Achilles tendon rupture: Is full recovery possible? An Orthopedic surgeon's, a Physical Therapist's and Biomechanist's perspective.

Combined Section Meeting 2016 Anaheim, California, February 17-20

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Course Description

This session will review the evidence and current knowledge concerning how to treat patients with Achilles tendon rupture. Achilles tendon rupture occurs to 12-37 per 100,000 people every year, in the general population. Recreational sports activity accounts for 73% of Achilles tendon ruptures, with the highest incidence occurring in individuals aged 30-49. Due to the level of disability following Achilles tendon rupture, many of these patients are unable to return to their prior level of physical activity or sport after injury. The best approach to treating individuals following Achilles tendon rupture is unclear. This session will include a review of the evidence concerning the best treatment approach both from the orthopedic surgeon's and the physical therapist's perspective. It will present how an Achilles tendon rupture affects function and how this limits the ability to return to sports. The session will describe what the obstacles are for full recovery with suggestions for how to overcome those.

Course Objectives

- 1. Interpret the evidence concerning the various types of initial treatment following an Achilles tendon rupture
- 2. Understand how to progress a patient with an Achilles tendon rupture through the various stages of rehabilitation and develop an individualized treatment program.
- 3. Identify the various reasons for impairments following an Achilles tendon rupture
- 4. Recognize how an Achilles tendon rupture can affect the biomechanics of gait.

What's the evidence behind Surgical or Non-Surgical treatment?

An Orthopedic surgeon's perspective

Katarina Nilsson Helander MD, PhD University of Gothenburg Kungsbacka Hospital, Sweden

Disclosure

Neither I, Katarina Nilsson Helander, nor any family member(s), have any relevant financial relationships to be discussed, directly or indirectly, referred to or illustrated with or without recognition within the presentation.

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Epidemiology

- Incidence peak 55/100 000 p Huttunen AJSM 2014, Housian Injury 1998, Leppilathi Acta Orthop Scand 1996, Moller Acta Orthop Scand 1996, Ganestam KSSTA 2015, Lantto Scand J Med SCI Sports 2015
- Incidence rising in the developed world Huttunen AJSM 2014, Malfulli Clin J of Sports Med 1999, Housian Injury 1998, Ganestam KSSTA 2015
- Bimodal distribution
 Housian Injury 1998, Moller Acta Orthop Scand 1996
- Gender difference
- Housian Injury 1998, Levi injury 1997, Cretnik Wiener kliniche Wochenschrift 2004
 Increased risk of contralateral rupture
 Aarona Scand J Med SCI Sootts 2004

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Etiology

Multifactorial

- *intrinsic, e.g.* degeneration, aging; reduced collagen fiber diameter (Sargon 2005), < tendon vascularity, >BMI, gender, GS dysfunction, pes cavus, lateral ankle instability
- *extrinsic factors, e.g.* sport activities; overuse; repetetive microtrauma, fluoroquinolone antibiotics, corticosteroids

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Acute Achilles tendon ruptures Diagnosis

- Clinical
- Medical history sudden pain, struck from behind, audibly snap, push of on weightbearing forefoot, extended knee
- Typical palpable gap, mid-substance rupture
- Thompson's or Simmond's, calf squeeze test
- · Matles test
- Achilles tendon resting angle (ATRA) Carmont 2013, Carmont 2015

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	al test	12-month evaluation				
Test	Nonsurgical	onth evaluatio Surgical	p-value	Non-surgical	Surgical	p-value
Heel-rise work	n=37	n=45	preneo	n=40	n=45	praiae
Teel-rise work	54% (20)	65% (17)	0.013	68% (20)	78% (20)	0.012
	17-102	36-100	0.015	20-119	28-113	0.012
leel-rise height	n=38	n=45		n=41	20-115 n=45	
neel-rise neight	68% (15)	75% (12)	0.009	77% (13)	81% (13)	0.053
	42-121	46-103	0.005	49-113	47-103	0.055
Jopping	42-121 n=38	n=45		n=38	n=46	
Hopping	75% (35)	90% (24)	0.037	90% (30)	101% (16)	0.222
	0-109	0-126	0.05/	0-133	68-144	0.222
Drop CMJ	n=37	n=45		n=40	n=44	
лорспо	76% (18)	79% (16)	0.379	83% (16)	88% (17)	0.179
	0-106	38-110	0.315	34-108	44-139	0.175
Concentric power	n=38	n=45		n=40	n=45	
concentric power	71% (32)	82% (26)	0.050	82% (33)	87% (24)	0.295
	21-161	26-140	0.030	29-180	42-151	0.255
Eccentric power	n=38	n=45		n=40	n=45	
Eccentric power	60% (29)	70% (21)	0.110	72% (20)	79% (19)	0 193
	0-116	26-119	0.110	24-133	49-135	0.133
For test variables n=/N				24-133	43-135	
Vann Whitney U test v			h a b c a a a bh a	and averaged a	ad aurainal a	

