239.9 (28.8)</td>
</tr>
<tr>
<td>Wait and see</td>
<td>181.7 (42.6)</td>
<td>210.1 (40.2)</td>
<td>200.4 (53.0)</td>
<td>NA</td>
</tr>
</tbody>
</table>

^a Improvement in grip strength compared with baseline status (P < 0.05).
^b Improvement in grip strength compared with the wait-and-see group (P < 0.05).
^c Improvement in grip strength of the PrT-D group compared with the PrT-DM group (P < 0.05).

NA indicates not applicable.

Change [%] from baseline

Subscale raw score, mean (SE)

<table>
<thead>
<tr>
<th>Measure</th>
<th>Baseline</th>
<th>Week 8</th>
<th>Week 16</th>
<th>Week 32</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pain</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PrT-D</td>
<td>24.2 (2.7)</td>
<td>16.2 (2.6)</td>
<td>15.5 (3.0)</td>
<td>13.6^e (3.6)</td>
</tr>
<tr>
<td>PrT-DM</td>
<td>20.8 (3.0)</td>
<td>20.4 (2.9)</td>
<td>16.7 (3.4)</td>
<td>7.9^e (4.0)</td>
</tr>
<tr>
<td>Wait and see</td>
<td>24.8 (2.6)</td>
<td>22.4 (2.5)</td>
<td>23.2 (2.9)</td>
<td>20.9^e (3.5)</td>
</tr>
<tr>
<td>Function</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PrT-D</td>
<td>16.4 (3.9)</td>
<td>11.1^b (3.0)</td>
<td>11.6^a (3.1)</td>
<td>9.1^a (3.7)</td>
</tr>
<tr>
<td>PrT-DM</td>
<td>18.1 (4.2)</td>
<td>15.6^b (3.3)</td>
<td>13.3^a (3.5)</td>
<td>7.3^a (4.2)</td>
</tr>
<tr>
<td>Wait and see</td>
<td>26.0 (3.5)</td>
<td>22.2^b (2.8)</td>
<td>23.2^a (3.0)</td>
<td>20.6^c (3.6)</td>
</tr>
</tbody>
</table>
Acupuncture

• Theory
  – Needle stimulates A-delta and C fibers that then causes a release of neuropeptides as well as vasodilatation

• Mechanism
  – Disrupted collagen fibers
  – Increase immature type III
  – Apoptosis is accelerated
  – Leads to imbalance of remodeling
  – Follows the theory of continuum

• Neovascularization
  – Increase in glutamate seen in painful tendons

• Research
  – Limited and most can not provide enough evidence to support or refute use of acupuncture
Clinical and Ultrasonographic Results of Ultrasonographically Guided Percutaneous Radiofrequency Lesioning in the Treatment of Recalcitrant Lateral Epicondylitis

Cheng-Li Lin,† MD, Jung-Shun Lee,‡ MD, Wei-Ren Su,* MD, Li-Chieh Kuo,§ PhD, Ta-Wei Tai,* MD, and I-Ming Jou,‖ MD, PhD
Investigation performed at National Cheng Kung University Hospital, Tainan, Taiwan

TABLE 1
Visual Analog Scale for Pain Before and After Radiofrequency Thermal Lesioning

<table>
<thead>
<tr>
<th>VAS Score</th>
<th>Pre-RTL</th>
<th>1 Month</th>
<th>3 Months</th>
<th>6 Months</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rest</td>
<td>4.9 ± 2.6</td>
<td>1.9 ± 2.3</td>
<td>1.7 ± 2.1</td>
<td>0.9 ± 1.1</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>Palpation</td>
<td>7.6 ± 3.2</td>
<td>4.5 ± 2.5</td>
<td>4.1 ± 2.5</td>
<td>2.5 ± 2.4</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>Grip</td>
<td>8.2 ± 2.8</td>
<td>4.2 ± 2.1</td>
<td>3.8 ± 2.4</td>
<td>2.9 ± 2.2</td>
<td>&lt;.01</td>
</tr>
</tbody>
</table>

aVAS, visual analog scale; RTL, radiofrequency thermal lesioning.

bAll posttreatment pain scores were significantly improved compared with pre-RTL data.

