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Dancers, Runners, Jumpers – Same Diagnoses, Similar Presentations – Unique Interventions?

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Performing Arts Special Interest Group
Combined Sections Meeting 23rd January 2013

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“It hurts when I bend backwards” – lumbar extension symptoms in dancers and volleyball players

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Objectives

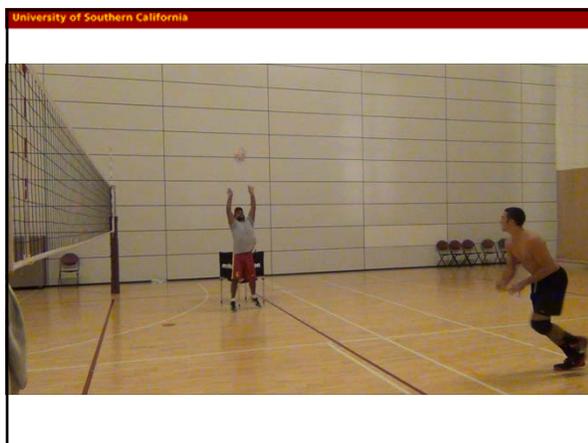
- To compare patient presentations:
volleyball player and dancer

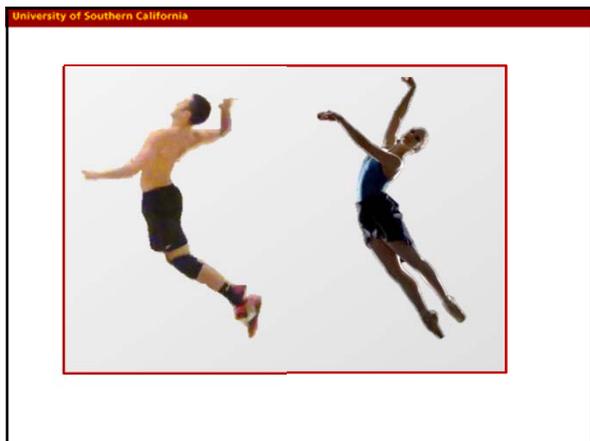


- To present the mechanical demands of volleyball and dance as they relate to the trunk
- To discuss the epidemiology of extension-sensitive low back pain in volleyball players and dancers
- To outline elements of a sport or dance-specific intervention









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VOLLEYBALL PLAYER

PRESENTATION

History:

- 22 year old female collegiate volleyball player
- 5 year history of recurrent low back pain (LBP)
- Insidious onset
- Pain during shots if not adequately warmed up
- Sensation of stretch in abdominals during spiking
- LBP after games
- No spinal imaging to date

Patient presentations
Mechanical demands
Epidemiology
Intervention

Two anatomical diagrams are shown. The top one is a front view of a human torso with a blue dot on the lower back. The bottom one is a side view of a human torso with a blue dot on the lower back. Below these is a small image of a volleyball spike.

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VOLLEYBALL PLAYER

PRESENTATION

History:

- 7 year history of competitive volleyball
- Previously only played indoor volleyball
- Primarily beach volleyball over last 2 years
- Trains/competes approx. 20 hours per week

Patient presentations
Mechanical demands
Epidemiology
Intervention

Two anatomical diagrams are shown. The top one is a front view of a human torso with a blue dot on the lower back. The bottom one is a side view of a human torso with a blue dot on the lower back. Below these is a small image of a volleyball spike.

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WHAT DO WE KNOW ABOUT THE BIOMECHANICS OF VOLLEYBALL SPIKES?

Patient presentations
Mechanical demands
Epidemiology
Intervention

Goal of the task is to maximize initial ball velocity

- Development of angular velocity in sagittal and axial planes
- Multiple segments involved: trunk, shoulder, elbow
- Proximal to distal pattern



Landing Take Off

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WHAT DO WE KNOW ABOUT THE BIOMECHANICS OF VOLLEYBALL SPIKES?

Patient presentations
Mechanical demands
Epidemiology
Intervention

- Counter-rotation between shoulder/upper trunk and pelvis (conservation of angular momentum)
- Stretch shortening cycle in the abdominals

Also consider effects of:

- High rate loading¹
- Impact: up to 200 jumps per day performed by professional players²

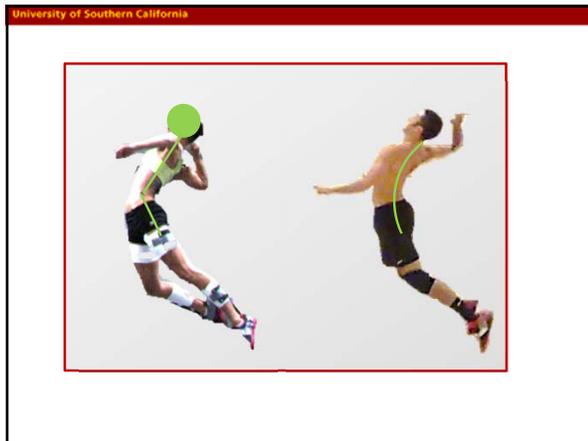
1. Duggleby and Kumar, *Disabil Rehabil*, 1997
2. Hayashi et al., *Br J Sports Med*, 2011

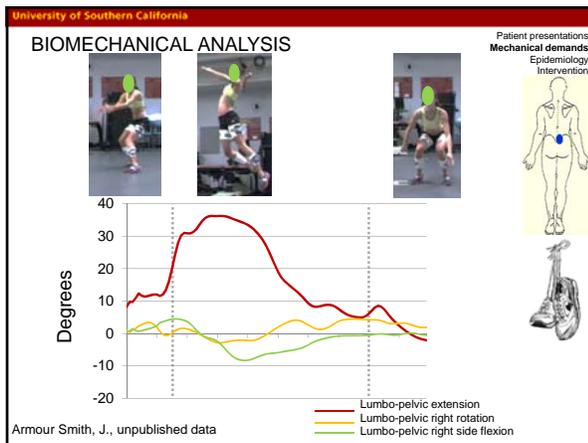
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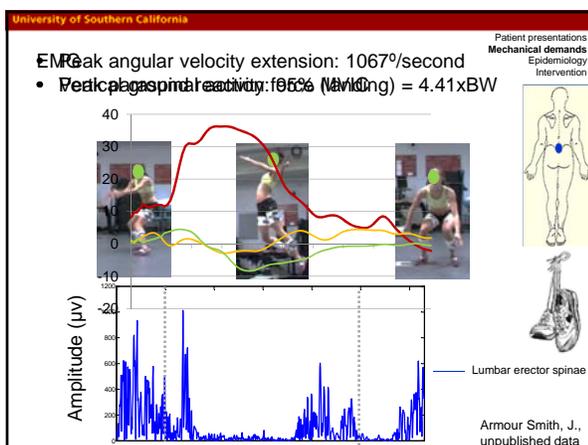
CLINICAL ANALYSIS

Patient presentations
Mechanical demands
Epidemiology
Intervention



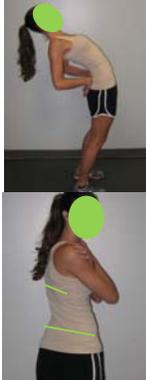






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CLINICAL EVALUATION



Range of motion

Lumbar:

- full and pain free

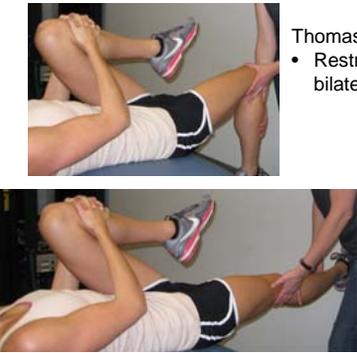
Thoracic:

- limited extension and rotation
- pain free

Symptoms only provoked by high velocity motion

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Patient presentations
Mechanical demands
Epidemiology
Intervention



Thomas test

- Restricted bilaterally



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CLINICAL EVALUATION

Patient presentations
Mechanical demands
Epidemiology
Intervention

Motor control assessment

- No aberrant motion in standing flexion
- Negative prone instability test
- Appropriate ability to recruit deep trunk musculature
- Poor eccentric abdominal control



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DANCER

Patient presentations
Mechanical demands
Epidemiology
Intervention

PRESENTATION

History:

- 20 year old female collegiate dancer
- 2-year history of recurrent LBP
- Insidious onset associated with increased dancing
- LBP during spinal extension activities: e.g. arabesque position
- Pain in full flexion
- Pain with prolonged sitting
- MRI 1 year ago: L5 spondylolysis



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PRESENTATION

Patient presentations
Mechanical demands
Epidemiology

History:

- 3 classes per day/30 hours per week
- Ballet, contemporary jazz, hip hop, tap
- Primarily ballet/jazz shoes
- Marley floor surface, sprung floors



Kristin Smith, Ballet North

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WHAT DO WE KNOW ABOUT THE BIOMECHANICS OF DANCE?

Patient presentations
Mechanical demands
Epidemiology
Intervention

- The goal of the task is to fulfill aesthetic requirements
- These include hip external rotation

Static trunk alignment in dancers:

- Use of anterior pelvic tilt to increase hip external rotation: mean 13.4° in female collegiate dancers¹
- Normal range² = 3 – 25°
- No association between relaxed standing posture and LBP in dancers³
- Dancers have less kyphotic thoracic spines and less lordotic lumbar spines than non-dancers³

1. Deckert et al., JDMs, 2007
2. Nguyen & Schultz, JOSPT, 2007
3. McMeeken et al., JDMs, 2002

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Trunk motion in dancers:

- Arabesque position (pelvis):
 - Up to 60° anterior pelvic tilt¹
 - Pelvis contributes 60% of gesture leg height¹
 - Anterior pelvic tilt, ipsilateral rotation, contralateral tilt²
- Jumping – 4.38 times BW on landing from saut de chat³




1. Wilson et al., *JOMS*, 2007
 2. Bronner & Ojofeitimi, *JOMS*, 2011
 3. Kulig, Fietzer, Popovich, *JSS*, 2011

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WHAT DO WE KNOW ABOUT THE BIOMECHANICS OF DANCE?