Knee Surg Sports Traumatol Arthrosc DOI 10.1007/s00167-011-1511-3	KSSTA, 2011
ANKLE	
Major functional deficits persist 2 ye tendon rupture	ars after acute Achilles
Nicklas Olsson • Katarina Nilsson-Helander • Jón Karlsson • Bengt I. Eriksson • Roland Thomée • Eva Faxén • Karin Grävare Silbernagel	Received: 14 January 2011/Accepted: 4 April 2011 O Springer-Verlag 2011
Only minor improvements occur betw	veen the 1- and 2-year
ATRS no significant differences betw	een surgical/non-surgica
treatment after 2 y	
Adjusted to their impairment	
functional deficits persist on the injur	5
treatment regardless treatment Nilsson He	









Surgical or Non-surgical treatment Consideration

Predictors
 age

gender Body Mass Index (BMI)

- Activity level
- Riskfaktors
- e.g. diabetes, immunosuppressive Therapy, neurovascular diseases
- Activity level
- Co-morbidity

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Conclusion

- Individual treatment
- Both Surgical and Non-surgical treatment with immediate weightbearing, and early mobilization could be recommended.
- Surgical treatment are recommended for young patients in high level sports – earlier return to sports.
- Return to sports functional perspective rather than a time perspective rehabilitation.

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Conclusion

- Regardless treatment 10-30% functional deficits persists, the reasons for variation are still unknown, and need to be further evaluated.
- Non-surgical treatment is not recommended >72 hours after initial injury.
- Tendon lengthening should be avoid.
- Predictors may affect outcome, further studies are needed.

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Conclusion

- Ultrasonography in acute setting; guidance Surgical or non-surgical treatment, further studies are needed.
- Important to distinguish between *midsubstance*, proximal, and insertional ruptures (different treatment recommendations).
- Partial ruptures are uncommon (except in patients with tendinopathy)

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Where are we today?

- What are the obstacles and impairements that limits full recovery?
- What can we recommend today for rehabilitation, especially in the early stage (irrespective of initial treatment)?



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· Patients describe not returning to sport due fear of re-injury





Evaluation of relationship between level of kinesiophobia (TSK-SV) ar patient-reported outcome 3 months after an Achilles tendon rupture						
Variable	Correlation coefficient	P-value				
Physical activity level	-0.275	0.013				
ATRS	-0.371	0.001				
FAOS - ADL	-0.376	0.001				
FAOS - Sport & Rec	-0.346	0.002				
FAOS - QOL	-0.321	0.003				
EQ - 5D	-0.239	0.032				



Can the impairments be fully resolved?

- Gait abnormalities two years after injury (Don et al 2007)
- Deficits in calf strength of 10-30% (Khan et al 2004)
- Tendon elongation and disproportionate weakness at end range of plantar flexion (Schepull et al 2012, Mullaney e tal 2006)
- Deficits in heel-rise endurance of 20-30% (range 0-70%) (Silbernagel et al 2009)
- Deficit in heel-rise height correlates with degree of tendon elongation (Silbernagel et al 2012)

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Possible reasons for deficits

Calf muscle weakness

- Deficits in strength of 10-30% (Khan et al. 2004)
- Deficits in heel-rise endurance of 20-30% (Silbernagel et al. 2009)
- Only 50% of patients can perform a standing single-leg heel-rise at 3 months (Olsson et al. 2014)
- Pain at 3 months or lower function at 6 months correlates with delayed recovery of calf muscle endurance at 1 year (Bostick et al. 2010)

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Possible reasons for deficits

Tendon elongation

- The tendon elongates during healing (Mortensen et al 1992)
- Similar elongation regardless of surgery or not (Schepull et al. 2012)
- Amount of tendon elongation correlates with heelrise height deficit (Silbernagel et al. 2012)
- Tendon elongation affects (Silbernagel et al. 2012)
 -Gait
- -Ability to generate plantar flexion force
- -Correlates with degree of symptoms

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The rehabilitation – the evidence and clinical application

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Why early mobilization?

- The tendon needs to be exposed to load during healing to improve tendon structure (Kjaer et al 2007, Aspenberger 2007)
- Increased physical activity gives larger/stronger tendon callus in shorter time (Andersson et al 2009)
- Higher physical activity was associated with a more mature tissue repair (Bring et al 2009)
- Early rehabilitation/mobilization results in decreased risk of rerupture (Nilsson-Helander et al 2010)
- Early rehabilitation/mobilization results in less tendon elongation (Kangas et al 2007)

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Early Controlled mobilization phase

Week 0-8

- · Most recent studies allow weight bearing through the heel in brace (with heel lift)
- · Improved outcome and decreased rerupture rates with this early weight bearing
- · However rarely exercise designed to load the tendon even though loading is needed for healing
- · It is in this phase the rehabilitation has differed between surgical and non-surgical treatments

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Early Controlled mobilization phase

Exercises during week 0-8

Two studies have used accelerated rehabilitation after both surgical and non-surgical treatment (Nilsson Helander et al. 2010, Willits et al. 2010)

