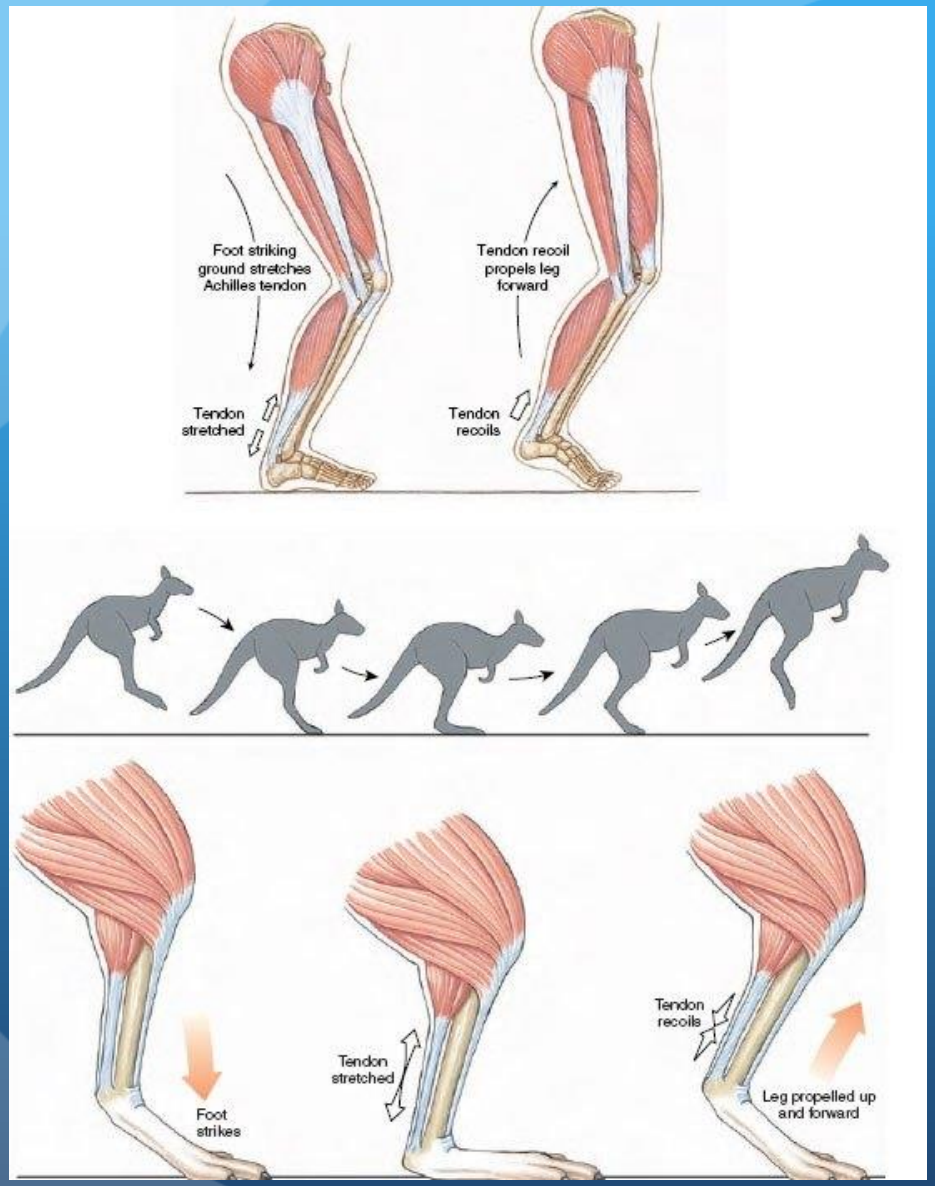
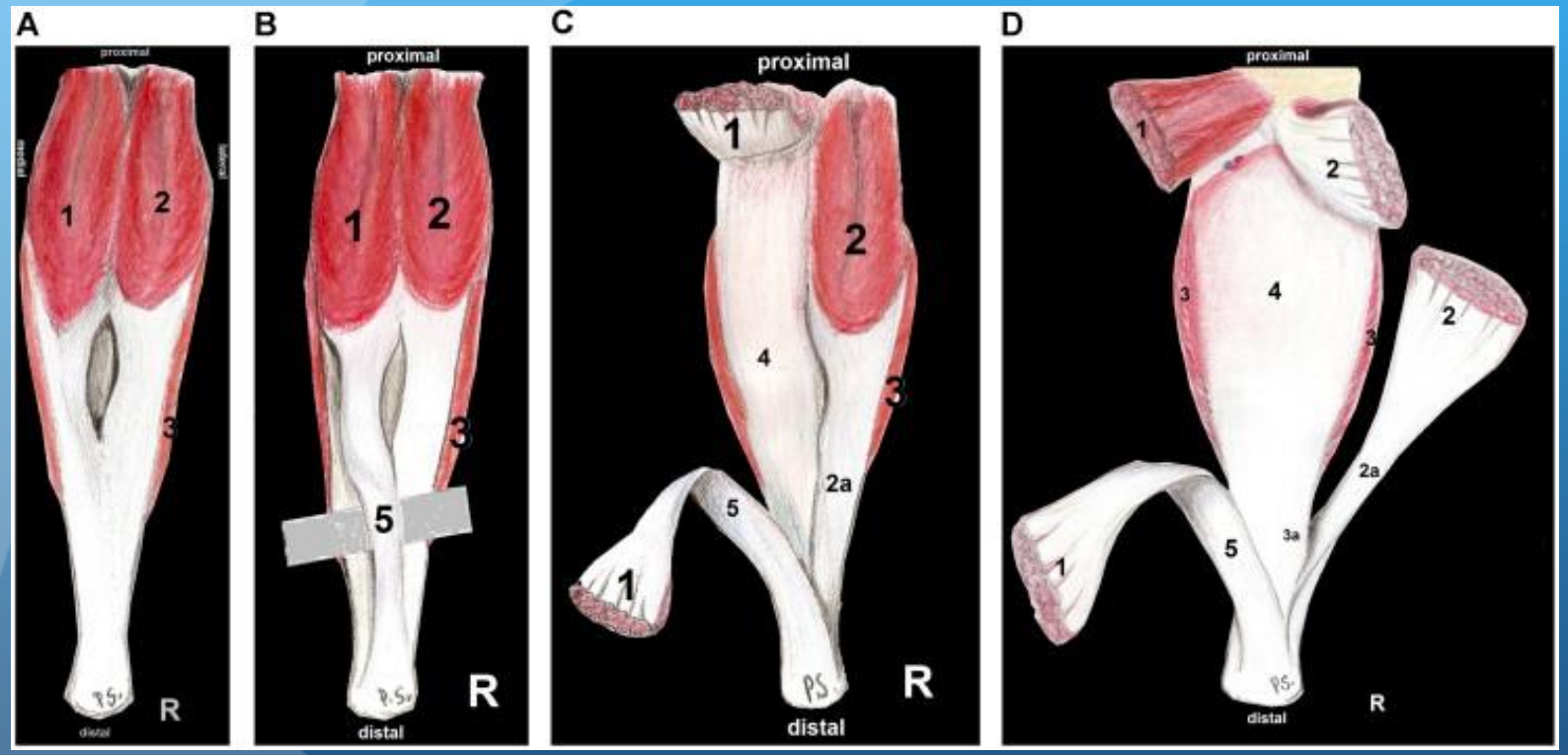
ACHILLES INJURIES IN OLDER PATIENTS

PETER GENDALL

River RADIOLOGY
Patient Focussed • Problem Oriented


Foot striking ground stretches Achilles tendon
Tendon stretched
Tendon recoil propels leg forward
Tendon recoils
Foot strikes
Tendon stretched
Tendon recoils
Leg propelled up and forward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3
R
distal
B
proximal
1
2
3
5
R
distal
C
proximal
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2
4
3
2a
5
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D
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4
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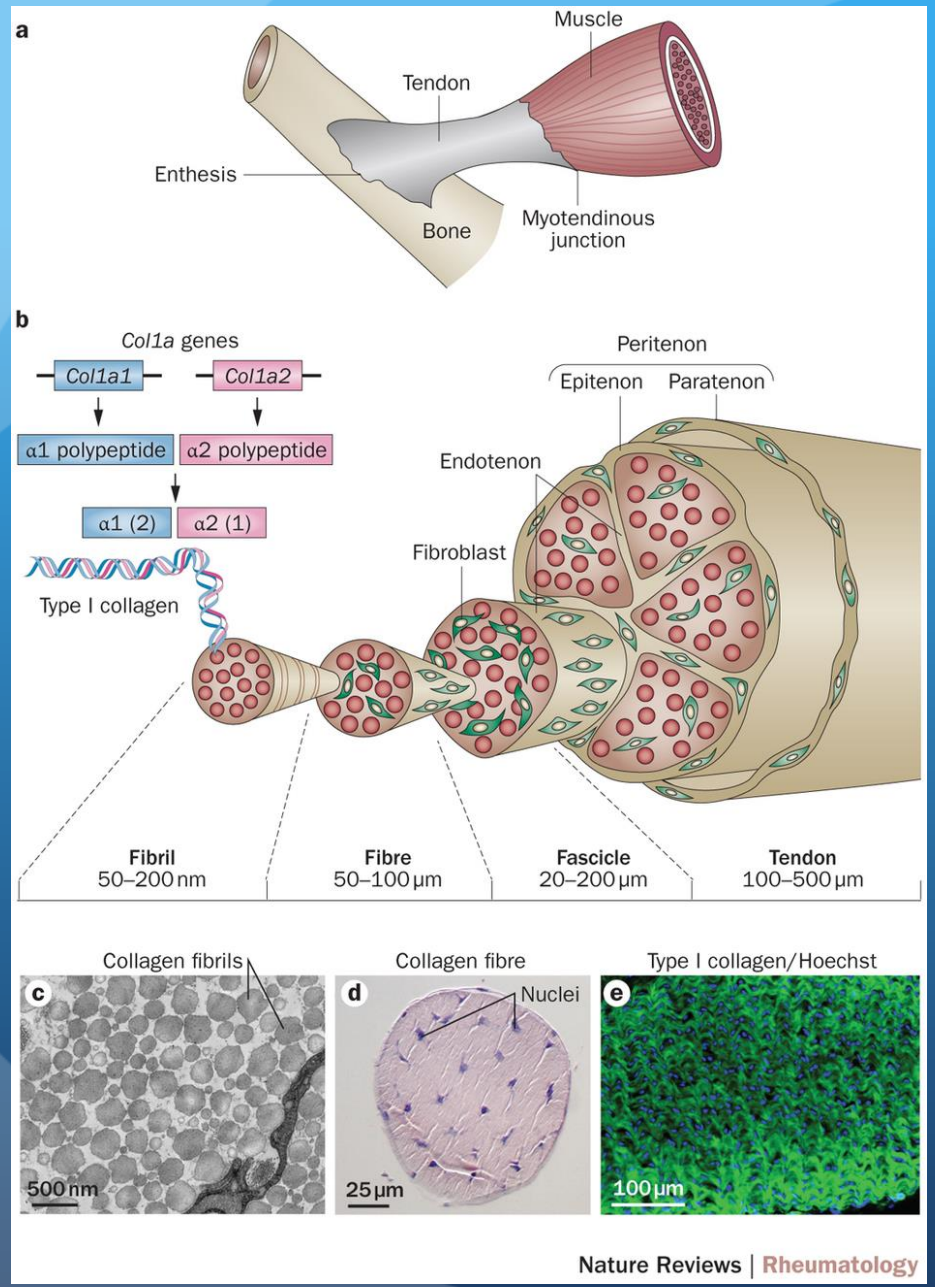
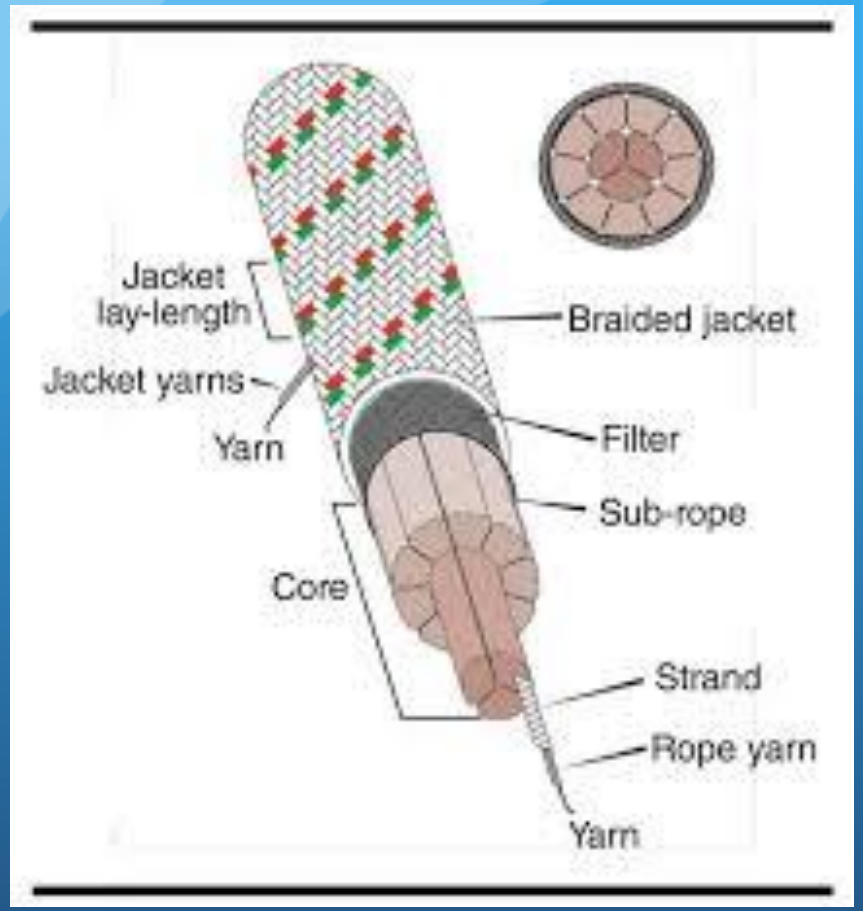
3
2a
3a
5
1
R
distal