Patient presentations
 Mechanical demands
 Epidemiology
 Intervention

- Effect of raked stages (on the pelvic alignment)?¹
- Dancers may accommodate to raked stages at the ankle more than at the trunk²





1. Wilmerding et al., *JOMS*, 2003
 2. Pappas et al., *JOMS*, 2008

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ADDITIONAL CONSIDERATIONS: LIFTING

Patient presentations
 Mechanical demands
 Epidemiology
 Intervention

- Effect of combined shear and compressive force at the lumbosacral junction
- Peak forces during overhead lifts exceed NIOSH limits¹





Dance Magazine 2012
 1. Alderson et al., *JOMS*, 2009

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CLINICAL ANALYSIS

Patient presentations
Mechanical demands
Epidemiology
Intervention

- Passé
- Tendu to arabesque

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CLINICAL ANALYSIS

Patient presentations
Mechanical demands
Epidemiology
Intervention

- Sauté

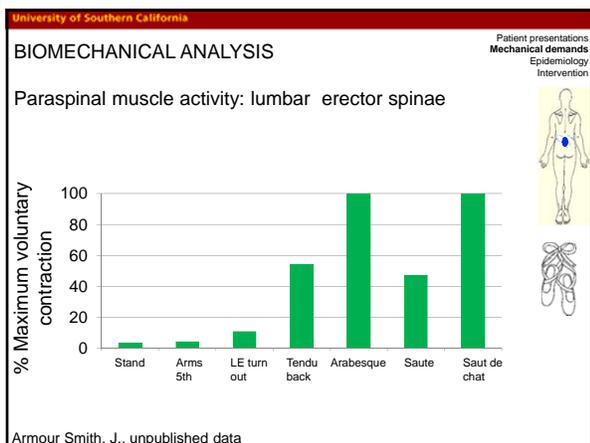
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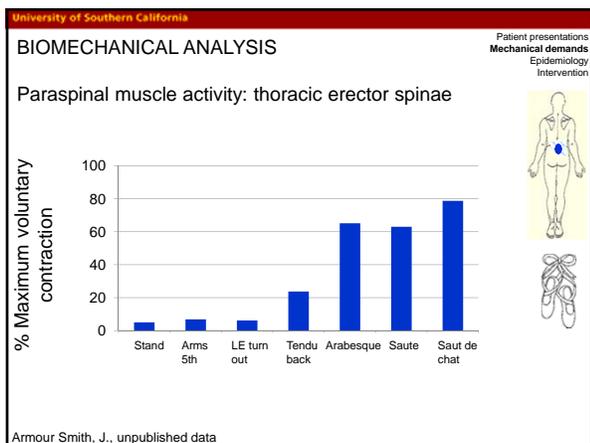
BIOMECHANICAL ANALYSIS

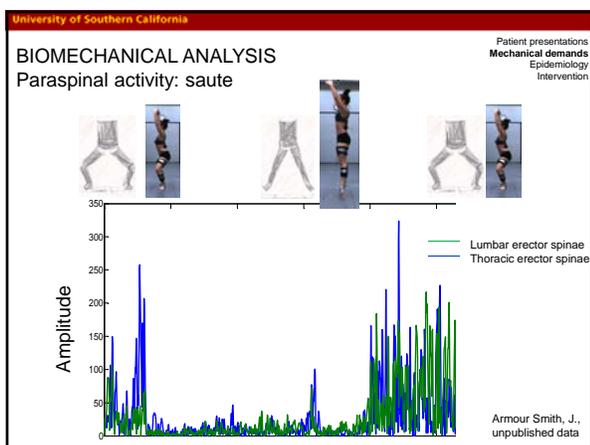
Patient presentations
Mechanical demands
Epidemiology
Intervention

— Lumbo-pelvic extension
— Lumbo-pelvic right rotation
— Lumbo-pelvic right side flexion

Armour Smith, J., unpublished data







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CLINICAL EVALUATION

- Painful and hypermobile extension, right side flexion
- Pain in end range flexion
- Normal hip and shoulder flexibility
- Hypertrophy of lumbar paraspinals R>L
- Poor ability to selectively recruit multifidus at L5



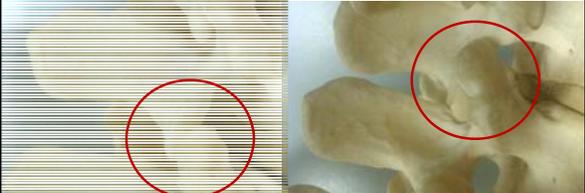

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CASE STUDIES – SIMILARITIES

Both activities involve repetitive:

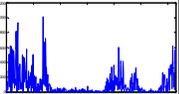
- Lumbopelvic extension
- Lumbopelvic rotation/side flexion
- Thoracic extension




Patient presentations
Mechanical demands
Epidemiology
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- High levels of paraspinal muscle activity
- Localized, recurrent symptoms
- Greater than 1-year history of pain
- No radicular pain, lumbosacral pain, generalized pain or cognitive deficits, selective factors
- Glenohumeral elevation & hip extension





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EPIDEMIOLOGY: 

Patient presentations
Mechanical demands
Epidemiology
Intervention

LBP in volleyball players

Indoor volleyball:

- Third most common acute injury¹
- Second or third most common chronic (repetitive strain) injury^{1,4}

Beach volleyball:

- Most common overuse injury³
- More shots due to smaller number of players

LBP is more prevalent in female volleyball players (and female athletes generally) than males²

1. Augustsson et al., *Scand J Med Sci Sports*, 2006
2. NCAA data, 1997-1998
3. Bahr and Reeser, *Am J Sports Med* 2003
4. Verhagen et al., *Br J Sports Med* 2004

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EPIDEMIOLOGY: 

Patient presentations
Mechanical demands
Epidemiology
Intervention

LBP in dancers

- Incidence of LBP per activity hour is lower in dancers than non-dancers¹
- Second or third most common injury in professional dancers^{2,3,4}
- Between 9 and 30% of all dance injuries occur in the back^{5,6,7}
- Low back injuries in dancers are not associated with hypermobility but may be associated with altered trunk motor control⁷

1. McMeeken et al., *JOMS* 2002
2. Allen et al., *JOSPT*, 2012
3. Bronner & Brownstein, *JOSPT*, 1997
4. Mayers et al., *JOMS* 2003
5. Gamboa et al., *JOSPT*, 2008
6. Garrick & Requa, *Am J Sports Med*, 1993
7. Roussel et al., *Int J Sports Med*, 2012

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EVIDENCE INFORMED INTERVENTION

Patient presentations
Mechanical demands
Epidemiology
Intervention

Patho-anatomical considerations:

- Lack of relationship between patho-anatomy and LBP⁵

BUT:

- High prevalence of disc degeneration in competitive volleyball players¹
- Association between extension/rotation activities and spondylolysis⁴
- Athletes more likely to have symptoms associated with spondylolysis than non-athletes²
- High suspicion for spondylolysis in young athletes³
- Need for adequate early intervention⁴

1. Hayashi et al., *Br J Sports Med*, 2011
2. Kalichman et al., *Spine*, 2009
3. Ralston, *Clin Ped*, 1998
4. Macci et al., *Br J Sports Med*, 2006
5. Delitto et al., *JOSPT*, 2012

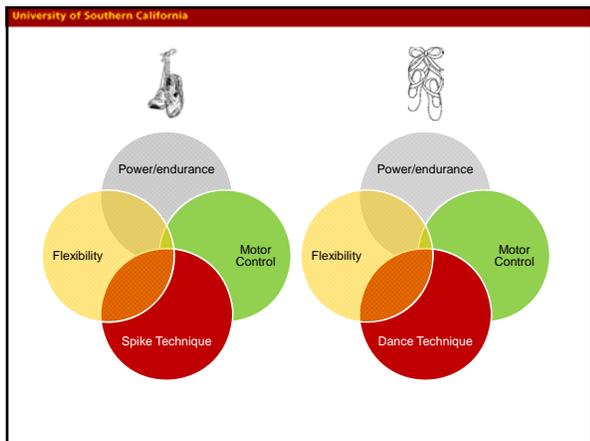
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Intervention

The challenge:

- Both dancers and volleyball players have to utilize significant spinal extension/rotation to achieve their performance goals
- Performance of high level motor skills require successful integration of control of deep and superficial trunk musculature through range and at high velocity

Smith et al., *JOSPT*, 2008
Comerford and Mottram, *Man Ther*, 2001



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Mechanical demands
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Intervention

INTERVENTION - DOSAGE

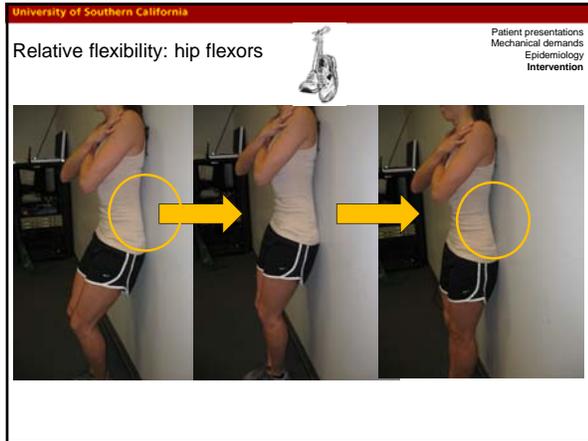
Motor control:

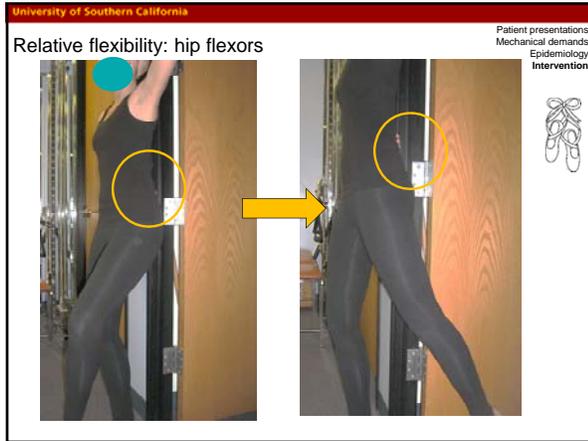
- maximize motor learning and retention
- high to low feedback
- random practice
- external focus