- · AROM in brace with limitations into DF is safe and beneficial (Nilsson Helander et al. 2010)
 - 0-2 weeks no AROM - DF locked at 30° PF 2-4 weeks, 10° PF 4-6 weeks and 10° of
 - DF 6-8 weeks
- · Ankle AROM out of brace to neutral week 2-6 started "other exercises" after that, this was also beneficial and safe (Willits et al. 2010)

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Early Exercise Protocols

Started early loading using theraband as resistance in surgically treated group

- -2-4 weeks
- AROM up to 15 of PF
- PF with theraband as resistance and sitting heel-rise -4-5 weeks
- Increased theraband resistance, sitting heel-rise with weight and increased ROM up to 0 degrees
- -6 weeks
- No brace, started standing heel-rise (2-legs) full AROM

(Olsson et al 2012 and 2013)

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Results – early mobilization At 3 months 50% of the patients were able to perform a onelegged heel-rise No difference between surgical or non-sugical aroup Heel-rise ability correlated with fear At 12 months

- Surgical group higher LSI values in all functional tests (only sig in 2 of the tests)
 - Again large variations in both groups (Olsson et al 2012 and 2013)

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Early Exercise Protocols

Concerns

- · What muscle is actually used?
- At what stage is the tendon healed enough for loading (in the individual)?
- How do we monitor the load and recovery in order to individualize treatment?

What guides can I have in the clinic?

- Achilles Tendon Resting Angle (Carmont et al 2013)
- Seated heel-rise test (Brorsson et al 2015)
- US imaging

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Early rehabilitation phase Early rehabilitation phase 6-11 weeks Exercises • This is when the patient starts to walk without brace Ankle and • Starting to strengthen the calf muscles Ankle and • If the patient is allowed to walk it is safe to perform double-leg heel-rise Starting to strengthen the speed of loading affects the tendon load • The greatest risk for rerupture is during this phase Leg extense

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Week 12-15

- Goal is to slowly progress to running and jumping
- Continue to progress by increasing external load and speed of movement
- Go from 2-leg jump to 1-leg jump
- Functional evaluations are important to determine if appropriate to starting a running and jumping program

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The effect of Achilles tendon rupture on sports performance
Basketball Players - NBA
Average age 29.7 y/o (same as average age)
39% (7/18) of the players never returned to the professional level
Significant decrease in playing time and performance (Amin et al 2013)

Summary

- Time to focus treatment on achieving full functional recovery not just on avoiding reruptures and infections
- · Current research indicates that the rehabilitation during the first 3 months are of great importance for outcome
- · Continued research needed for:
- Determining how much the patient is loading the calf and Achilles tendon with the exercises
- · Determining the ideal loading conditions/Exercises for the early phase
- Develop outcome measures that can be used early in the rehabilitation to help with individualizing the treatment

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Delaware Tendon Research Group STAR Campus, University of Delaware Thank you!

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Achilles tendon ruptures: Biomechanics perspective

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Disclosures I have no disclosures or conflicts of interest

Outline

- 1. Achilles and Triceps surae: Functional anatomy
- 2. Tissue biomechanics
- 3. Biomechanical challenges post-ATR
- 4. Movement patterns post-ATR:
- a. Walking
- b. Running
- 5. Biomechanical considerations for ATR rehabilitation

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Calculation of tissue loading



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ATR: Rehabilitation considerations

- Loss of mechanical properties with disuse Reeves 2005
- Tendon responds to loading Aspenberg 2007
- Assists with collagen fiber alignment Bring 2007
- Contralateral limb considerations Argen 2004
- Strengthening: consider endrange (shortened) Maquirriain 2011
- Mechanical loading:
 - Increases collagen synthesis кјаег 2009
 - Increases tendon CSA
 - Strength training Milgrom 2014
 - 22% greater: Chronic endurance running Magnusson 2003 – Not apparent with short-term running Hansen 2003

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Changes in ankle power per shoe 10 (+) Concentric Ankle power (Watts/kg*m) 8 6 4 2 0 -2 -4 (-) Eccentric -6 Normative Standard Mid-drop Zero Drop Shift Gastroc/soleus complex to more optimal length-tension range East Carolina University.

Take home points

- · ATR affects the entire Gastroc/soleus/Achilles complex
 - Tendon elongation
 - Restricts crossbridge formation
- Largest limitations: fast and endrange plantarflexion
- · Affects ability to absorb and generate ankle power
- Proximal effects. Risk unknown.
- Rehab: little to change length of tendon
- · Focus on stretch-shorten strengthening
- · Potential role for chronic endurance training

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Acknowledgements SAABS: Karin Silbernagel, Annelie Brorsson, Roy Tranberg, Hayley Powell John Willson, PhD, PT, Stacey Meardon, PhD, PT, ATC, Nick Murray, PhD, Michael Baggaley, MS Research Assistants: Nate Blaylock, Barbara Cherry, Hayley Powell, Sam

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