a
Muscle
Tendon
Enthesis
Bone
Myotendinous junction
b
Col1a genes
Col1a1
Col1a2
α1 polypeptide
α2 polypeptide
α1 (2)
α2 (1)
Type I collagen
Peritenon
Epitenon
Paratenon
Endotenon
Fibroblast
Fibril
50–200 nm
Fibre
50–100 μm
Fascicle
20–200 μm
Tendon
100–500 μm
Collagen fibrils
c
500 nm
Collagen fibre
d
Nuclei
25 μm
Type I collagen/Hoechst
e
100 μm
Nature Reviews | Rheumatology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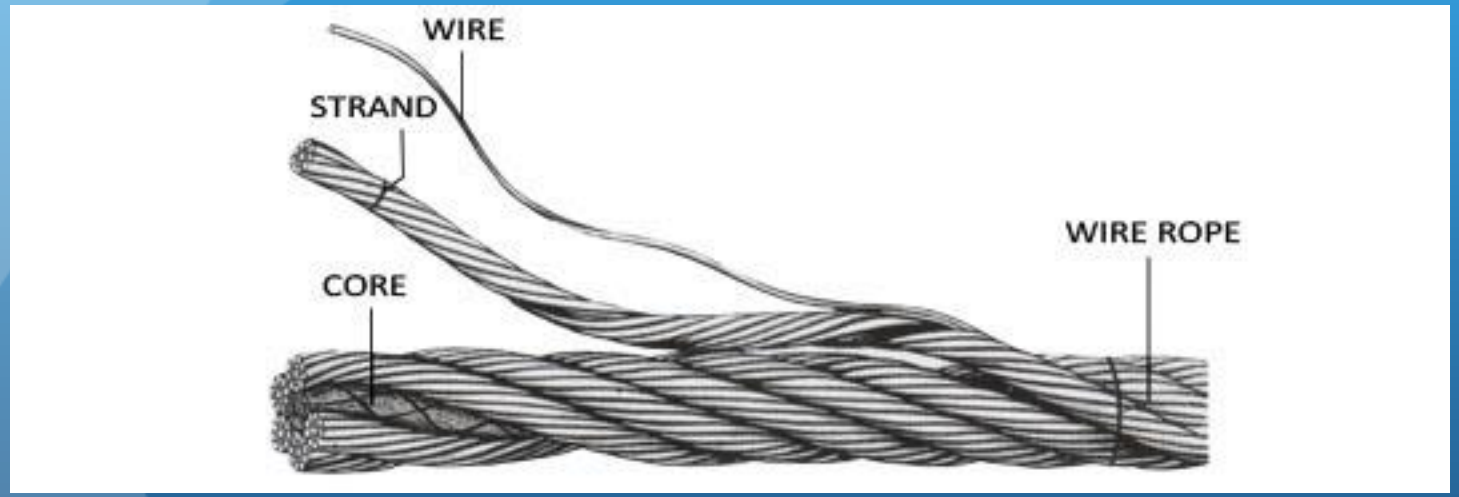
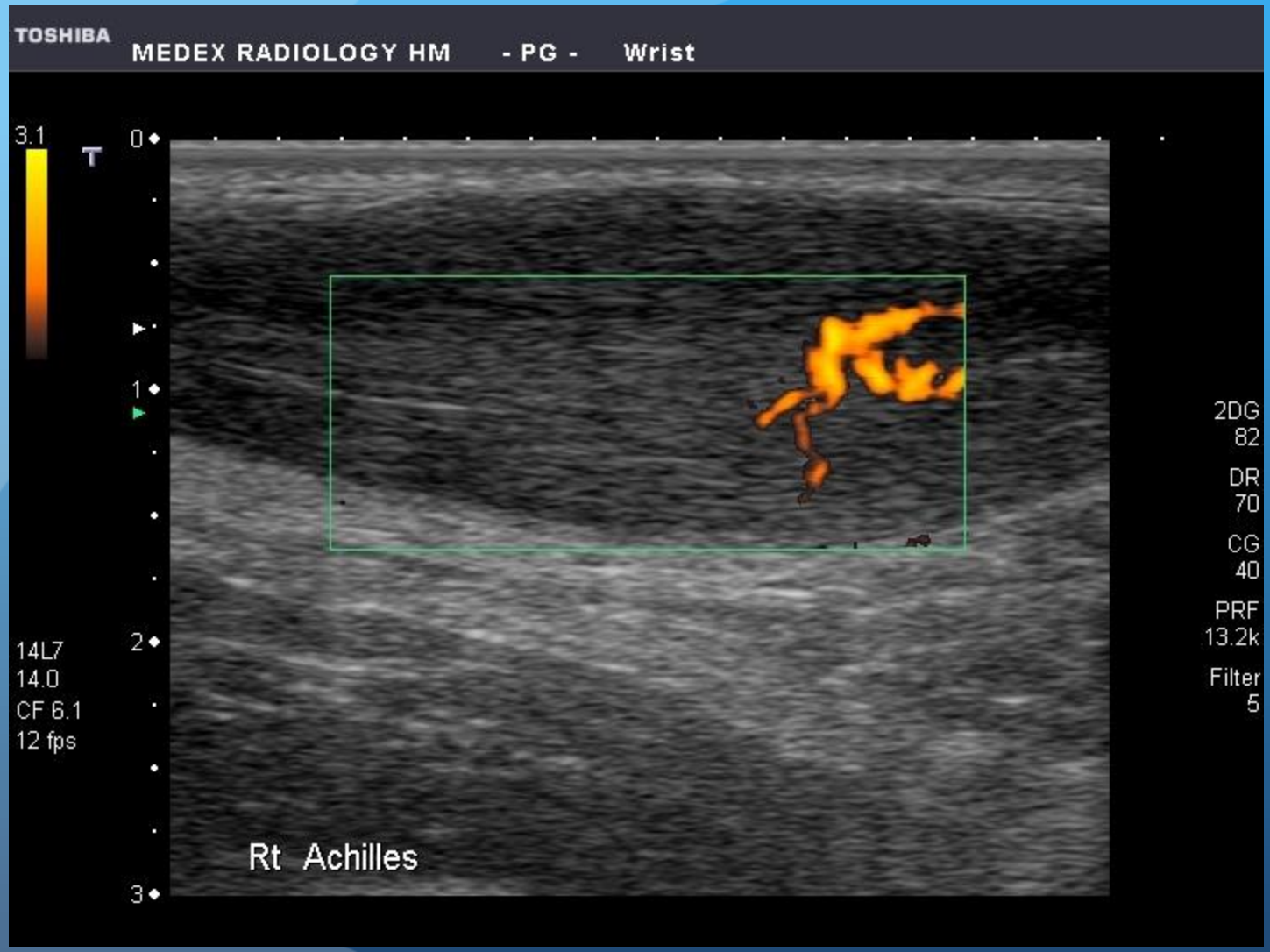
lay-length
Jacket yarns
Yarn
Braided jacket
Filter
Sub-rope
Core
Strand
Rope yarn
Yarn