TABLE 2
Functional Measurement Before and After Radiofrequency Thermal Lesioning

<table>
<thead>
<tr>
<th>Functional Measurement</th>
<th>Pre-RTL</th>
<th>1 Month</th>
<th>3 Months</th>
<th>6 Months</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grip strength, kg</td>
<td>20.6 ± 11.0</td>
<td>20.8 ± 10.5</td>
<td>24.9 ± 12.9b</td>
<td>27.0 ± 14.1b</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>QuickDASH</td>
<td>54.3 ± 14.4</td>
<td>28.5 ± 18.6b</td>
<td>22.8 ± 21.4b</td>
<td>21.0 ± 24.8b</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>MMCPI</td>
<td>50.6 ± 16.6 (poor)</td>
<td>81.7 ± 15.3b</td>
<td>86.1 ± 8.2b</td>
<td>90.2 ± 6.3b (excellent)</td>
<td>&lt;.01</td>
</tr>
</tbody>
</table>
Several tendons were treated (14): 5 patella, 4 Achilles, 1 Prox glut med, 1 Prox IT band, 1 Prox hamstring, 1 Common extensor of elbow, 1 proximal rectus femoris.

Primary outcomes:

- VAS pain scores

Results:

- VAS score reduction at 4 & 12 weeks:
  - Baseline – 5.8 → 4 wks – 2.4 → 12 wks – 2.2

No complications

Limitations:

- No standardized treatment process
- Small number of non-homogenous patients
- No control
- Not blinded
- No follow up US after procedure

Figure 1. Images from a 36-year-old man with proximal patellar tendinosis and VAS scores of 6 (before the procedure), 1 (at 4 weeks), and 1 (at 12 weeks). A, Sonogram longitudinal to the proximal patellar tendon showing tendinosis as abnormal hypoechoogenicity (arrows) with a normal distal patellar tendon (arrowheads). B, Sonogram transverse to the proximal patellar tendon showing abnormal hypoechoogenicity (arrows) within the patellar tendon (arrowheads). C, Power Doppler sonogram in the sagittal plane showing increased flow. D, Sonogram longitudinal to the patellar tendon during tenotomy showing the echogenic 22-gauge needle (arrows) with the distal tip in the area of tendinosis. F indicates femur; and P, patella.
Platelet-Rich Plasma Versus Focused Shock Waves in the Treatment of Osteoarthritis of the Knee: A Randomized, Double-Blind, Placebo-Controlled Trial

THOMAS HORSTMANN, MD, DPA • HOLGER M. JUD, MD • VANESSA FRÖHLICH, MD
ANNEGRET MÜNDEMMANN, PhD • STEFAN GRAU, PhD

Whole-Body Vibration Versus Eccentric Loading, Shock-Wave Treatment, Water Exercise, and Patellar Taping for Treatment of Osteoarthritis of the Knee

Ongoing Positive Effect of Platelet-Rich Plasma Versus Corticosteroid Injection

Treatment of Lateral Epicondylitis With Platelet-Rich Plasma, Glucocorticoid, or Saline

A Randomized, Double-Blind, Placebo-Controlled Trial

Thøger Persson Krogh,* MD, Ulrich Fredberg,* MD, PhD, Kristian Stengaard-Pedersen,† MD, DMSc, Robin Christensen,‡§ MSc, PhD, Pia Jensen,* RN, and Torkell Ellingsen,*∥ MD, PhD