Muscle strengthening:

- muscle adaptation
- power
- endurance

Exercise progression based upon performance and rating of perceived exertion





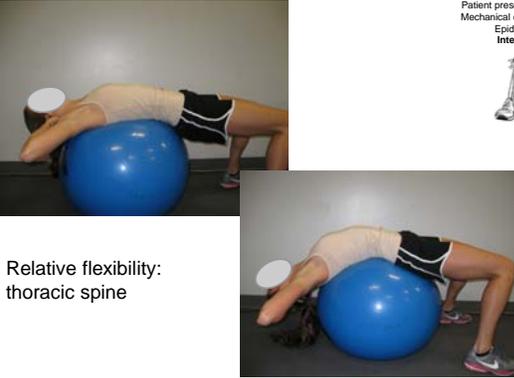


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Relative flexibility: thoracic spine

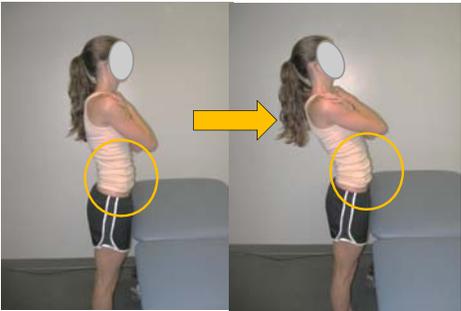


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Motor control: thoracic and lumbar extension

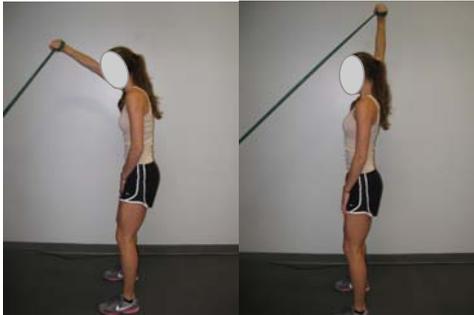


Patient presentations
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Motor control and power/endurance:



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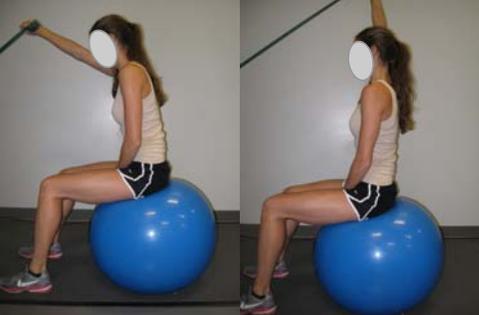
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Motor control and power/endurance: through range

Patient presentations
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Intervention



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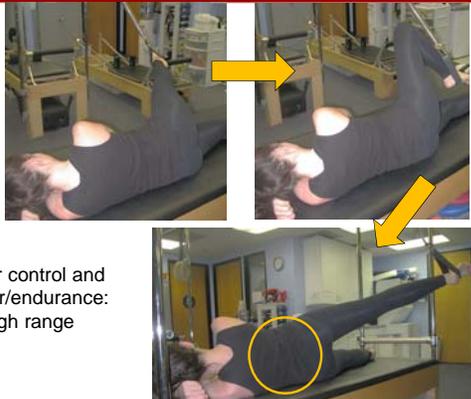
Motor control and power/endurance: through range

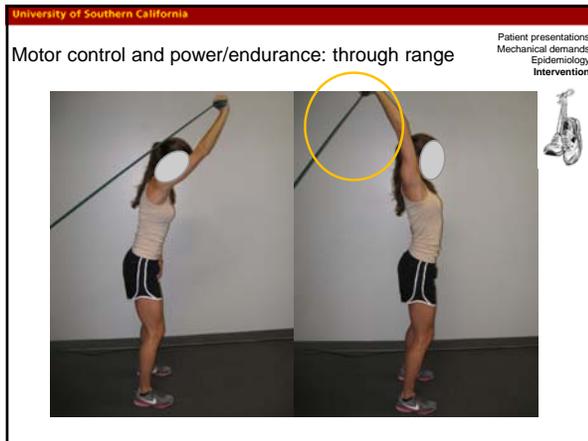
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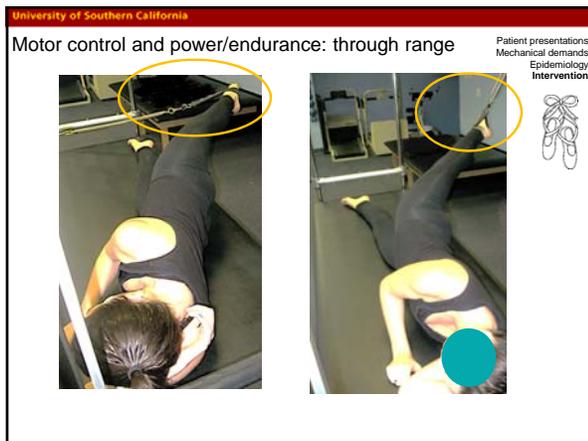


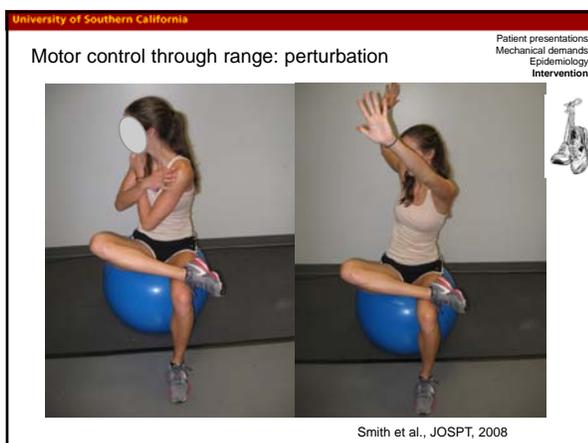
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Motor control and power/endurance: through range









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Patient presentations
Mechanical demands
Epidemiology
Intervention



Motor control and
power/endurance:
through range



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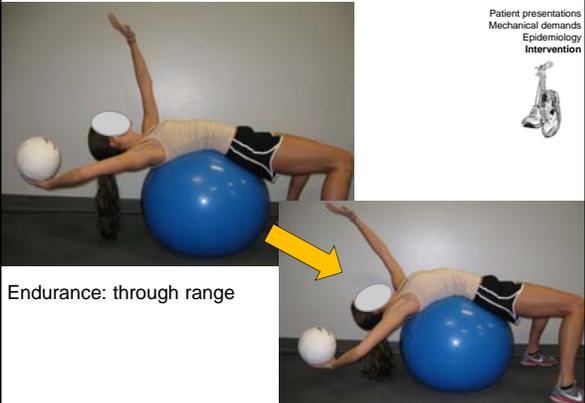
Patient presentations
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Epidemiology
Intervention

Motor control
through
range:
perturbation



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Patient presentations
Mechanical demands
Epidemiology
Intervention



Endurance: through range



Dancers, Runners, Jumpers – Same
Diagnoses, Similar Presentations – Unique
Interventions? Part 1

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Endurance: through range



Patient presentations
Mechanical demands
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Intervention



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Endurance: through range

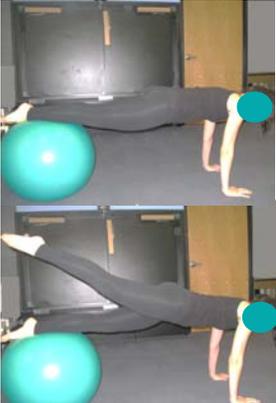


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Epidemiology
Intervention



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Endurance: through range



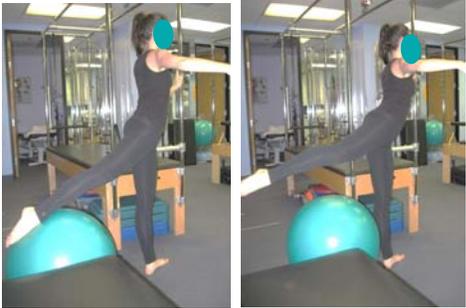
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Endurance: inner range

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Mechanical demands
Epidemiology
Intervention



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THE DANCER'S PERSPECTIVE

"It wasn't one thing in particular. I had done "Romeo + Juliet", and I remember it hurting me during that, but there were lots of arabesques.....I got thrown into the jumping girl [role] and I did the turn where you kick the back of your head, and I remember up until then, I had been able to deal with the pain when I was onstage. I didn't feel it. And during that show I could feel it. I went offstage and I was like, There is definitely something wrong....."
Time Out NY 2010

"a stress fracture in her lower back put her out of action for the last half of 2007. After three months of rest at home in California, and three more months of vigorous physical therapy, Peck was back....."
Dance Magazine, 2010



<http://www.dancemagazine.com/issues/May-2010/The-Magnetic-Tiler-Peck>

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“Patellar tendinopathy; a jumper’s or lander’s knee?”
– anterior knee pain in volleyball players and dancers

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Objectives

- To compare patient presentations: volleyball player and dancer



- To present the mechanical demands of volleyball and dance as they relate to the landing leg
- To discuss the epidemiology of patellar tendon pain in volleyball players and dancers
- To outline elements of a sport specific intervention using the EdUReP framework

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What are the characteristics of the ground-contact phases during a volleyball spike?