WIRE
STRAND
WIRE ROPE
CORE


TOSHIBA
MEDEX RADIOLOGY HM - PG - Wrist
3.1
T
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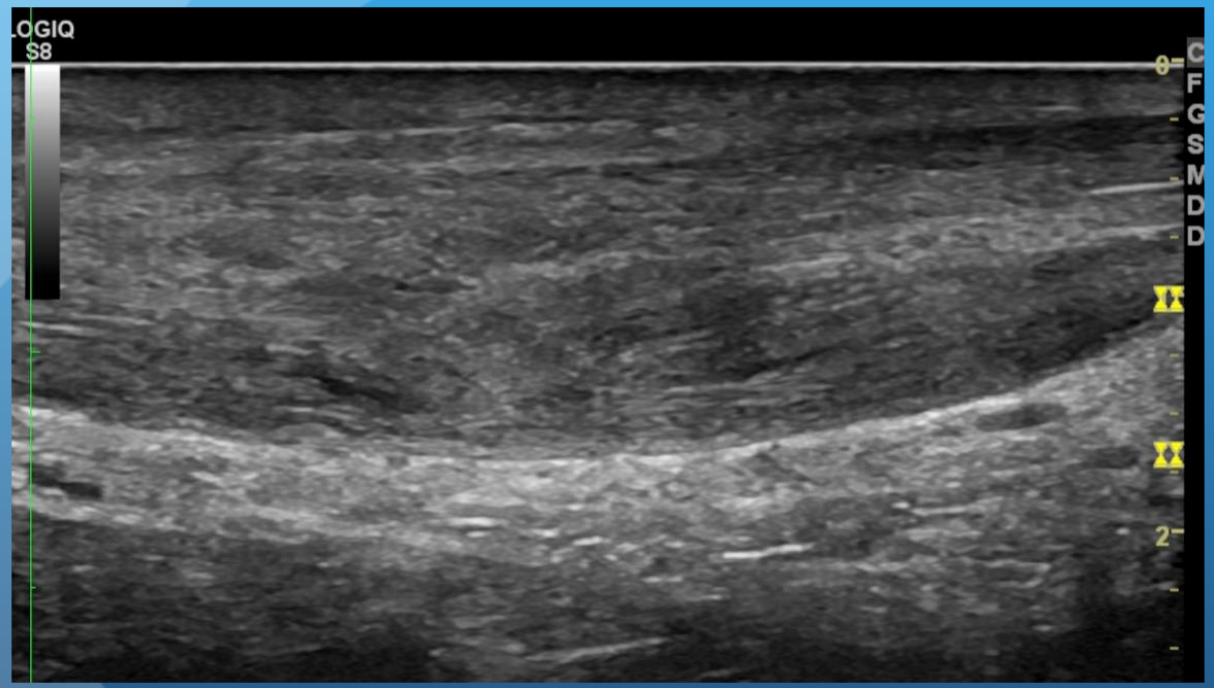
1
2
3
14L7
14.0
CF 6.1
12 fps
2DG
82
DR
70
CG
40
PRF
13.2k
Filter
5
Rt Achilles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C
F
G
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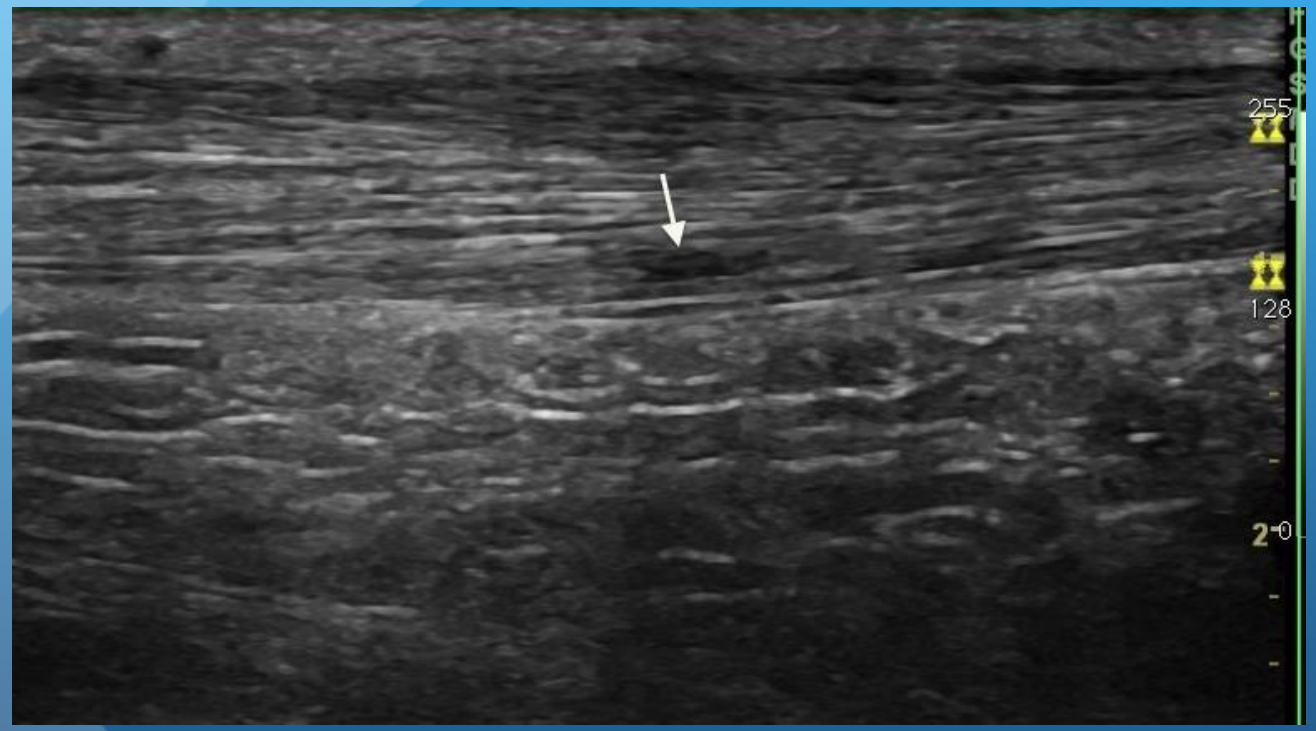
M
D
D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128
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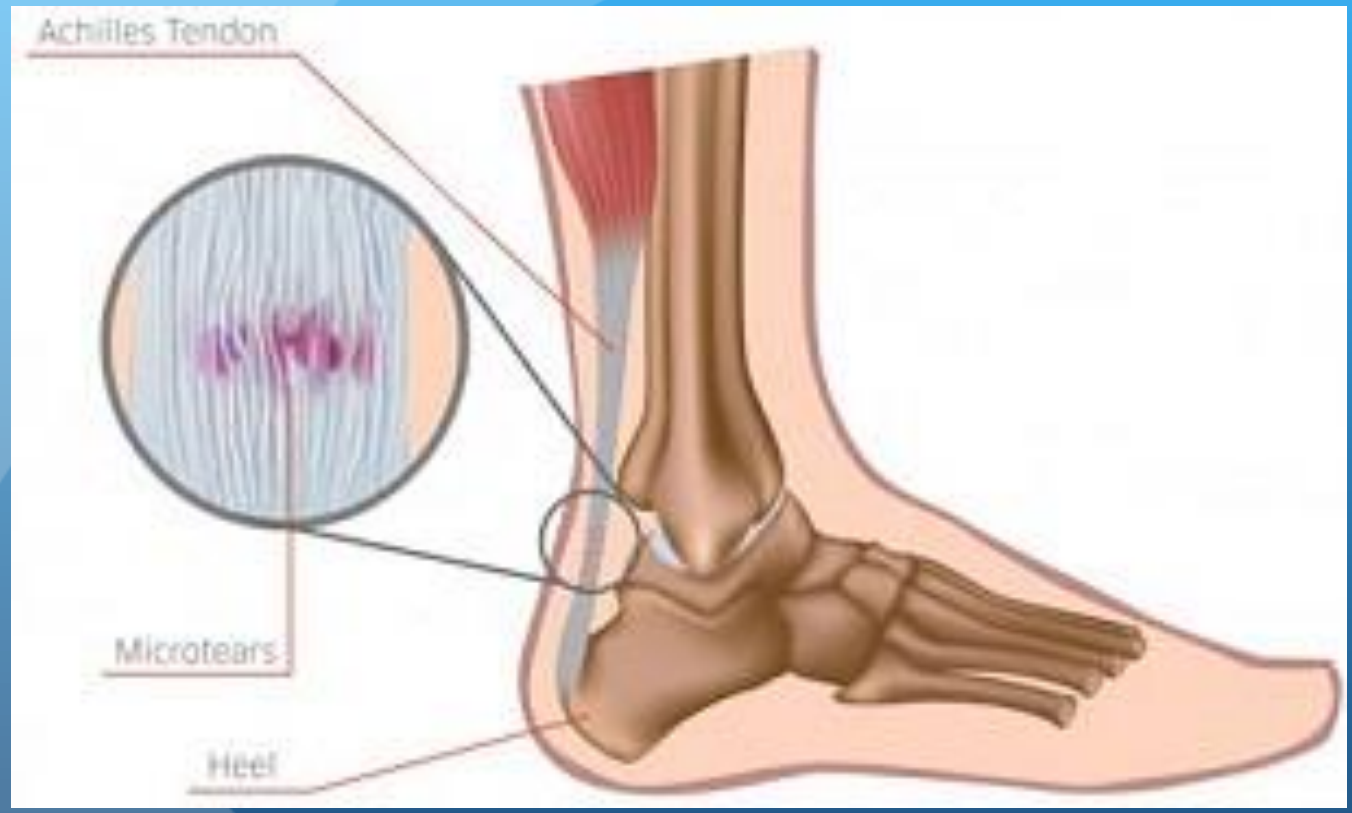
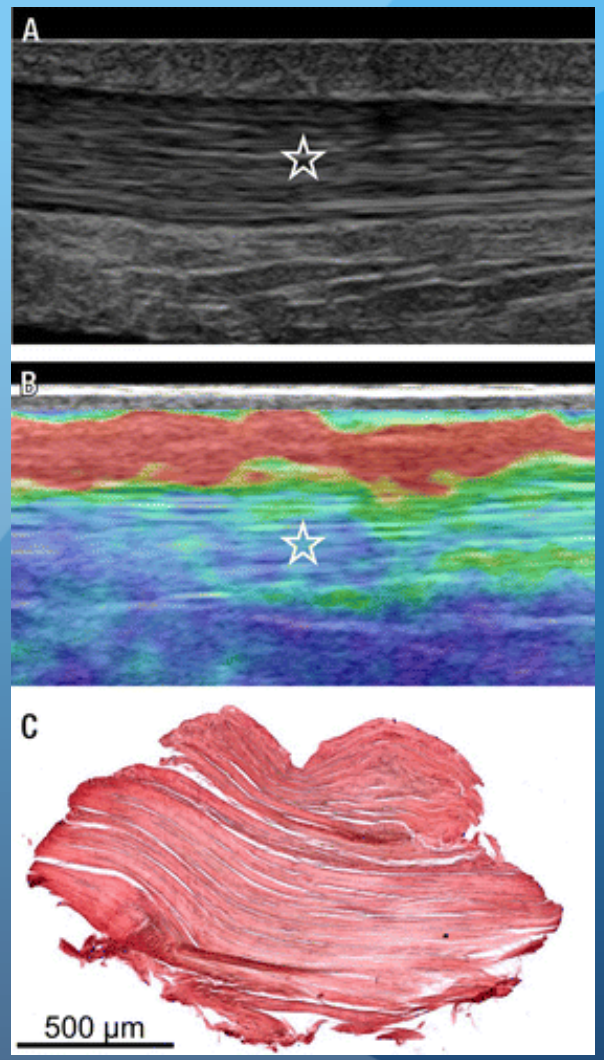
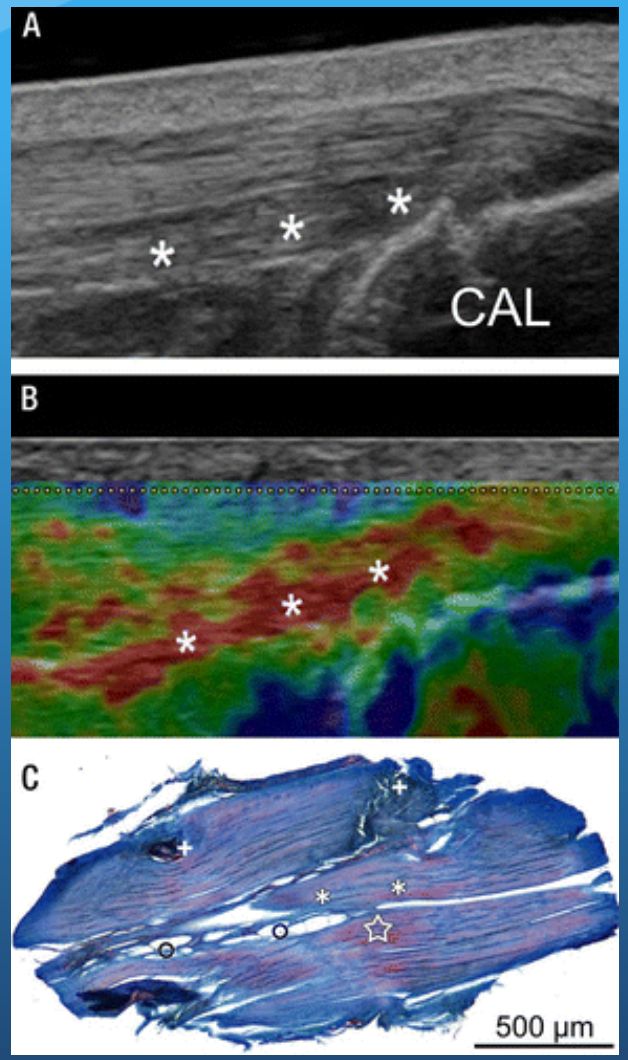

Achilles Tendon
Microtears
Heel



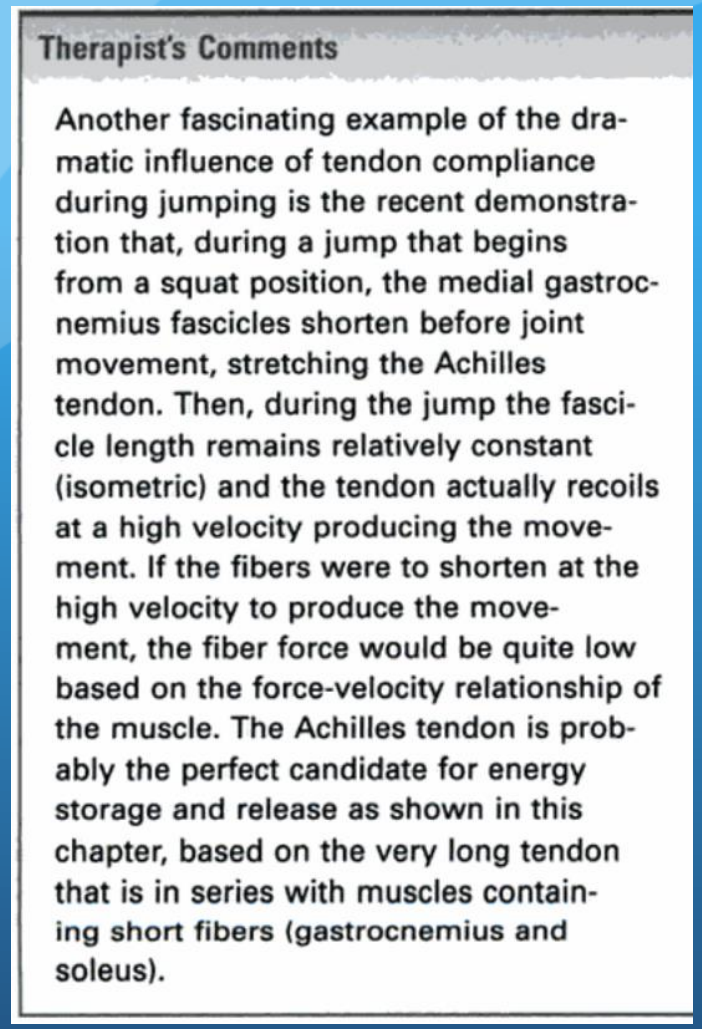


Klauser et al Radiol 267:3; June 2013

Box 3-2. Can a Tendon Lengthen While a Muscle Shortens?

Amazingly, yes! Tendons are fairly compliant tissues. Under conditions where a muscle is highly active and the entire muscle-tendon unit is forced to lengthen rapidly (for example, hopping on toes, when your toes hit the ground), much of the length increase caused by ankle dorsiflexion can be all taken up by the tendon while muscle fibers continue to shorten! This has been directly demonstrated in walking cats using sophisticated implanted length transducers.

Skeletal Muscle Structure, Function and Plasticity
Richard Lieber
Wolters Kluwer 2002



Therapist's Comments

Another fascinating example of the dramatic influence of tendon compliance during jumping is the recent demonstration that, during a jump that begins from a squat position, the medial gastrocnemius fascicles shorten before joint movement, stretching the Achilles tendon. Then, during the jump the fascicle length remains relatively constant (isometric) and the tendon actually recoils at a high velocity producing the movement. If the fibers were to shorten at the high velocity to produce the movement, the fiber force would be quite low based on the force-velocity relationship of the muscle. The Achilles tendon is probably the perfect candidate for energy storage and release as shown in this chapter, based on the very long tendon that is in series with muscles containing short fibers (gastrocnemius and soleus).

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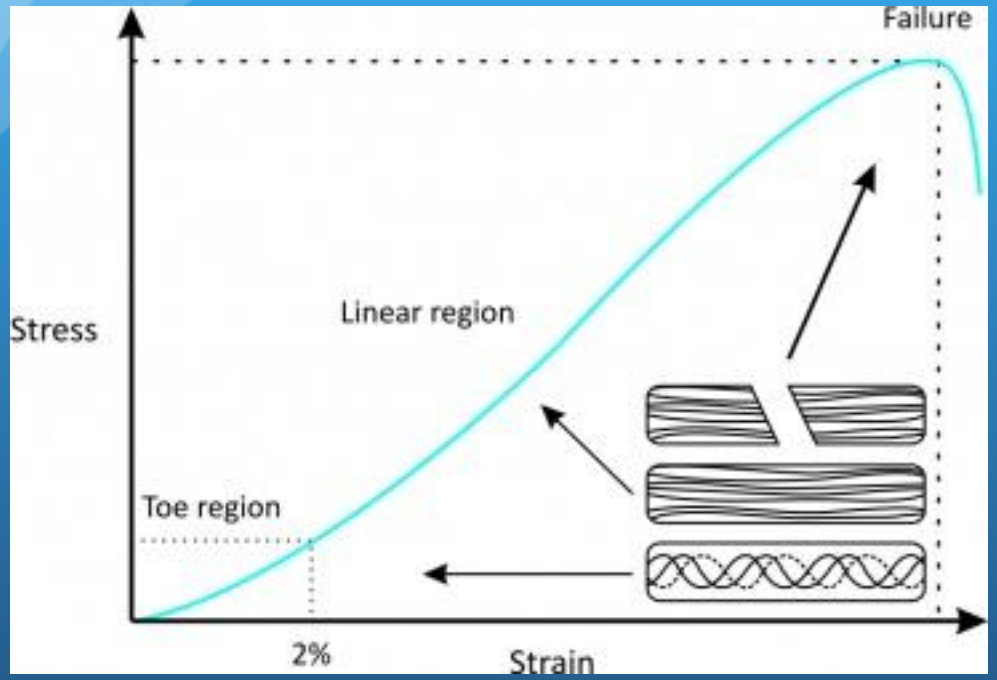
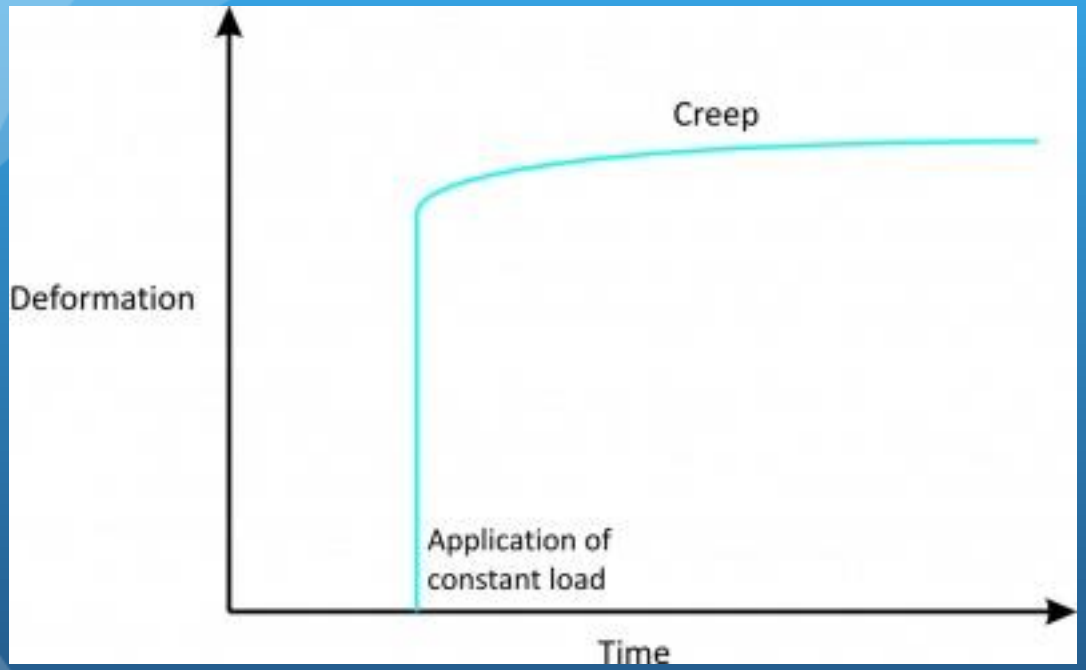