Investigation performed at the Diagnostic Centre, Region Hospital Silkeborg, Silkeborg, Denmark
<table>
<thead>
<tr>
<th>Article</th>
<th>Tendon</th>
<th>PRP or group 1</th>
<th>Vs... group 2, group 3</th>
<th>US</th>
<th>Post tx</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vetrano et al 2013</td>
<td>Patellar</td>
<td>Leuk rich</td>
<td>ESWT 3 sessions q 48-72</td>
<td>Yes</td>
<td>Stretch, strength, 2 wks water; 4wks up</td>
<td>2, 6, 12 mo VISA-P:55.3-76.2-86.7-91.3 vs 56.1-71.3-73.7-77.6 VAS: 6.6-1.5 vs 6.3-3.2</td>
</tr>
<tr>
<td>Rand DB</td>
<td></td>
<td>No act 3-5 conc 2 inj q 2 wk</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rompe et al 2007</td>
<td>Achilles</td>
<td>Eccentric 3 sets 15 BID 7 d/w x12w</td>
<td>ESWT 3 sessions q week 2000pul Wait - NSAIDS</td>
<td>Yes</td>
<td></td>
<td>6, 16 wks VISA-A: improved 75.6%/70.4%/55% Likert: 15/25 vs 13/25 vs 6/25 were 1 or 2 Tendon diameter: no difference</td>
</tr>
<tr>
<td>Rand</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Horstmann et al 2013</td>
<td>Achilles</td>
<td>Whole body vibration Board 13-21Hz: 4-7 m</td>
<td>Eccentrics 3 sets 15, add 4th Wait – normal training log</td>
<td>Yes</td>
<td></td>
<td>12 wks VAS: improved Force: ROM improv with vib US: no sig changes</td>
</tr>
<tr>
<td>Rand Blind</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gosens et al 2011</td>
<td>Elbow ext</td>
<td>Leuk rich</td>
<td>Corticosteroid</td>
<td></td>
<td></td>
<td>4,8, 12,26, 52, 104 wks DASH: 54.3-20-17.6 vs 43.3-36.8-36.5 VAS: 69-25.9-21.3 vs 66.2-48.8-42.4</td>
</tr>
<tr>
<td>Rand DB</td>
<td></td>
<td>No act</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Krogh et al 2013</td>
<td>Elbow ext</td>
<td>Leuk rich</td>
<td>Corticosteroid 40mg triamcin Saline 3ml</td>
<td>Yes</td>
<td>Minimal use of arm 3-4 days, stretch</td>
<td>4wks, 3,6,12 mo PRTEE: only at 1 &amp; 3 mo due to dropout rate</td>
</tr>
<tr>
<td>Rand DB</td>
<td></td>
<td>Buffered Anest</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
• Definition of tendinopathy
• Disease pathophysiology
• Common overuse injuries of tendon
• Treatment overview
  – Eccentric exercises
  – Nitroglycerin
  – Shockwave
  – PRP
  – Others

• Definition of overuse bone injury
• Disease pathophysiology
• Treatment overview
• Return to play
• Closing remarks and questions
Definition

• Stress fracture, bone edema, stress reaction
  – Increase tensile forces across bone resulting in increased osteoclastic activity without appropriate increase in osteoblastic activity

• Pathophysiology
  – RANKL stimulates osteoclasts maturation
  – RANKL is expressed on osteoblasts
  – Pro-inflammatory cytokines induce RANKL causing an increase in bone resorbtion
Types

• Long bones – weight bearing
  – Tibia, femur, fibula
  – Humerus, radius
• Misc. bones
  – Sacrum, ilium, tarsal bones
  – Carpal bones
  – Spine
Outline

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• Treatment overview
  – Eccentric exercises
  – Nitroglycerin
  – Shockwave
  – PRP
  – Others
• Definition of overuse bone injury
• Disease pathophysiology

**Treatment overview**

• Return to play
• Closing remarks and questions
Treatments

- Depends on location of fracture
  - Femoral neck – tension vs compression
  - Anterior tibia
  - Scaphoid

- Lower extremity
  - Walk without pain if not assisted ambulation
  - Activity as tolerated – if activity is not painful and non traumatic this is allowed
    - ie: biking, elliptical, swimming but no running

- Upper extremity
  - Similar if an UE athlete – gymnast
  - Limit weight bearing

- Immobilization?
  - Cast, boot, splint, brace, crutches

- Gradual return to play with intent to avoid future injury
Outline

- Definition of tendinopathy
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  - Nitroglycerin
  - Shockwave
  - PRP
  - Others
- Definition of overuse bone injury
- Disease pathophysiology
- Treatment overview

Return to play
- Closing remarks and questions
Return to Play

• Tendinitis
  – Continuum is a theory
  – Tendinitis is not linked to increased risk of rupture
  – Allowed to participate to tolerance

• Bone
  – Allow proper healing times
  – Treatment directed by pain
Outline

• Definition of tendinopathy
• Disease pathophysiology
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• Treatment overview
  – Eccentric exercises
  – Nitroglycerin
  – Shockwave
  – PRP
  – Others
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• Disease pathophysiology
• Treatment overview
• Return to play
• Closing remarks and questions
Treatment Controversy

- Or conundrum?
- What works?
  - My personal opinions being a young up coming sports medicine physician

Conformity

Sometimes the only way to stand out is to make a complete ass of yourself.
References


References

References


• Horstmann T, Jud H, Frohlich V, Mundermann A, Grau S. Whole-body vibration versus eccentric training or a wait-and-see approach for chornic achilles tendinopathy: a randomized clinical trial. *J of Orthopaedic and sports physical therapy* 2013;43:794-803