Patient presentations
Mechanical demands
Epidemiology
Intervention

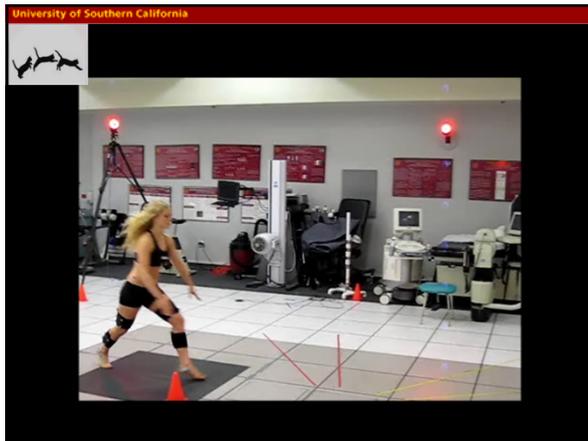


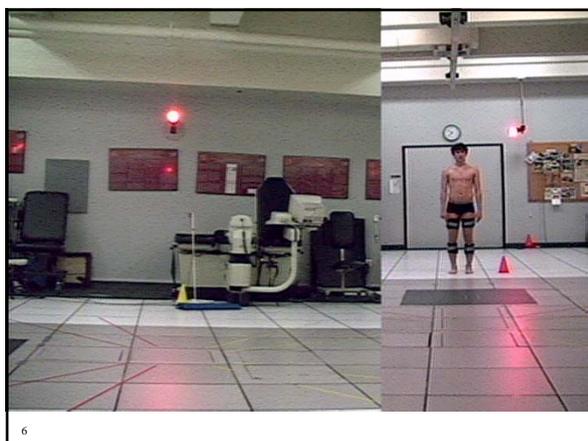
Landing

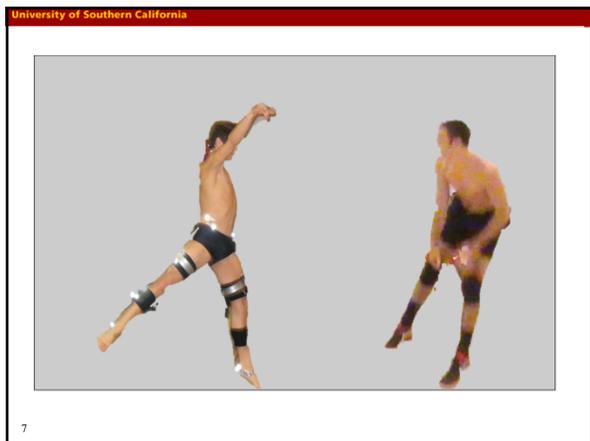
- be ready to play defense, immediately
- avoid contacting the net
- avoid running into another player

Take Off

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VOLLEYBALL PLAYER

Patient presentations
Mechanical demands
Epidemiology
Intervention

PRESENTATION
History:

- 20 year old male collegiate volleyball player
- 4 year history of recurrent bilateral patellar tendon pain (left > right)
- Insidious onset
- Pain during practice, weight lifting, competition
 - Trains/competes 20-25 hours per week
- No pain during common student activities

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WHAT DO WE KNOW ABOUT THE BIOMECHANICS OF VOLLEYBALL SPIKE?

Patient presentations
Mechanical demands
Epidemiology
Intervention

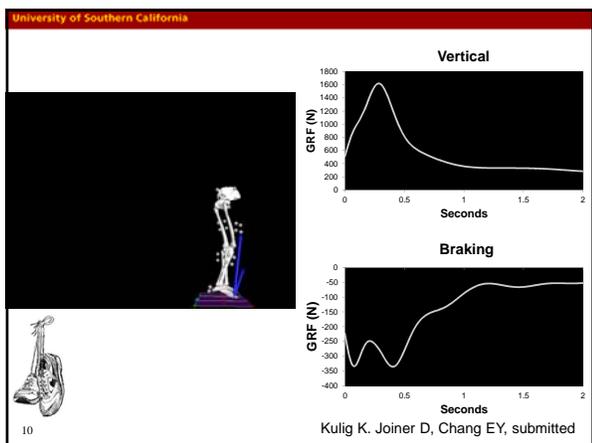
- Up to 200 jumps per day performed by professional players¹
- When spiking faster sets, the players are more likely to use one-footed landing²
- Early phase landing dynamics might be related to development of tendinopathies³

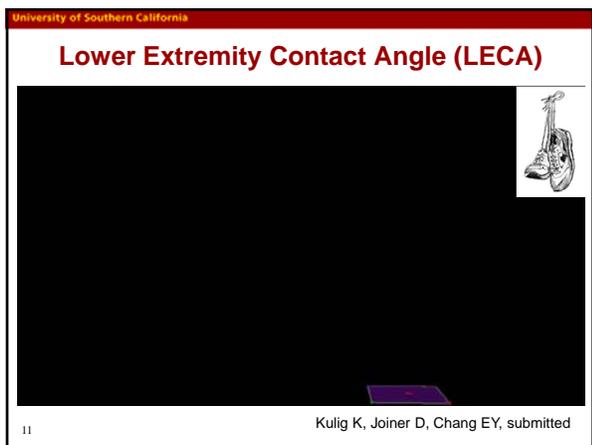
1. Hayashi et al., *Br J Sports Med*, 2011
2. Lobietti R et al., *J Sports Sci*, 2010
3. Bisseling RW et al. *Br J Sports Med*, 2002, 2007

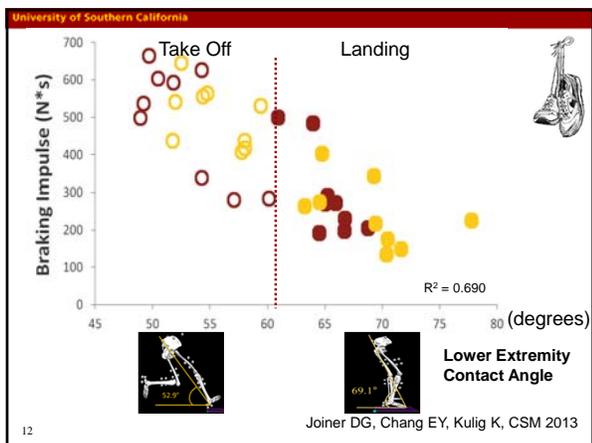
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Dancers, Runners, Jumpers – Same Diagnoses, Similar Presentations – Unique Interventions? Part 2

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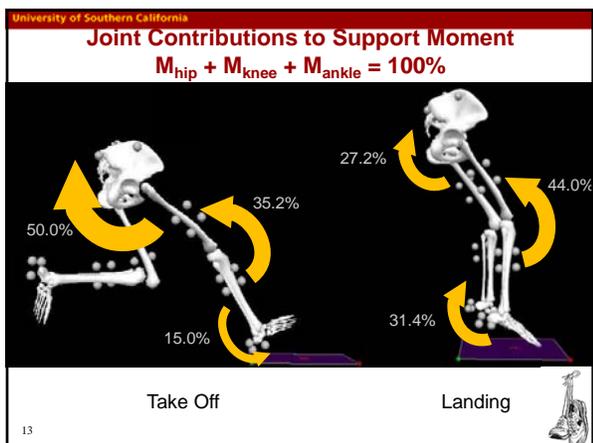


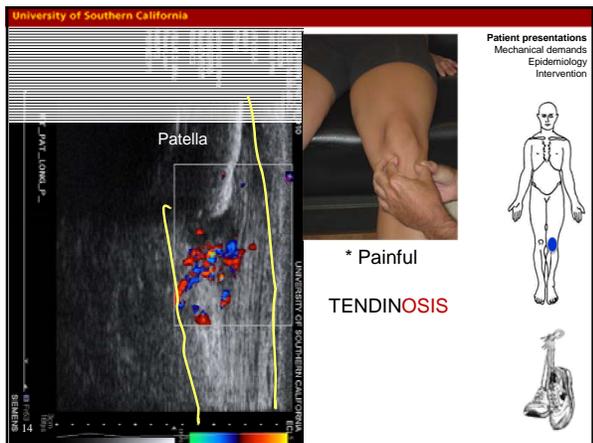


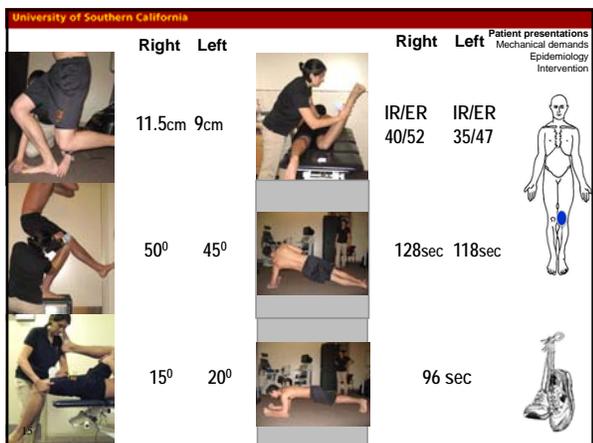


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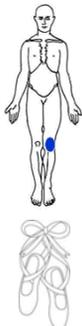
DANCER

Patient presentations
Mechanical demands
Epidemiology
Intervention

PRESENTATION

History:

- 20 year old male collegiate dancer
- 2 year history of recurrent left patellar tendon pain
Exacerbated over the past 3 months
- Onset associated with increased practice
- Pain increased while rehearsing for a performance requiring a lot of jumping and catching of a leaping partner



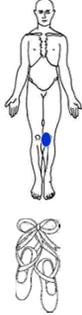
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PRESENTATION

History:

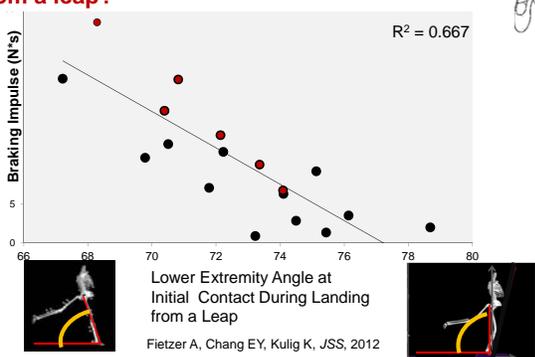
- 3 classes per day
- 25-30 hours/week
- Ballet, contemporary, jazz, hip hop, tap
- Primarily barefoot
- Marley floor surface, concrete under floor

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What do we know about biomechanics of landing from a leap?