Failure
Stress
Linear region
Toe region
2%
Strain

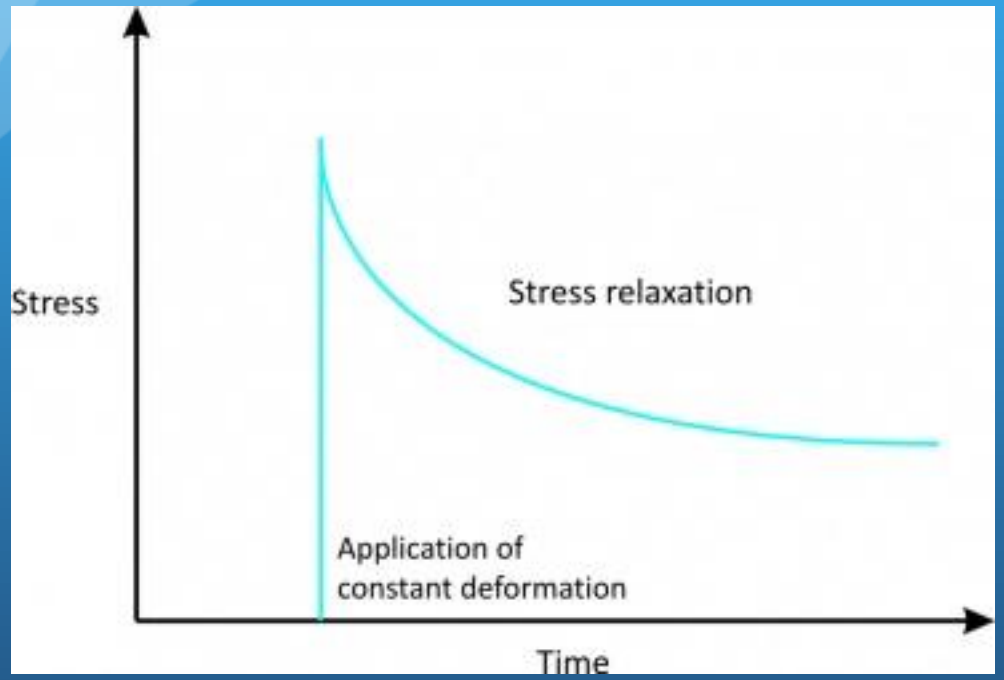
Tendons

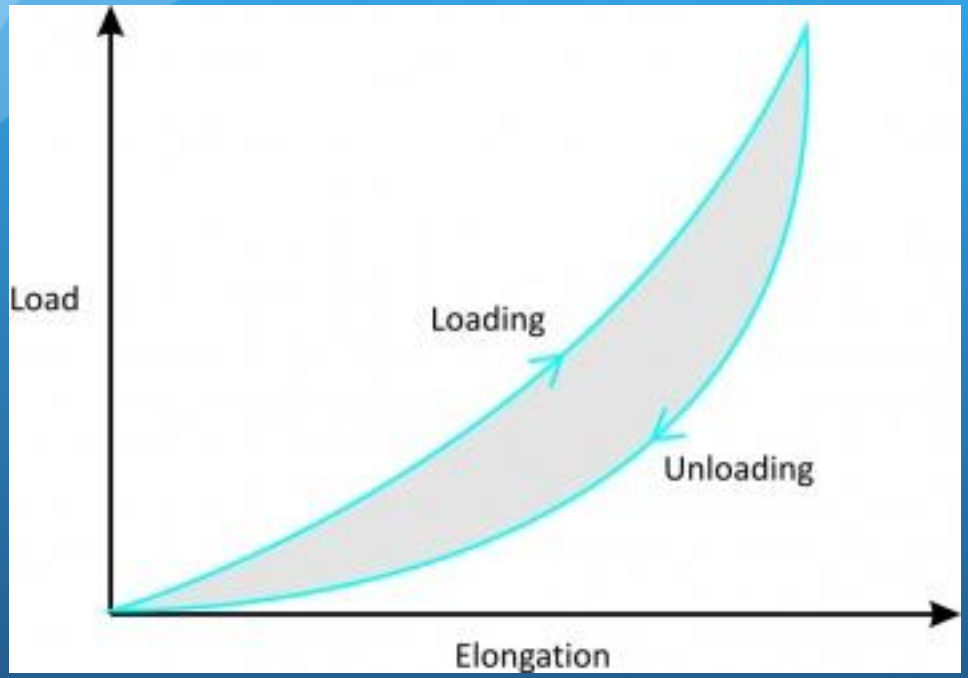
Mechanical Behavior

Region 1: "Toe" Region	Collagen fibers straighten (less prominent than in ligaments because fibers begin more aligned); Continued elongation stiffens tissue
Region 2: Linear Response	Slope represents stiffness; Micro failure occurs at the end; Elastic recovery at stresses less than 4%
Region 3	Corresponds to strains of 3-8% Crosslinks fail; Collagen fibers slide past one another; irreversible changes such as tearing or permanent stretching occurs
Region 4: Macroscopic Failure	Tensile failure of the fibers Shear failure between the fibers Once maximum load is surpassed ➢ Complete failure occurs rapidly ➢ Fibers recoil and blossom ➢ Tangled bud at ruptured end ➢ Loses Load supporting ability

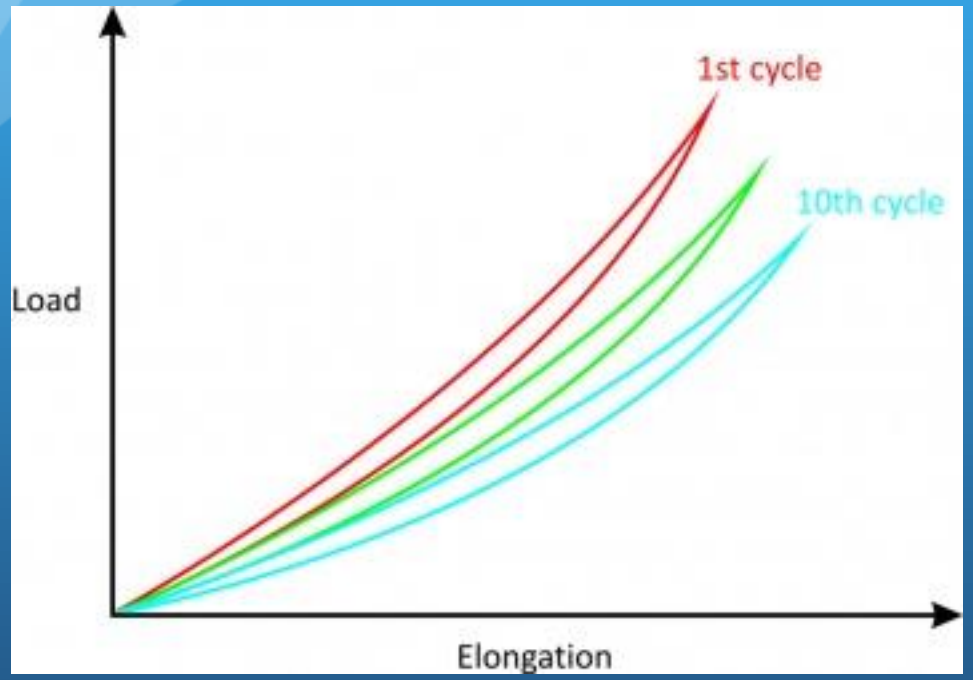
Viscoelasticity

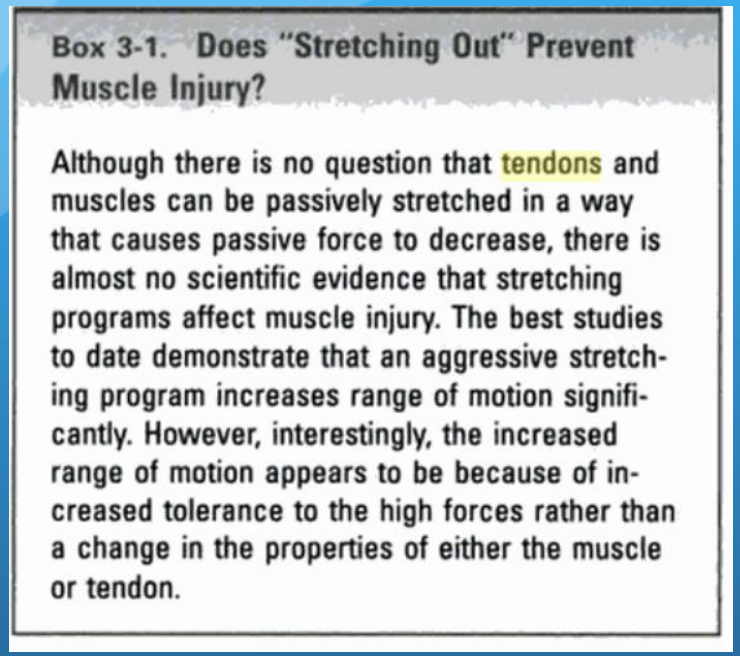



Stress
Stress relaxation
Application of
constant deformation
Time



Hysteresis Curve


1st cycle
10th cycle
Load
Elongation



Box 3-1. Does "Stretching Out" Prevent Muscle Injury?

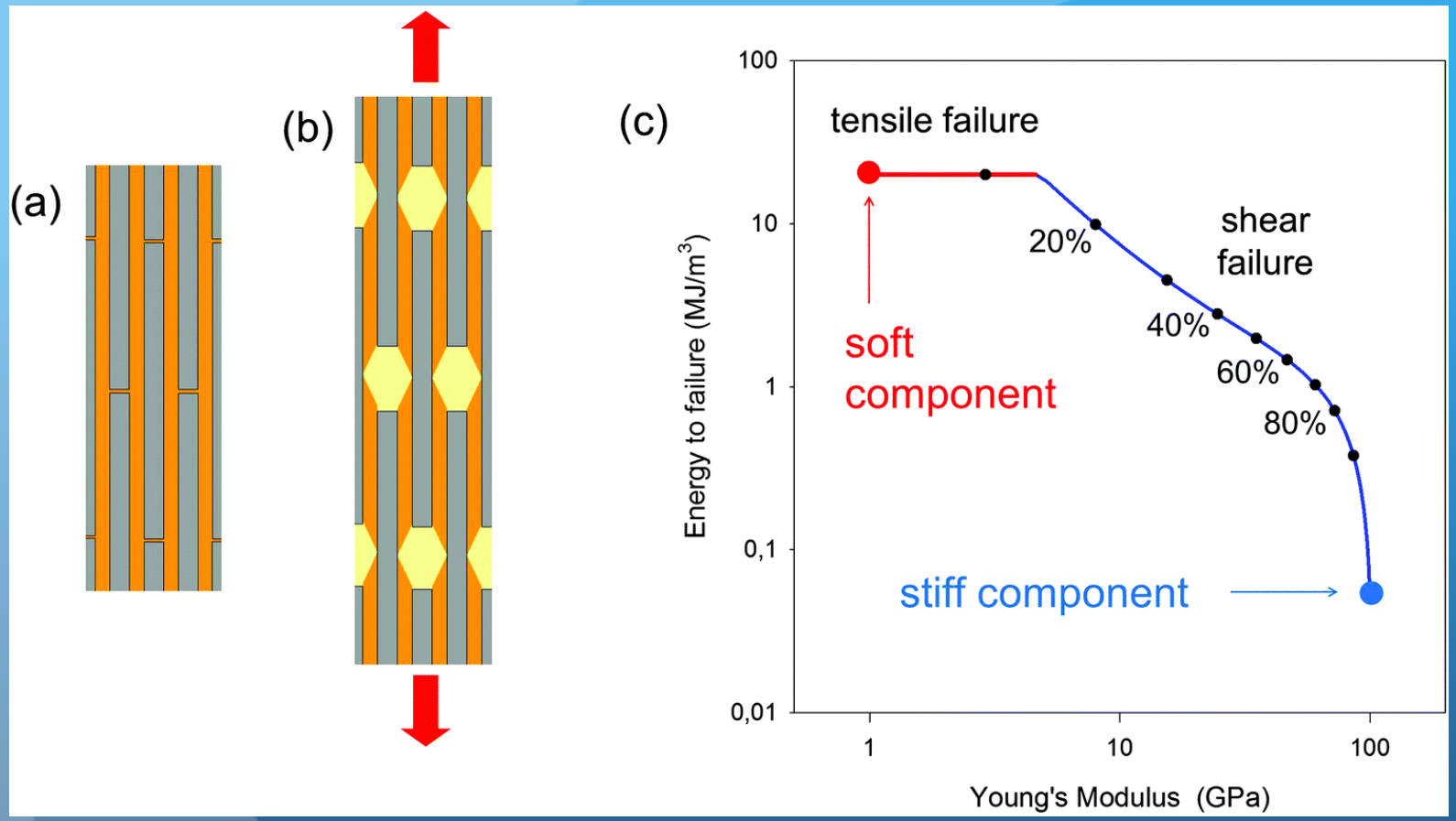
Although there is no question that tendons and muscles can be passively stretched in a way that causes passive force to decrease, there is almost no scientific evidence that stretching programs affect muscle injury. The best studies to date demonstrate that an aggressive stretching program increases range of motion significantly. However, interestingly, the increased range of motion appears to be because of increased tolerance to the high forces rather than a change in the properties of either the muscle or tendon.