Lower Extremity Angle at Initial Contact During Landing from a Leap

Fietzer A, Chang EY, Kulig K, JSS, 2012

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Patient presentations
Mechanical demands
Epidemiology
Intervention

CLINICAL ANALYSIS of TECHNIQUE (OBSERVATION)



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What do we know about biomechanics of take-off and landing from a leap?

Take off		Landing
0.1 ± 0.02	Weight acceptance [s]	0.18 ± 0.06
3.5 ± 0.4	Peak Vertical GRF [x BW]	4.4 ± 0.8
0.46 ± 0.1	Peak Braking GRF [x BW]	0.34 ± 0.15
0.24 ± 0.07	Knee stiffness [Nm/rad]	0.16 ± 0.05

Saut de Chat

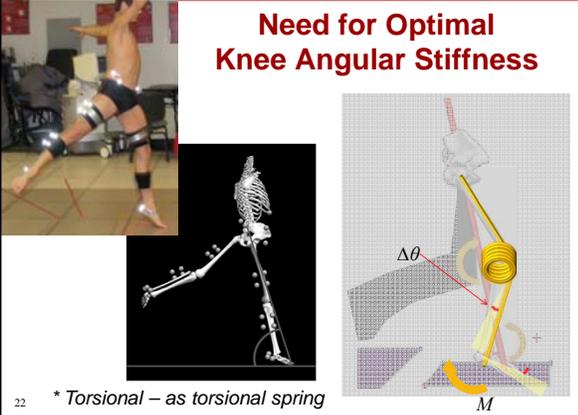


Kulig K, Fietzer AL, Popovich JM Jr, JSS, 2011
Fietzer AL, Chang EY, Kulig K, JSS, 2012

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Need for Optimal Knee Angular Stiffness



22 * Torsional – as torsional spring

Dancers, Runners, Jumpers – Same Diagnoses, Similar Presentations – Unique Interventions? Part 2

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Do dancers with history of patellar tendon pain land differently?

Asymptomatic		Tendinopathic
0.15 ± 0.05	Knee stiffness [Nm/rad]*	0.74 ± 0.11

Saut de Chat

Fietzer AL, Chang EY, Kulig K, JSS, 2012
 * Fietzer AL, Chang EY, Kulig K, ACSM 2011 (male subjects only)

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* Painful

TENDONITIS
 with micro-morphological changes at the tibial attachment

Patient presentations
 Mechanical demands
 Epidemiology
 Intervention

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Right	Left	Right	Left	
11.5cm	9cm	IR/ER 27/57	IR/ER 20/58	Patient presentations Mechanical demands Epidemiology Intervention
40°	30°	R	L	
5°	5°	Trunk on top of leg	Trunk behind leg	

CASE STUDIES SIMILARITIES AND DIFFERENCES

Patient presentations
Mechanical demands
Epidemiology
Intervention

Both activities involve repetitive:

- High physical and cognitive demands
- Take offs and landings
- Loading of the knee extensor mechanism
- Control of the leg by hip and trunk musculature



Volleyball requires:

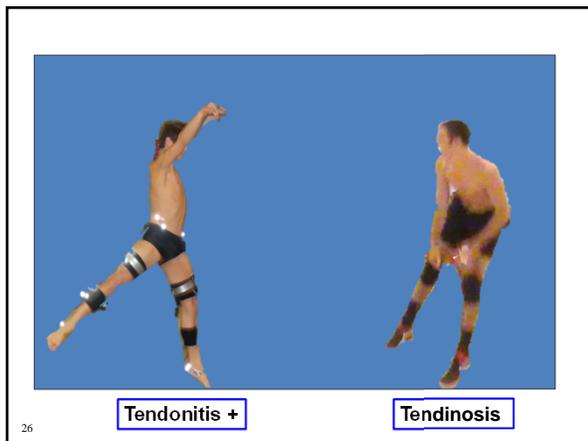
- Court awareness
- Abrupt stops

Dance requires:

- Elegance and aesthetics
- Execution of rhythmic movements with precision



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EPIDEMIOLOGY:

- High Prevalence of Patellar Tendinopathy¹
 - 14.2% among all athletes
 - 31.9% in Basketball
 - 44.6% in Volleyball
- Weight-acceptance during landing place increased loads on tendons²

¹ Lian et al., *Am J Sports Med*, 2005
² Bisseling et al., *Br J Sports Med*, 2007

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Patient presentations
Mechanical demands
Epidemiology
Intervention

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Patient presentations
Mechanical demands
Epidemiology
Intervention

EPIDEMIOLOGY:

- Male soloists and principals perform more jumps, plies and changes of direction than their female counterparts¹
- Male soloists commonly perform up to 14 jumps per minute¹
- Knee, lower leg and thoracic spine are the three body regions when male dancers' injury incidence exceeds those of female dancers²
 - thigh muscle strain
 - knee derangement

¹ Twitchett E et al., *J Dance Med & Sci*, 2009
² Allen N et al. *JOSPT*, 2012



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Patient presentations
Mechanical demands
Epidemiology
Intervention

Management framework for tendinopathy: EdUReP

- Educate
- Unload
- Reload
- Prevent



Davenport, Kulig, Matharu and Blanco, *Phys Ther*, 2005

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Educate about...

- Condition of the tendon
 - NOT inflammation
- No direct association with pain
 - likely recurrent
- Time course of intervention
 - Unload: weeks
 - Reload: months
 - Prevent: carrier long



Davenport, Kulig, Matharu, and Blanco, *Phys Ther*, 2005

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Patient presentations
Mechanical demands
Epidemiology
Intervention

Unload: Patellar Tendon



- 'Tent' tape or "V" tape
- Stretch long hip flexors
- Decrease the number of jumps during practice
- Modify overreliance of quadriceps

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Davenport, Kulig, Matharu, and Blanco, *Phys Ther*, 2005

Patient presentations
Mechanical demands
Epidemiology
Intervention

Reload the tendon



Goals of the intervention are to:

- Activate tenocytes
- ↑collagen synthesis
- Remodel tendon structure
- Produce a less compliant tendon

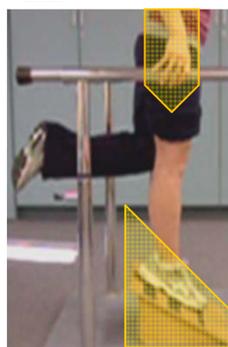
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Patient presentations
Mechanical demands
Epidemiology
Intervention

Reload the Patellar Tendon



- Knee bends = eccentric exercise to knee extensors
- Gradually building up to a 25° *slant board*
- Slow (3 sec down)
- 15 reps x 3 sets, twice per day
- Upward motion with other leg, or with help from arms
- Pain < 5/10 during exercise, diminishing with each set
- NO SHORTCUTS!!!

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Vishes H, Bahr R, *Br J Sports Med*, 2007



Dancers, Runners, Jumpers – Same
Diagnoses, Similar Presentations – Unique
Interventions? Part 2

January 23, 2013

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Reload the tendon

Patient presentations
Mechanical demands
Epidemiology
Intervention



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Davenport, Kulig, Matharu, and Blanco, *Phys Ther* 2005



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Reload Relevant Regions

Patient presentations
Mechanical demands
Epidemiology
Intervention



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Prevent

Patient presentations
Mechanical demands
Epidemiology
Intervention



To increase ankle dorsiflexion



To improve extensibility at distal quadriceps

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Prevent

Patient presentations
Mechanical demands
Epidemiology
Intervention



To increase flexibility of hip flexor

To increased flexibility of hip rotators

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Prevent throughout carrier

Patient presentations
Mechanical demands
Epidemiology
Intervention



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Management framework for tendinopathy: EdUReP

Patient presentations
Mechanical demands
Epidemiology
Intervention

- Educate
- Unload
- Reload
- Prevent



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Davenport, Kulig, Matharu and Blanco, *Phys Ther.*, 2005

Educate about...

- Condition of the tendon
 - likely of inflammatory origin
 - likely recurrent if movement strategies are not modified
- Time course of intervention
 - **U**nload: 2 weeks
 - **R**eload: several weeks
 - **P**revent

40 Davenport, Kulig, Matharu, and Blanco, *Phys Ther*, 2005

Patient presentations
Mechanical demands
Epidemiology
Intervention



Unload: Patellar Tendon

- Modified class participation
 - Participate in baby barre
 - Limit jumps and leaps
 - Limit deep squats and grand plies
- Symptom management:
 - Icing as needed
 - Over the counter anti-inflammatories
- Reassess after 2 weeks
 - Decide is ready for **R**e-loading

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Patient presentations
Mechanical demands
Epidemiology
Intervention



Reload the tendon

Not during the acute stage of the inflammation

42 Davenport, Kulig, Matharu, and Blanco, *Phys Ther*, 2005

Patient presentations
Mechanical demands
Epidemiology
Intervention



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Prevent recurrence

Improve dorsiflexion

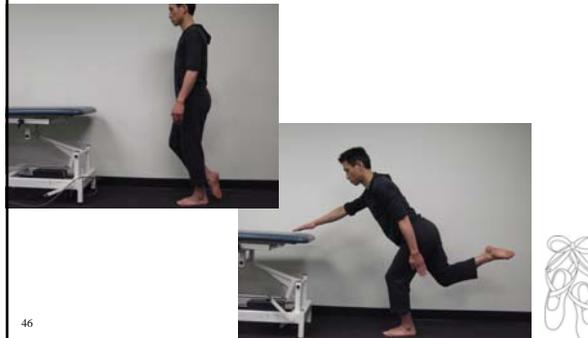


45

Patient presentations
Mechanical demands
Epidemiology
Intervention

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Prevent recurrence
single leg control



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Patient presentations
Mechanical demands
Epidemiology
Intervention

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Prevent recurrence
Close chain control for landing:
hip extensors, gluteus medius and core/pelvic stability targeted
with slides in sagittal & frontal plane