Skeletal Muscle Structure, Function and Plasticity
Richard Lieber
Wolters Kluwer 2002

Stiffness of tendons reduces with age

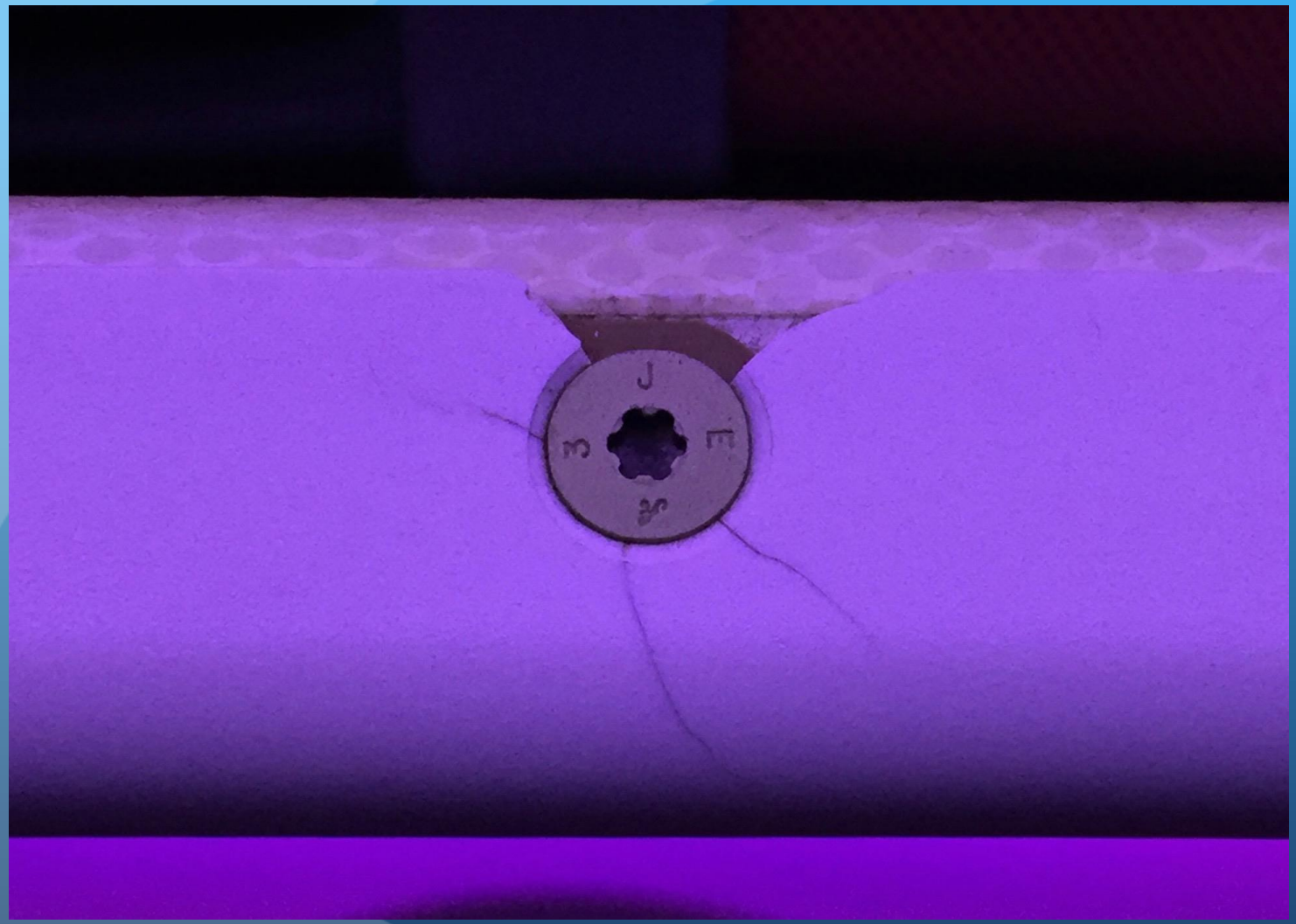
Does this predispose to injury?

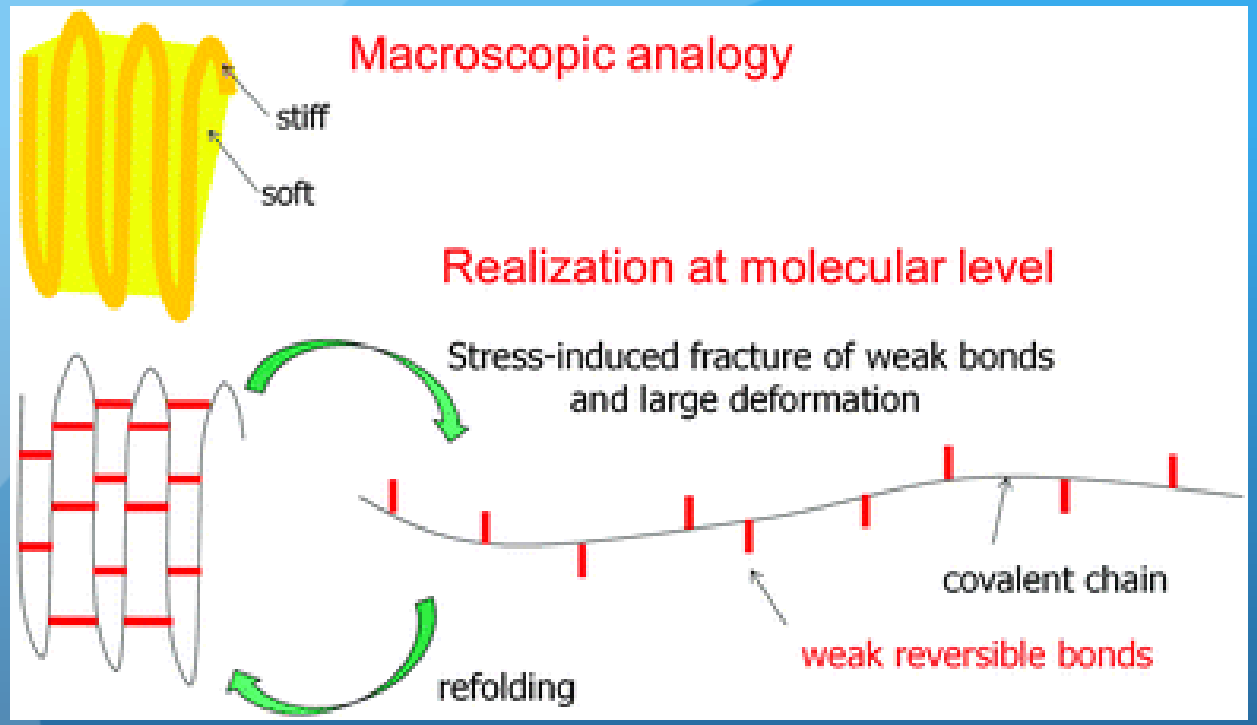
Either
1. repetitive injury
2. instantaneous failure
3. vibration/impaction



The mechanics of tessellations – bioinspired strategies for fracture resistance
Peter Fratzl,*a Otmar Kolednik,b F. Dieter Fischerc and Mason N. Deana

Chem. Soc. Rev., 2016, 45, 252


J
E
C



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(2) On a smaller but still large scale, the tendon is modular, composed of protofibrils (10–15 nm) which, in unstressed tendon, follow a helical path along the axis of the fibril (Scott, 1990). Part of the extension of the tendon fibre under stress may be due to the straightening of this helix (Castellani et al. 1983), as in the straightening of a spring. This could account for reversible extension in the linear region of the stress–strain curve. It is relevant that sometimes there is axially oriented PG between the protofibrils (Scott, 1990), which could act as both lubricant and elastic deformation space to facilitate movement among the protofibrils. When helical straightening is complete, further extension may entail damage to the tendon.

Both mechanisms 1 and 2 would give thinner fibrils under tensile stress, as was observed.

Tendon Response to Tensile Stress:
An Ultrstructural Investigation of collagen:
Proteoglycan interactions in stressed tendon

Cribb and Scott
J. Anat. (1995) 187, 423-428

What might predispose to injury?

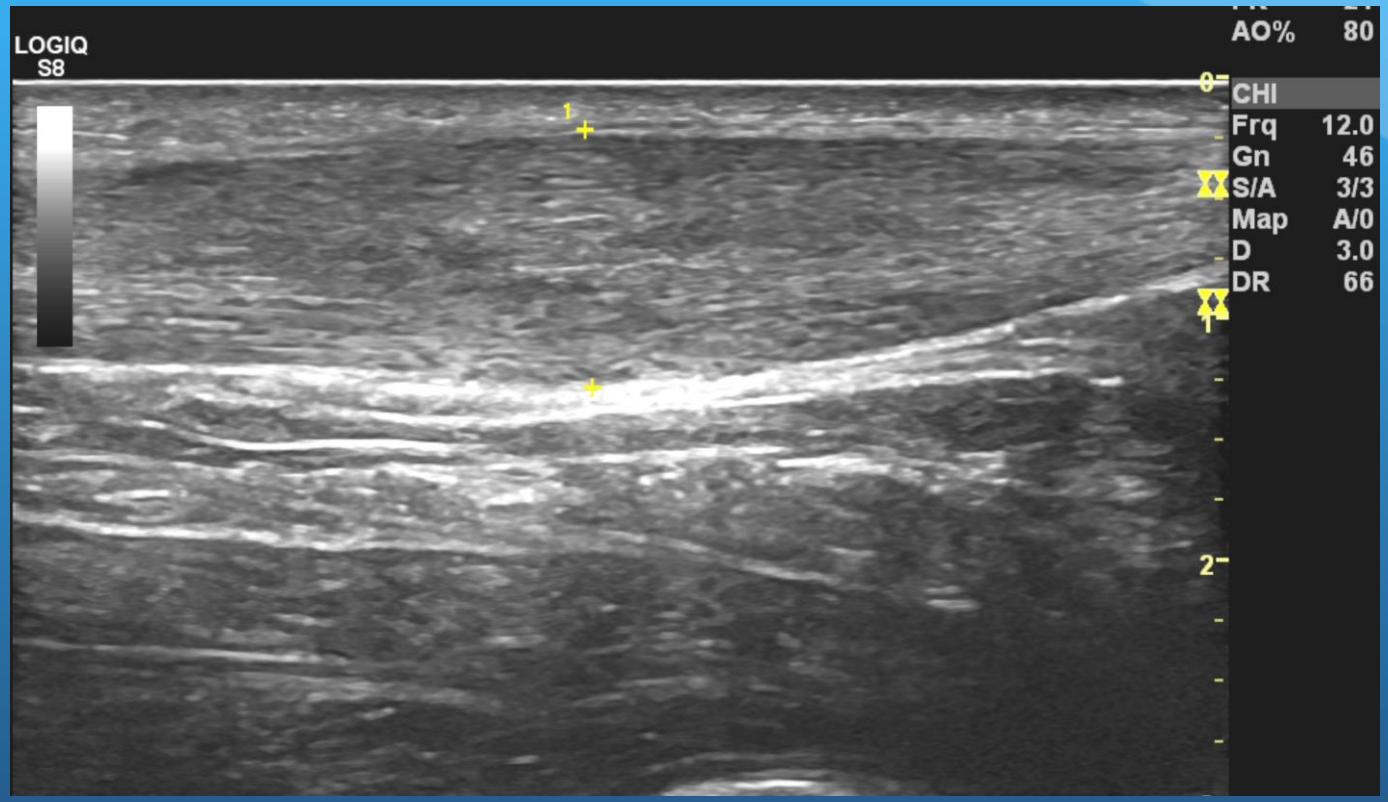
OVERUSE?

Over stretching?

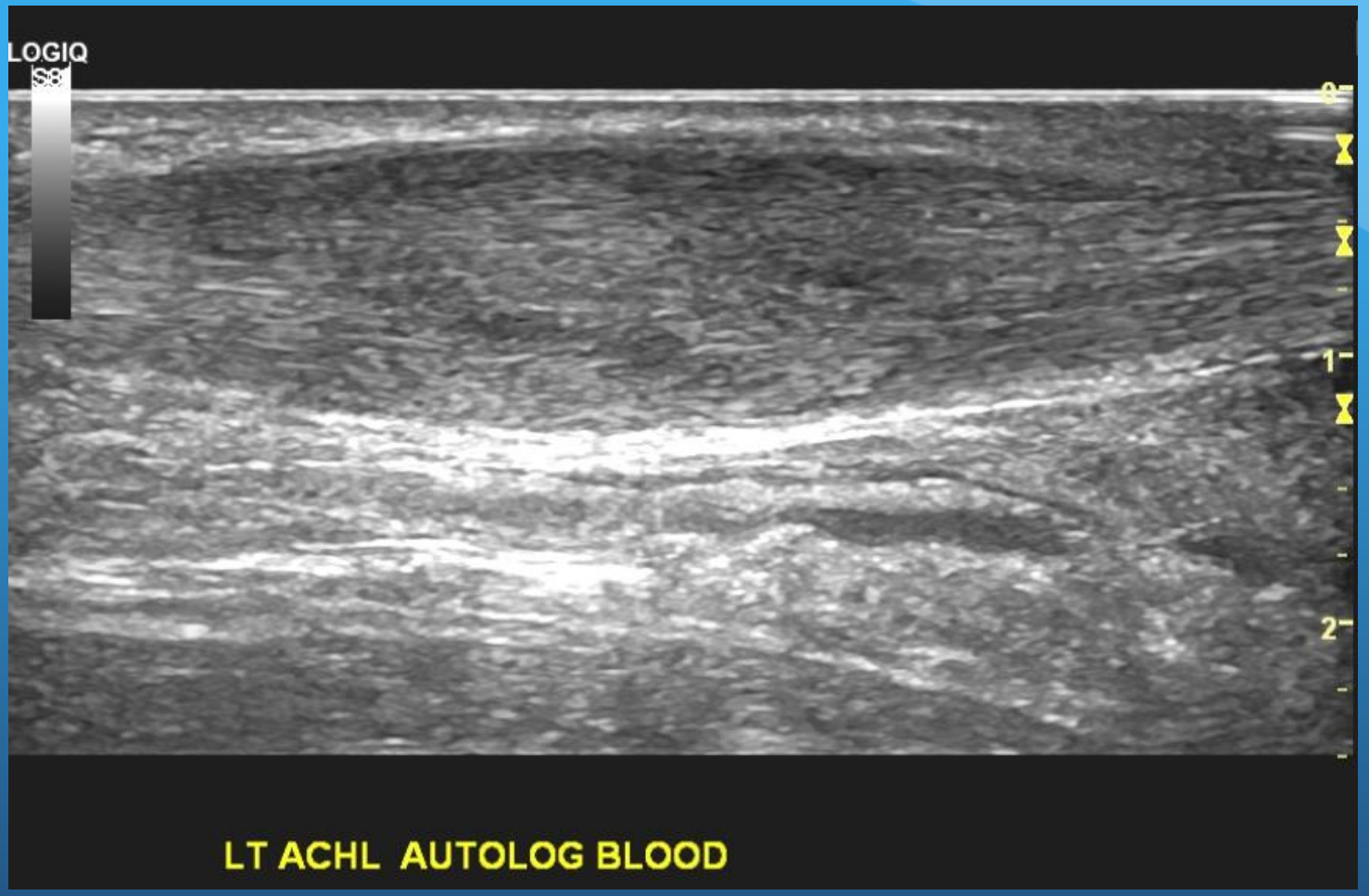
Short tendon?

Overweight?