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Prevent recurrence

Strengthen hip musculature:
gluteus maximus, medius, and **control** of deep external rotators,
while challenging single leg stability



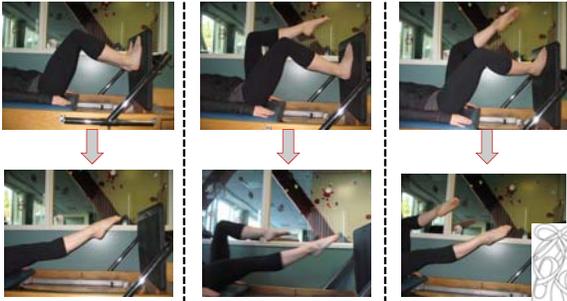
Tendu back in parallel: (glut max control, single leg stability)
Tendu to the side in parallel: (control of hip abductors, external rotators)
Tendu back in turnout (deep external rotator control)

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Prevent recurrence returning to jumping technique

Patient presentations
Mechanical demands
Epidemiology
intervention



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Prevent recurrence returning to jumping technique – double leg, neutral



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Prevent recurrence
returning to jumping technique – single leg, neutral



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Prevent recurrence
returning to jumping technique – single leg, turn out



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Prevent



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“The Road Back to Leaps and Bounds-
The progression of a dancer and runner returning to jumping and running following FHL and Achilles tendinopathy

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“Our similarities are different...”
Dale Berra
(Son of Yogi Berra)

Loading Response Mid-Stance Terminal Stance Preswing

Braking Phase Push off

Lieberman, et al., *Nature*, 2010
Lohman, et al., *SPTS*, 2011

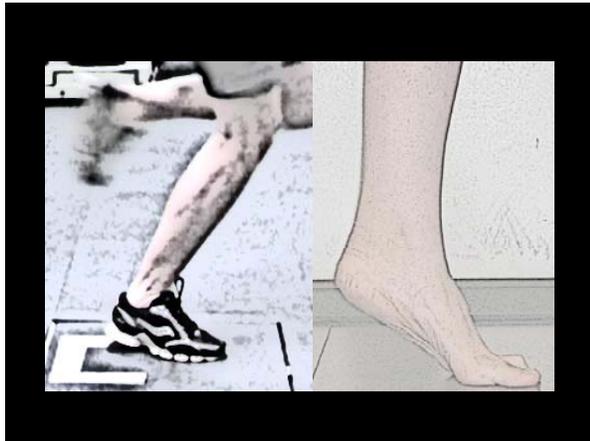
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“Our similarities are different...”
Dale Berra
(Son of Yogi Berra)

Initial Contact Foot Flat Heel off Toe off

Braking Phase Push Off Phase

Kullig, Loudon, Popovich, Pollard, Winder, *JOSPT*, 2011



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Objectives

1. To compare 2 patient presentations:
Runner vs Dancer

2. To discuss **Differential Diagnosis**
3. To present **Epidemiology**
4. To show different **Treatment** options using EdUReP framework

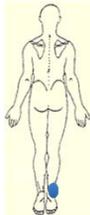
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RUNNER

History
35 year old male
1 year history of right posterior ankle pain
Insidious onset

Recreational runner
Typical mileage: 25-30 miles/week
Speed: 10 minute-mile

Runner vs Dancer
Differential Diagnosis
Epidemiology
Treatment



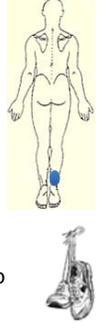
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RUNNER

Runner vs Dancer
Differential Diagnosis
Epidemiology
Anatomy
Treatment

Current Symptoms:
Pain ~ 4 cm above calcaneal tuberosity
Pain and stiffness in morning
Pain after running

Current Running Status:
10-12 miles/week
Shod runner with Semi-Curved Last
Midfoot Striker
Last pair of shoes purchased ~ 12 months ago



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Altered Running Mechanics

Runner vs Dancer
Differential Diagnosis
Epidemiology
Treatment

Proximal Weakness

Degraded Mechanical/
Material Properties

Disorganized Morphology

Achilles Tendinitis

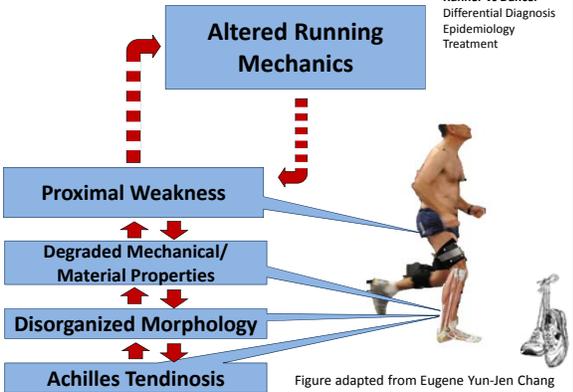


Figure adapted from Eugene Yun-Jen Chang

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Mechanical response to pathology

NORMAL

DEGENERATED

Calc

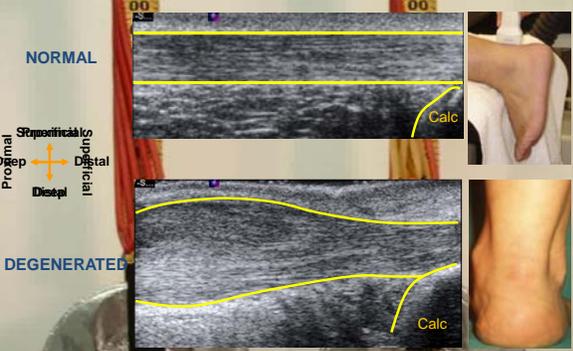


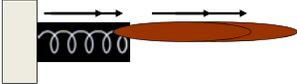
Figure developed by K. Kulig & D. Asami

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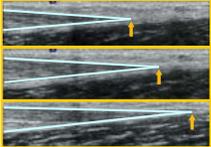
Achilles Tendon Stiffness (N/mm)

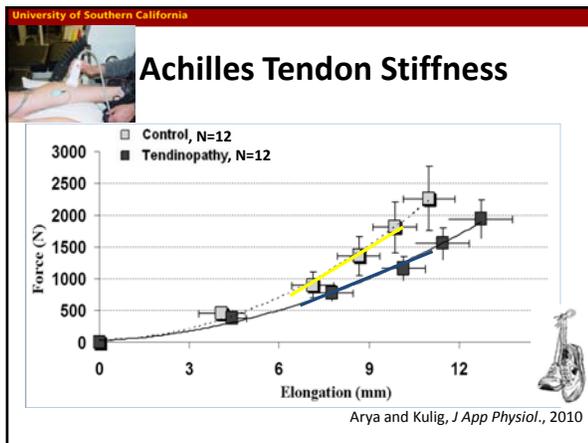
Ratio of:

Force (N)



Elongation (mm)

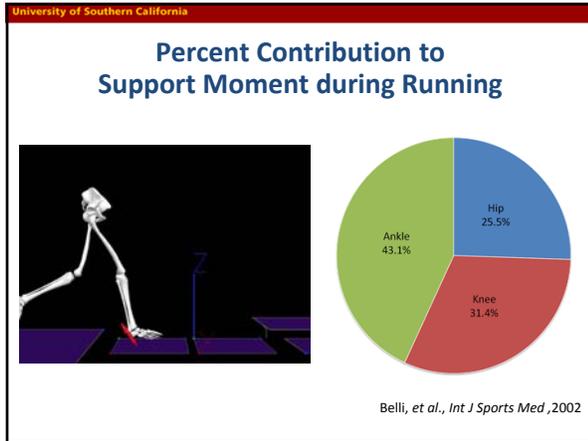


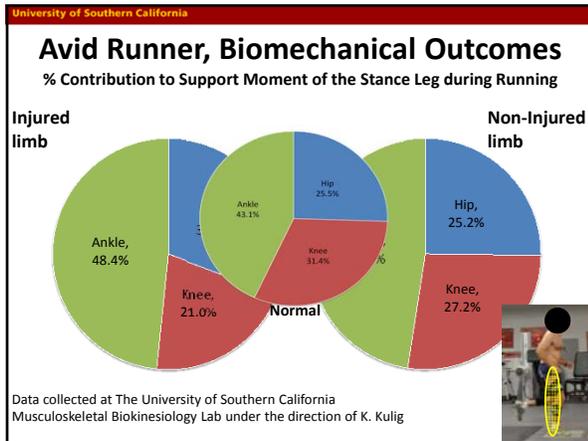


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Support Moment accounts for contribution of the three joints =

$$M_{Ankle} + M_{Knee} + M_{hip} = 100\%$$



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- Tenderness to palpation
- Evidence of thicker tendon

Subtalar Eversion:
R: 0° L: 5°

Dorsiflexion
R: 6 cm L: 9 cm

SL Heel Rise
R: 10 L: 20

Weak Glut Medius
R < L

Movement Analysis

- Heel whip
- Excessive midfoot pronation
- Trendelenberg during braking

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DANCER

Runner vs Dancer
Differential Diagnosis
Epidemiology
Treatment

PRESENTATION

History:

- 21 year old female
- Collegiate dancer
- 3-year Hx of recurrent posterior ankle pain
- Exacerbation over the past 3 months
- Pain increased while rehearsing for a performance requiring increased Pointe work



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DANCER

Runner vs Dancer
Differential Diagnosis
Epidemiology
Treatment

Current Symptoms:

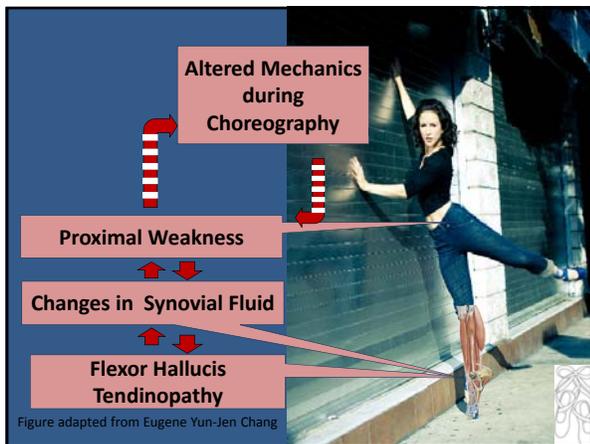
- Pain in grandplie'
- Pain with releve'
- Pain on Pointe



Current Dance Status:

- Modified Participation: 3-5 classes per week
- No "Across the floor"
- No Pointe classes





Altered Mechanics during Choreography

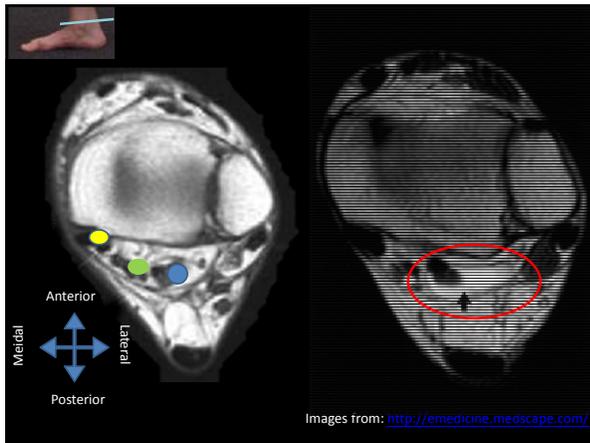
Proximal Weakness

Changes in Synovial Fluid

Flexor Hallucis Tendinopathy

Figure adapted from Eugene Yun-Jen Chang



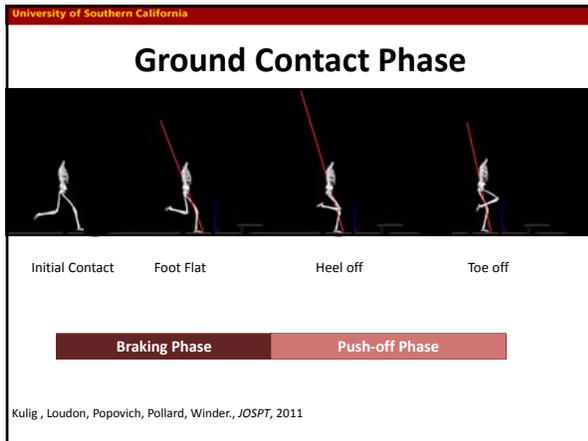


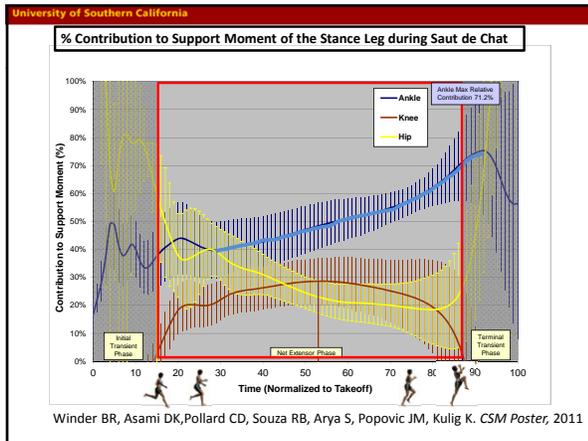
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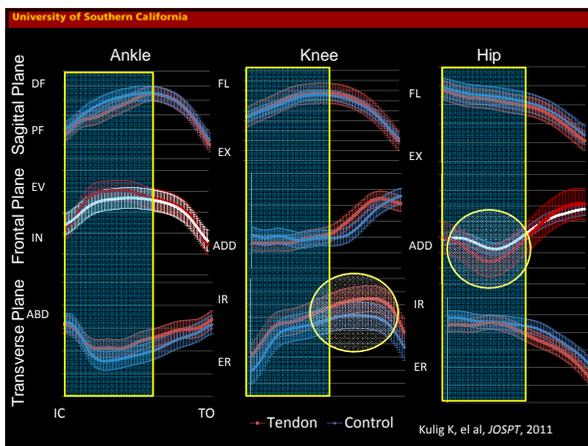
Not a Tendon Compliance Problem...

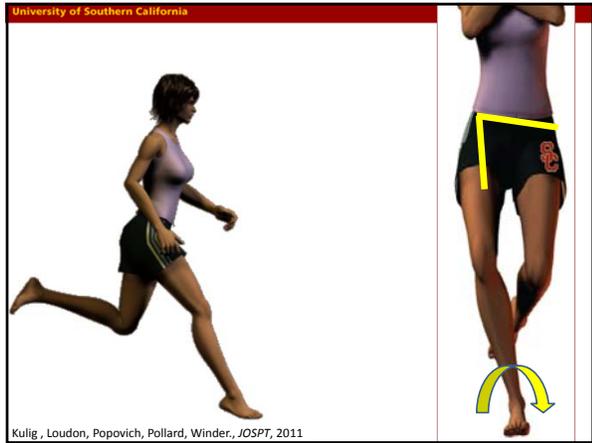


Hammer, et al. *Nature Immunology*, 2011









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Pain with palpation over the FHL

Decreased weight bearing 1st ray motion

Unable to maintain level pelvis with SL hop

Decreased 1st ray motion

FHL Strength R* < L *Pain with 1st toe flexion

Altered take off mechanics Hip Adduction Tibial IR



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Runner vs Dancer
Differential Diagnosis
Epidemiology
Treatment

Epidemiology

- Achilles tendinopathy 6-7% of all running injuries¹
- Runners:10 –fold compared to age matched controls²
- Increased incidence:⁴
 - Middle aged
 - Recreationally active
 - Males
- Location: 66% occur 2 to 6 cm proximal to its insertion³

1. McLauchlan, et al., *Cochrane Database of Systematic Reviews*, 2001
2. Kujala, et al., *Med Sci Sports Exerc*, 1999.
3. Paavola, et al., *Jt Surg (Am)*, 2002
4. Ryan , et al., *Foot & Ankle International*, 2009



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Runner vs Dancer
Differential Diagnosis
Epidemiology
Treatment

Epidemiology

- Factors linking running to Achilles tendonopathy:¹
 - Excessive millage
 - Sudden increase in mileage
 - Decreased recovery time
 - Change in running surface
 - History of Achilles pain
 - Poor shoe wear

1. Sorosky, et al., *Clin J Sport Med*, 2004



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Runner vs Dancer
Differential Diagnosis
Epidemiology
Treatment

Epidemiology

- Most frequently reported injury involves the Foot/ankle
 - 76% of injuries effect the lower extremity²
 - Tendonitis in the ankle or foot joints 24.5%³
- Overuse injuries:¹
 - Women: 68% of all injuries
 - Men: 60% of all injuries

1. Allen , et al. *JOSPT*, 2012
2. Leanderson, et al., *Knee Surg Sports Traumatol Arthrosc*, 2011
3. Steinberg, et al., *J Sport Sci*, 2012



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Runner vs Dancer
Differential Diagnosis
Epidemiology
Treatment

Epidemiology

- During a single season of performing (1 year)
 - 6.8 injuries per dancer¹
 - 0.8 injuries per 1,000 hrs of dance²
- Increase in injury with increase in age³
 - Difference between < 10 y.o. to 15-21 y.o.
 - Boys: 0.6 injuries per 1,000 hrs
 - Girls: 0.3 injuries per 1,000 hrs
- Increase in ankle/foot tendinopathy⁴
 - Increased hours per week
 - Incorrect dance technique

1. Allen , et al. *JOSPT*, 2012
2. Leanderson, et al., *Knee Surg Sports Traumatol Arthrosc*, 2011
3. Steinberg, et al., *J Sport Sci*, 2012
4. Steinberg, et al ., *Foot Ankle Int.* 2011



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Runner vs Dancer
Differential Diagnosis
Epidemiology
Treatment

Management framework for tendinopathy: EdUReP

- Educate
- Unload
- Reload
- Prevent



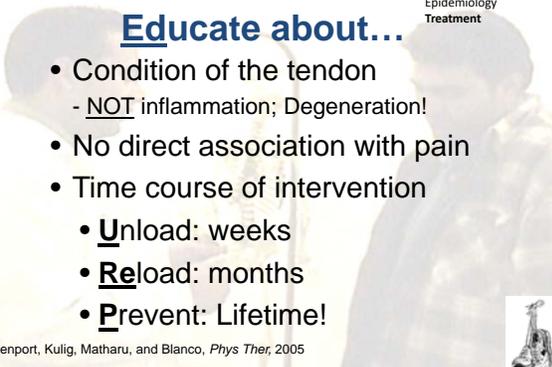

Davenport, Kulig, Matharu and Blanco, *Phys Ther.*, 2005

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Runner vs Dancer
Differential Diagnosis
Epidemiology
Treatment

Educate about...

- Condition of the tendon
 - NOT inflammation; Degeneration!
- No direct association with pain
- Time course of intervention
 - Unload: weeks
 - Reload: months
 - Prevent: Lifetime!