IMPACT

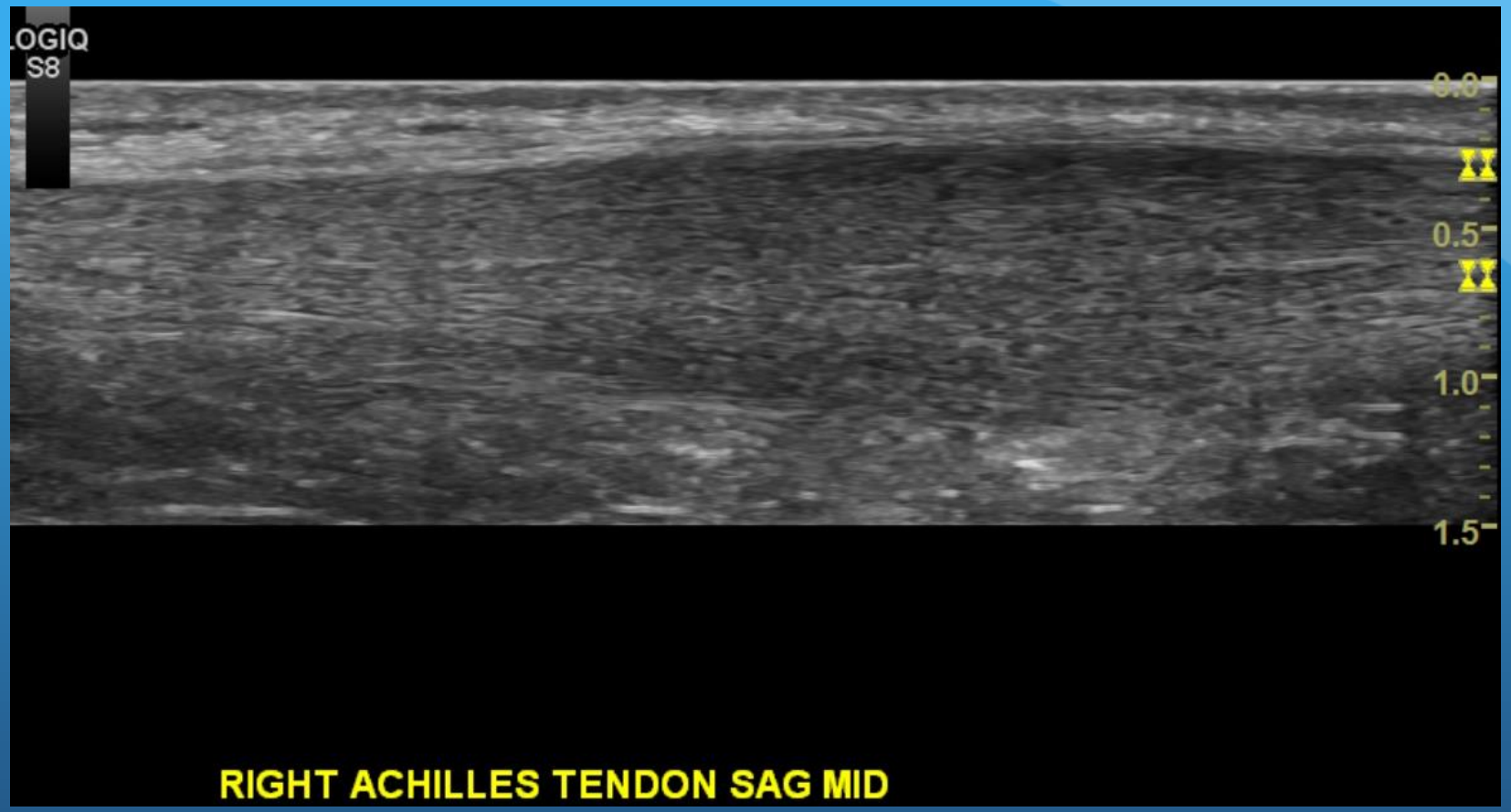


Achilles Tears Pre ABI , Pt A

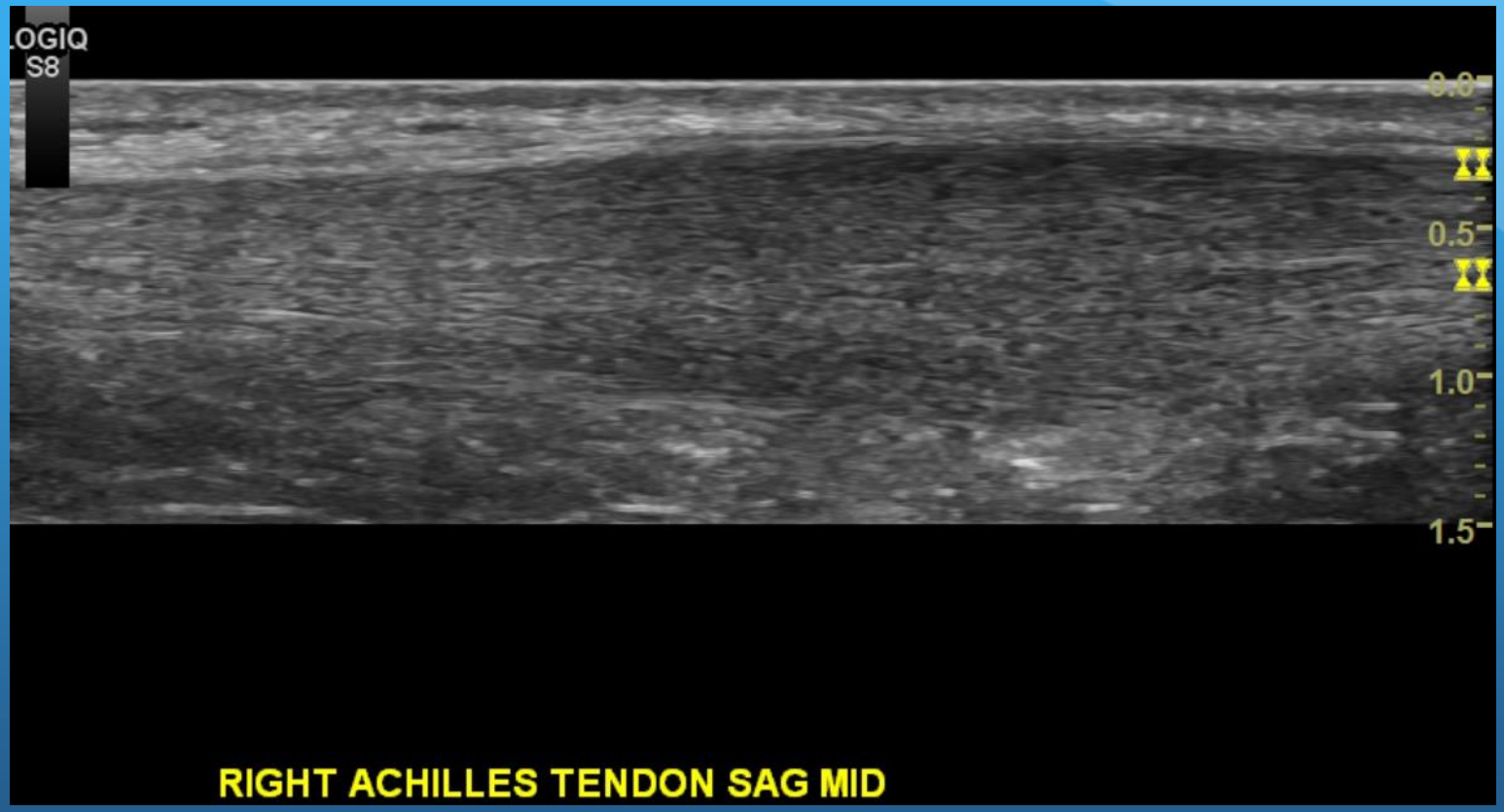


Pt A Post ABI Immed

Pt A post ABI 1 M



Post ABI 1 Yr



Post ABI 24 M Pt A

Achilles Tendon Injuries

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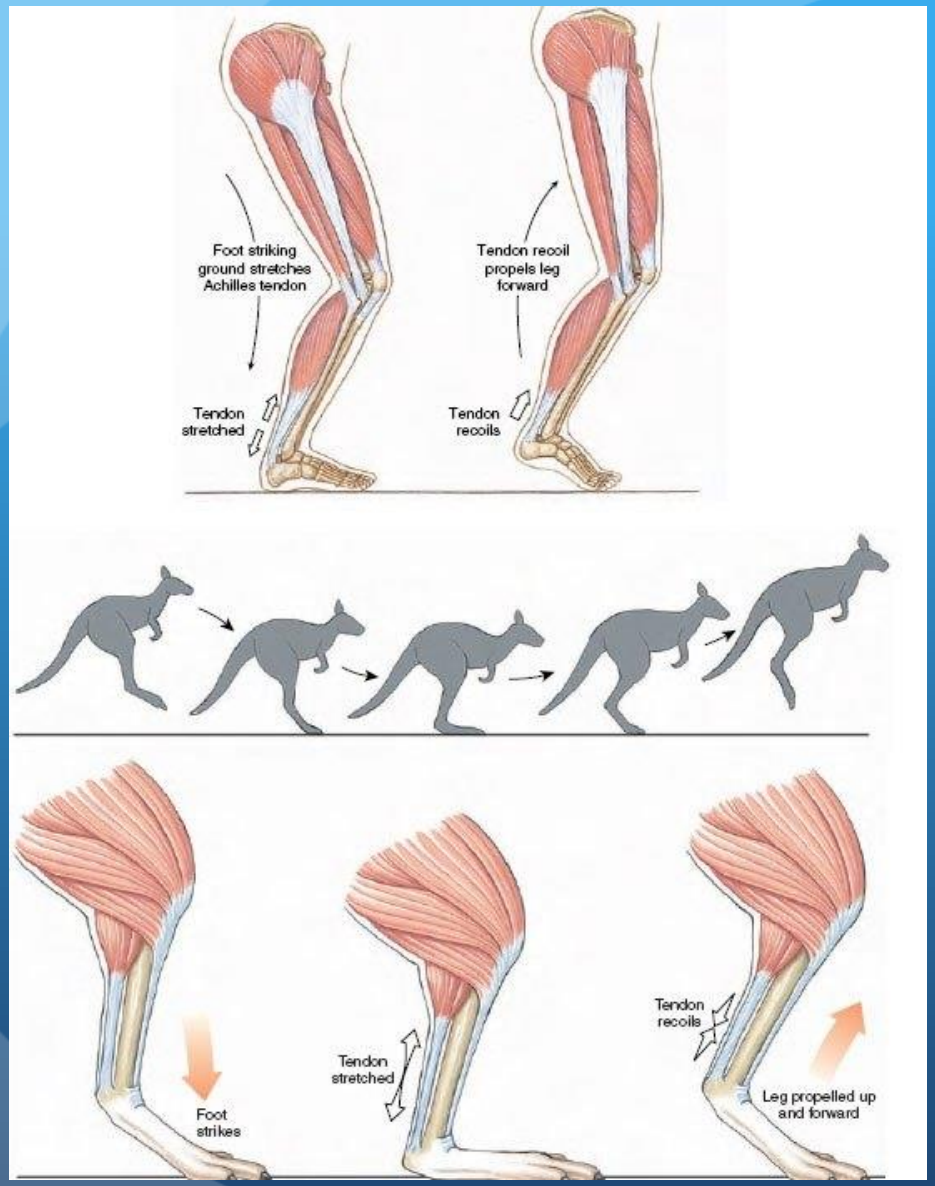
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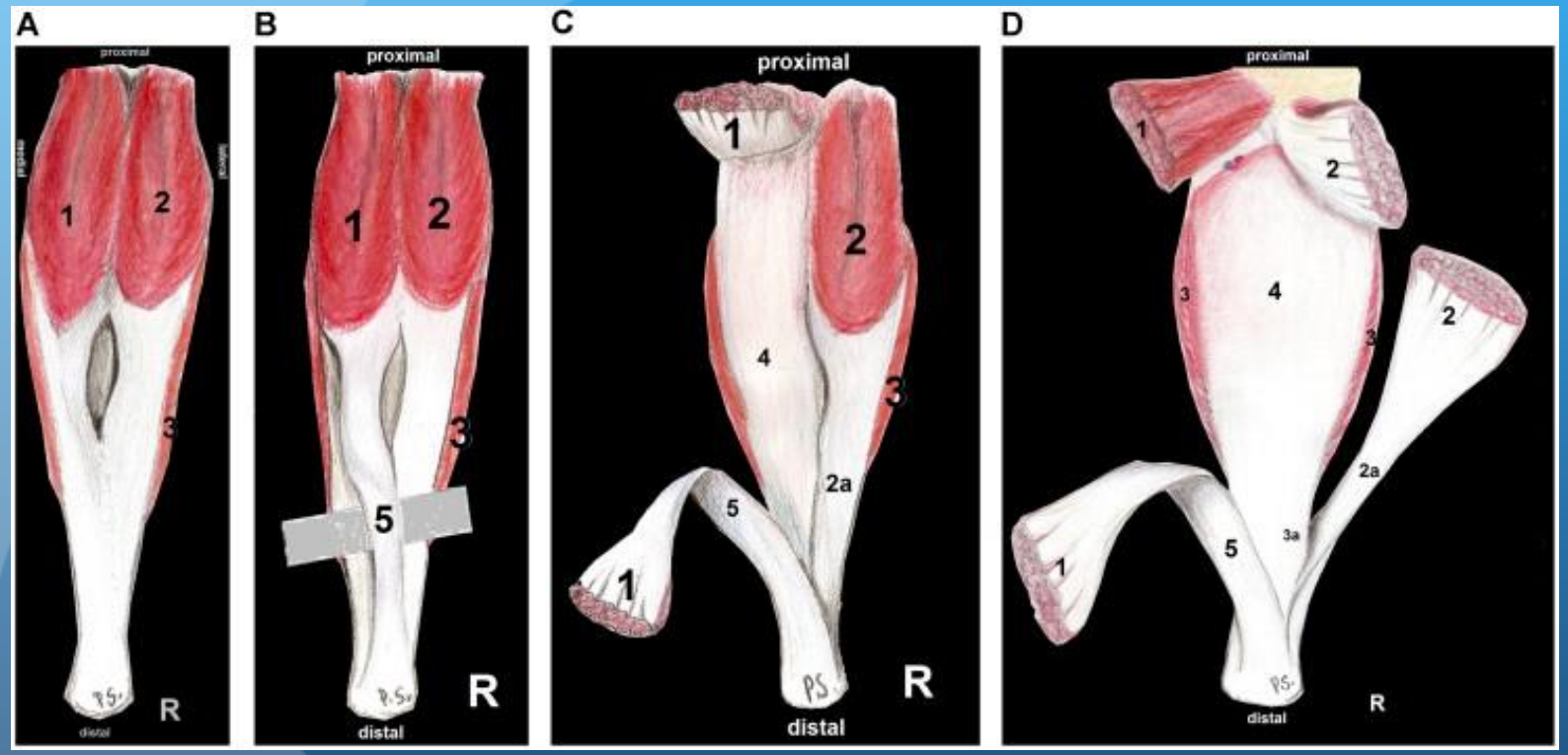
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C
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4
3
2a
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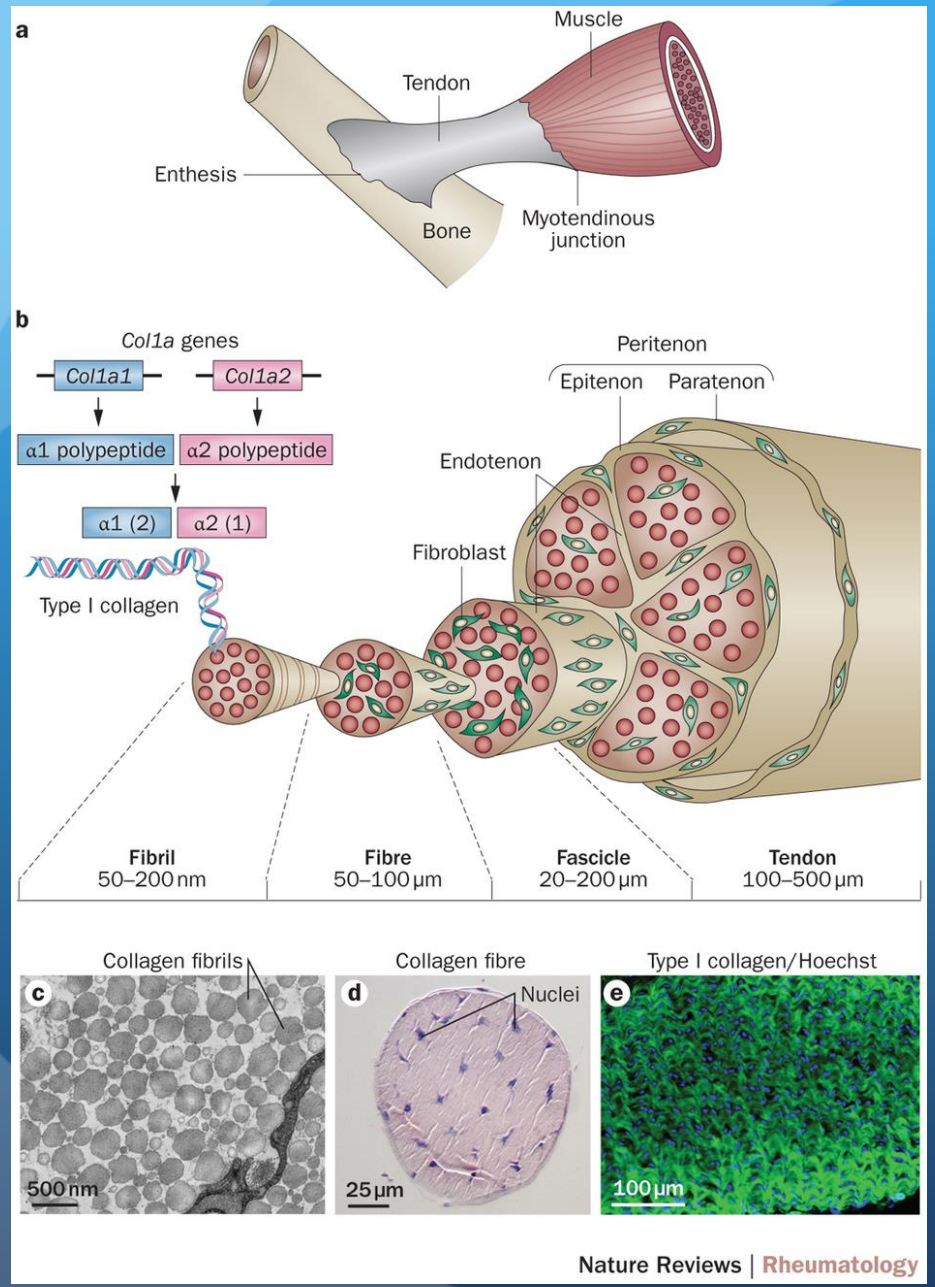
5
1
R
distal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Bone
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Col1a1
Col1a2
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α2 polypeptide
α1 (2)
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Type I collagen