Davenport, Kulig, Matharu, and Blanco, *Phys Ther*, 2005

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EVIDENCE INFORMED INTERVENTION

Unload

- Heel lift (1/2 inch)
- Active rest with alternative exercise
- Last resort...
Immobilization

Runner vs Dancer
Differential Diagnosis
Epidemiology
Treatment



Nichols et al., *J Am Board Fam Pract*, 1989
Lee et al., *Arch Phys Med Rehabil*, 1987

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Unloading of Achilles Tendon
Use of 1/2-inch heel lift



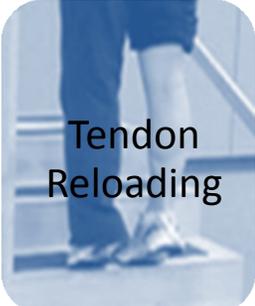
Nichols, *Am Board Fam Pract*, 1989; Lee, et al., *Arch Phys Med Rehabil*, 1987

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EVIDENCE INFORMED INTERVENTION

Reload

Achilles Tendinopathy



Tendon Reloading

Runner vs Dancer
Differential Diagnosis
Epidemiology
Treatment



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2010 Clinical Practice Guidelines Linked to ICF. Achilles Pain, Stiffness and Muscle Power Deficits: Achilles Tendinitis¹

Diagnosis based on self-reported pain and perceived stiffness
Interventions targeting tendon and foot only

• Soft tissue mobilization	Expert Opinion
• Taping	Expert Opinion
• Heel lift	Conflicting Evidence
• Stretching	Weak Evidence
• Orthoses	Weak Evidence
• Low-level laser	Moderate Evidence
• Iontophoresis	Moderate Evidence
• Eccentric loading to tendon	Strong Evidence

¹ Garcia et al., et al. Clin Pract Guide, JOSPT, 2010



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Reload the Achilles tendon



Goals of the intervention are:

- Activate tenocytes
- Increase collagen synthesis
- Remodel tendon structure
- Produce a less compliant tendon

Davenport, Kulig, Matharu, and Blanco, *Phys Ther*, 2005



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Reloading of Achilles Tendon



- Eccentric Program
- Specifics
 - 3 sets of 15 reps
 - 2 positions
 - Twice per day
 - = **180 repetitions**
- **12 weeks!**



Alfredson et al., *A J Sports Med*, 1998

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Characteristics of an effective eccentric Achilles tendon Reloading program

- Very slow
- Within full range of motion; into a stretch
- Progressively resistive, and guided by:
 - symptoms (to tolerance; into pain is desired)
 - technique (full range, no help from arms)

KEY Factor : Dosage!!!
180 repetitions per day
12 weeks

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Progressively Resistive Reloading Program



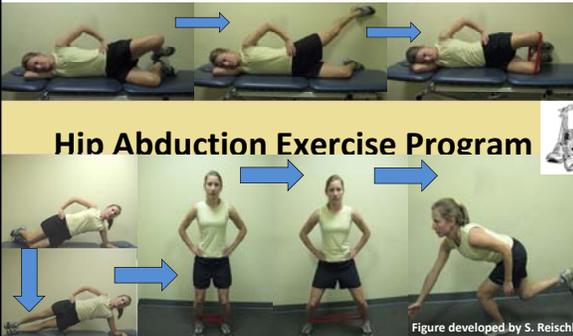
LEVEL 8: 25% BW
LEVEL 7: 20% BW
LEVEL 6: 15% BW in backpack
LEVEL 5: 10% body weight in backpack
LEVEL 4: full WB on step; heel lowered below
LEVEL 3: full WB on ground; minimal UE support
LEVEL 2: partial WB on ground; extra upper extremity support
LEVEL 1: non-weight-bearing eccentric ankle plantar flexion with theraband

Figure developed by K. Kulig & D. Asami

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Prevent recurrence of symptoms

Runner vs Dancer
Differential Diagnosis
Epidemiology
Treatment



Hio Abduction Exercise Program

Figure developed by S. Reischl

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Prevent recurrence of symptoms

Runner vs Dancer
Differential Diagnosis
Epidemiology
Treatment

Hip Extension Exercise Program

Figure developed by S. Reischl

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Management framework for tendinopathy: EdUReP

Runner vs Dancer
Differential Diagnosis
Epidemiology
Treatment

- Educate
- Unload
- Reload
- Prevent

Davenport, Kulig, Matharu and Blanco, *Phys Ther.*, 2005

EVIDENCE INFORMED INTERVENTION

Educate

Runner vs Dancer
Differential Diagnosis
Epidemiology
Treatment

Educate about...

- **Time course of intervention**
 - Inflammation
 - Often associated with **tendosynovitis**
- **Unload: weeks**
- **Reload: months**
- **Prevent: Lifetime!**
- Importance of Relative Risk
- Potential impact of different shoe wear

Davenport, Kulig, Matharu and Blanco, *Phys Ther.*, 2005
Hiller, Peace, Hulme, Healy, *Br J Radiol.*, 2004
Michelson, et al., *Foot & Ankle International*, 2005

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EVIDENCE INFORMED INTERVENTION

Unload

- No high heels
- No Pointe shoes
- Active Rest:
 - Floor Ballet
 - Pilates
 - Cardiovascular activities
- 1st MTP insert
- Last Resort...
 - Immobilization

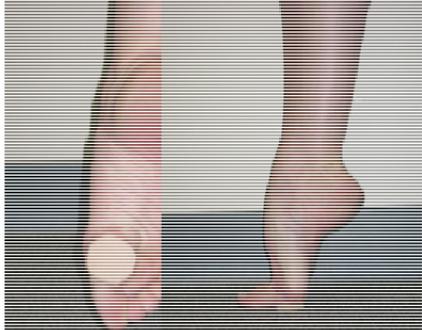
Runner vs Dancer
Differential Diagnosis
Epidemiology
Anatomy
Treatment



Nichols et al., *J Am Board Fam Pract*, 1989
Lee et al., *Arch Phys Med Rehabil*, 1987

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**Unloading of Flexor Hallucis Longus
1st Metatarsal Pad**



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EVIDENCE INFORMED INTERVENTION

Reload

 **Achilles Tendonopathy**

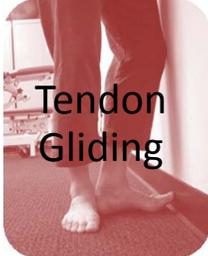
Inflammatory Care

- Ice
- Anti-inflammatory

Tendon Reloading

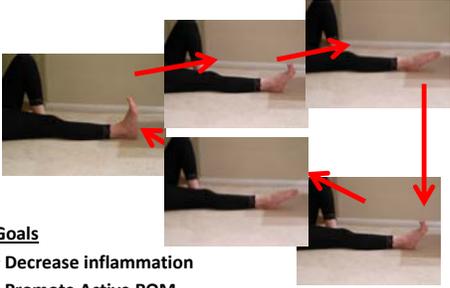
 **Flexor Hallucis Longus Tendonopathy**

Tendon Gliding



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Reload: Tendon Gliding



Goals

- Decrease inflammation
- Promote Active ROM

Michelson J, et al., *Foot & Ankle International*, 2005



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Reload : 1st MTP Stretch



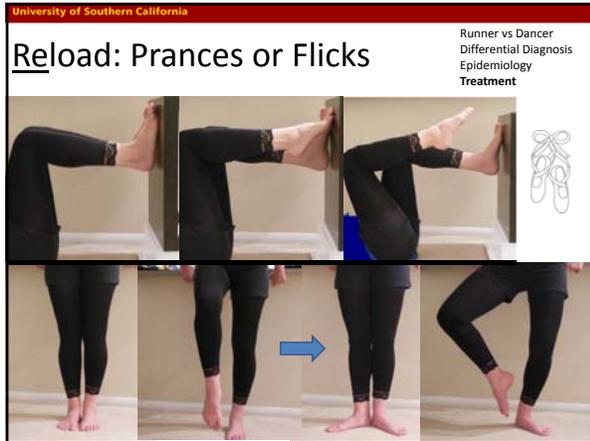
Dosage
10 seconds, 10 times
3-4 times per day

Modified from Michelson J, et al., *Foot & Ankle International*, 2005

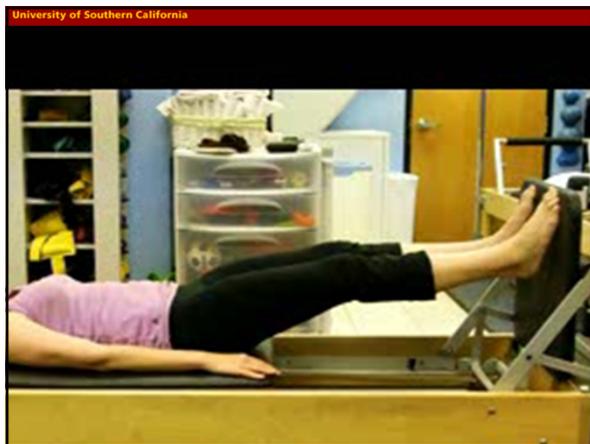
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Reload: Progression

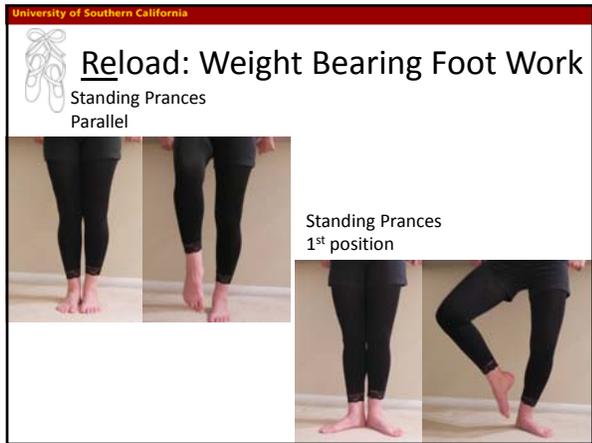


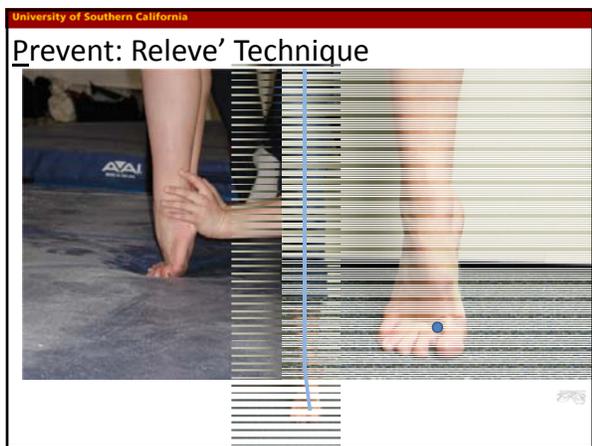


















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3 Dancers...
3 Different Presentations...
3 Interventions





Special Thanks

Performing Arts Special Interest Group
Orthopaedic Section

Faculty and Students at
The University of Southern California
Special Thanks to the USC Residence
Sakima Productions
Layfield & Associates Physical Therapy

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Questions