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Epitenon
Paratenon
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Fibroblast
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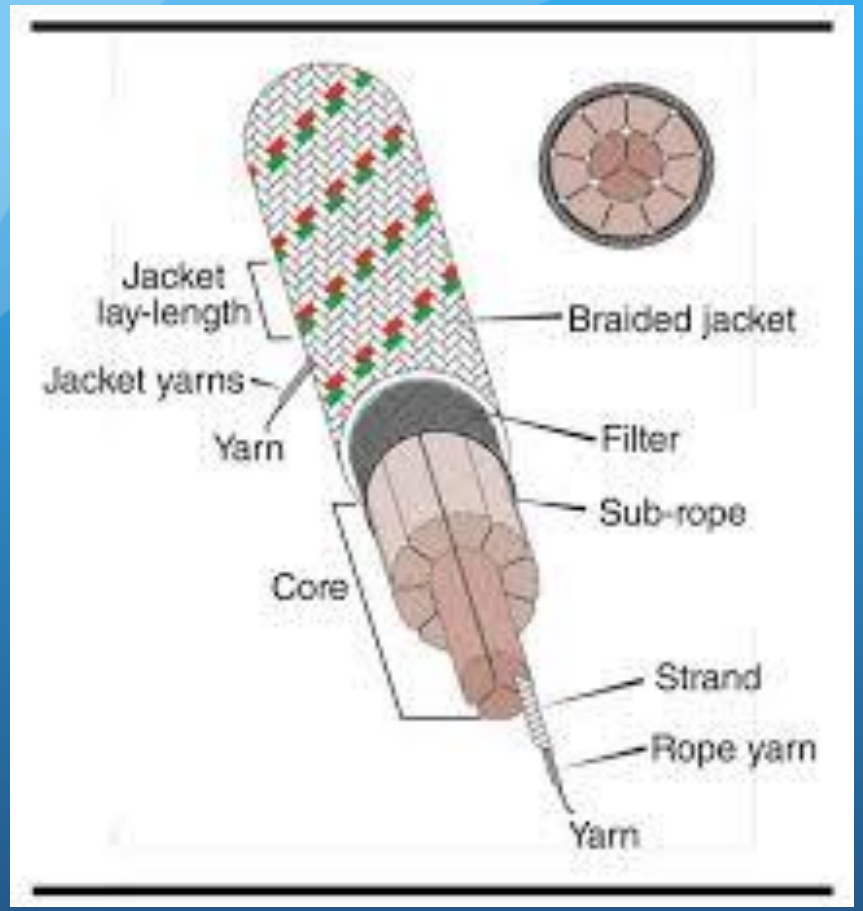
Nature Reviews | Rheumatology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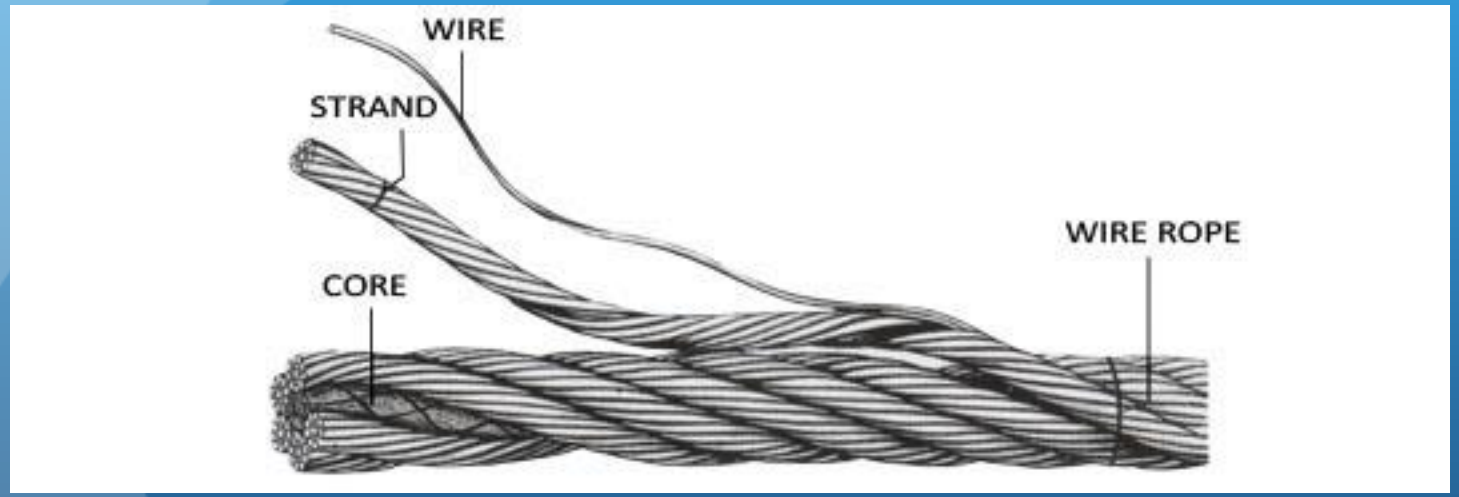
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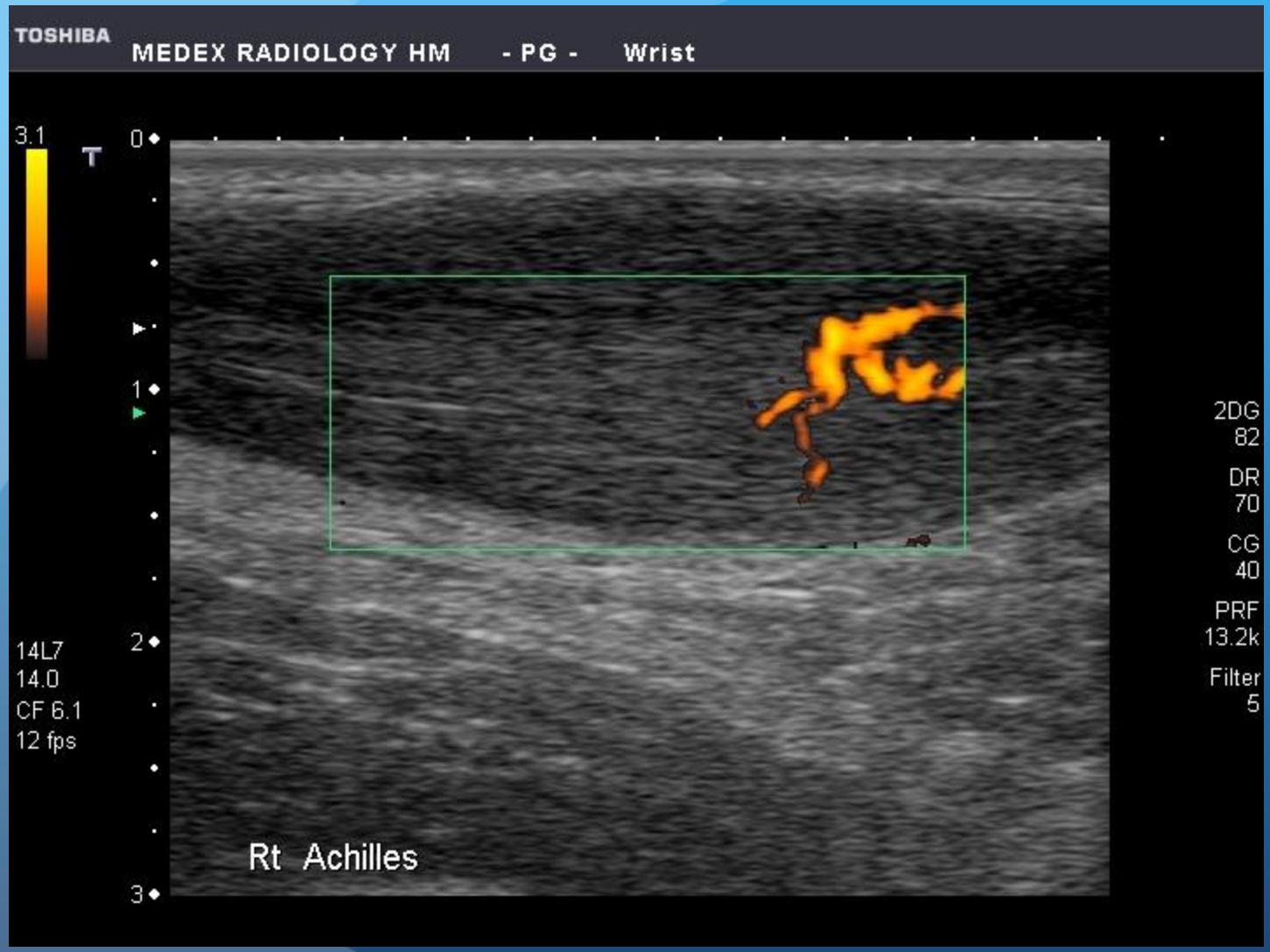
TOSHIBA
MEDEX RADIOLOGY HM - PG - Wrist
3.1
T
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Filter
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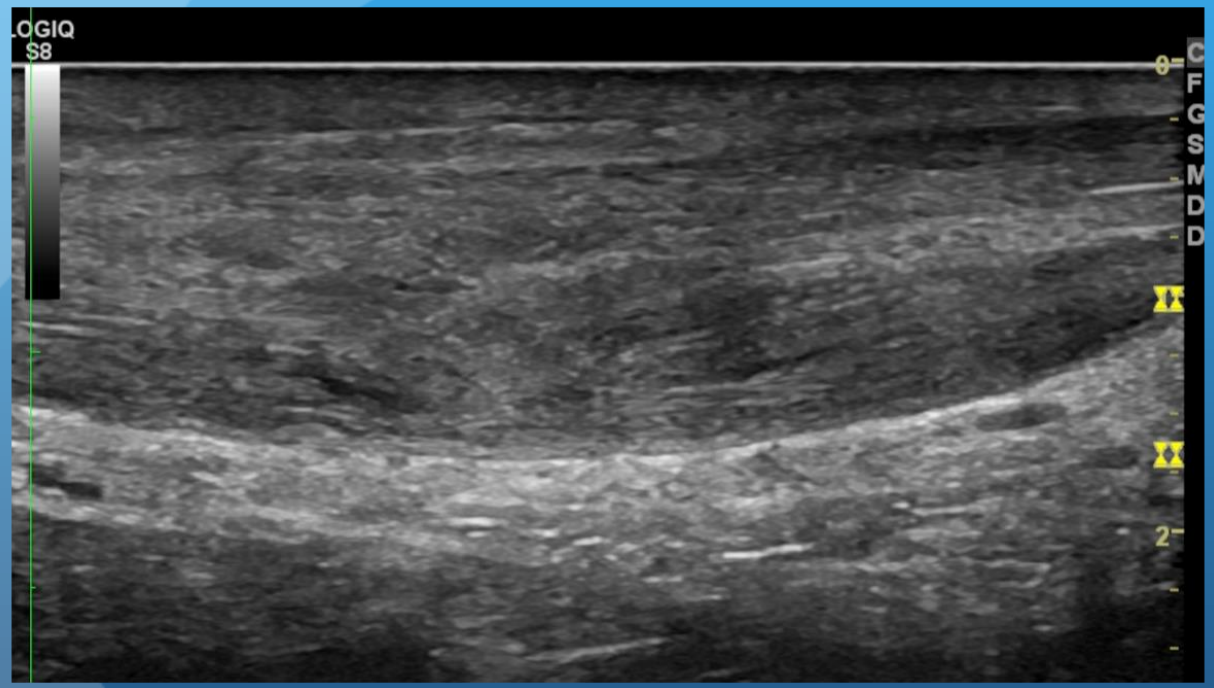
Rt Achilles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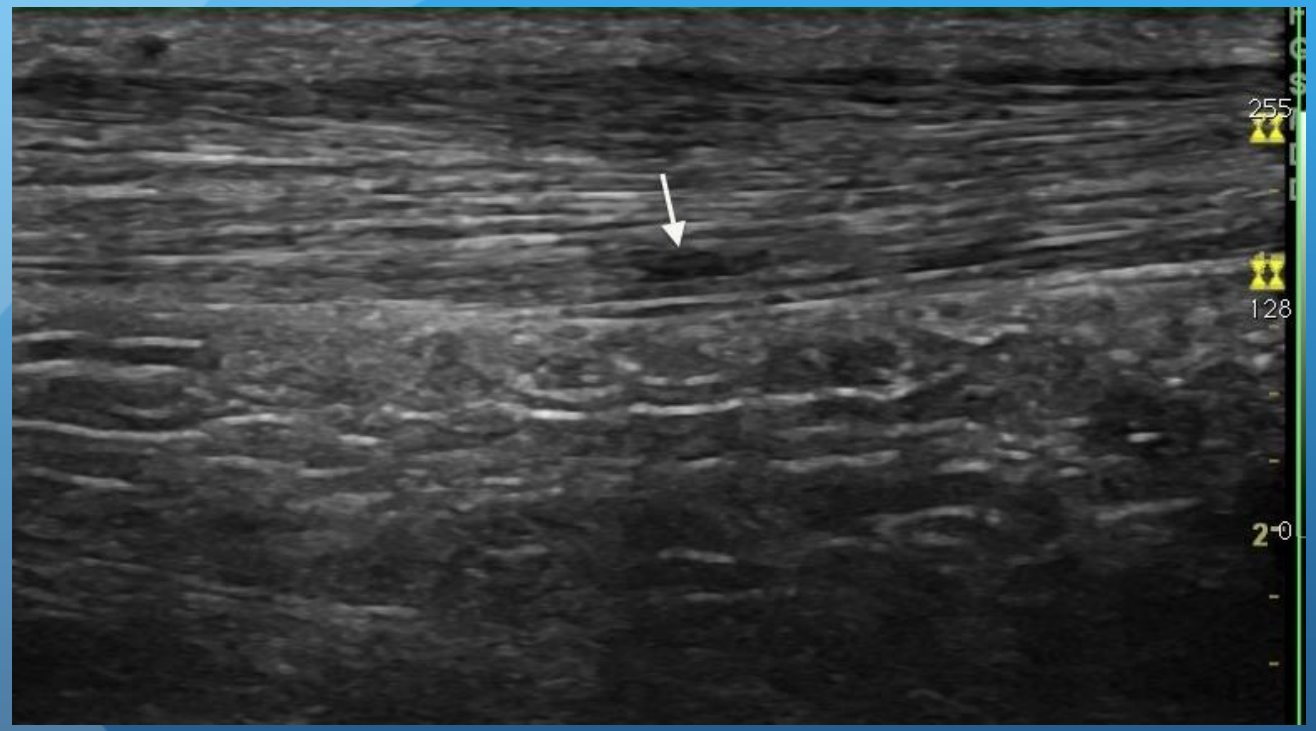
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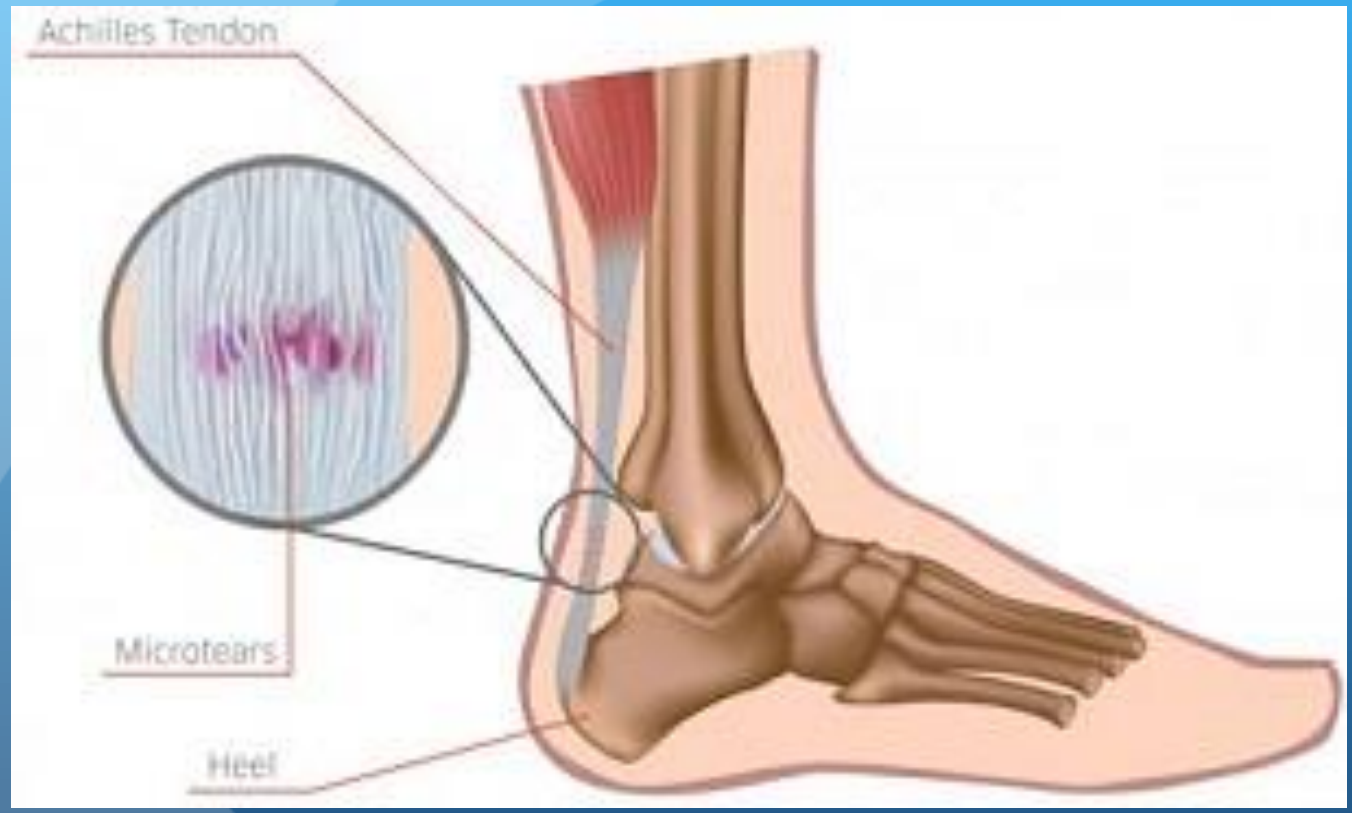
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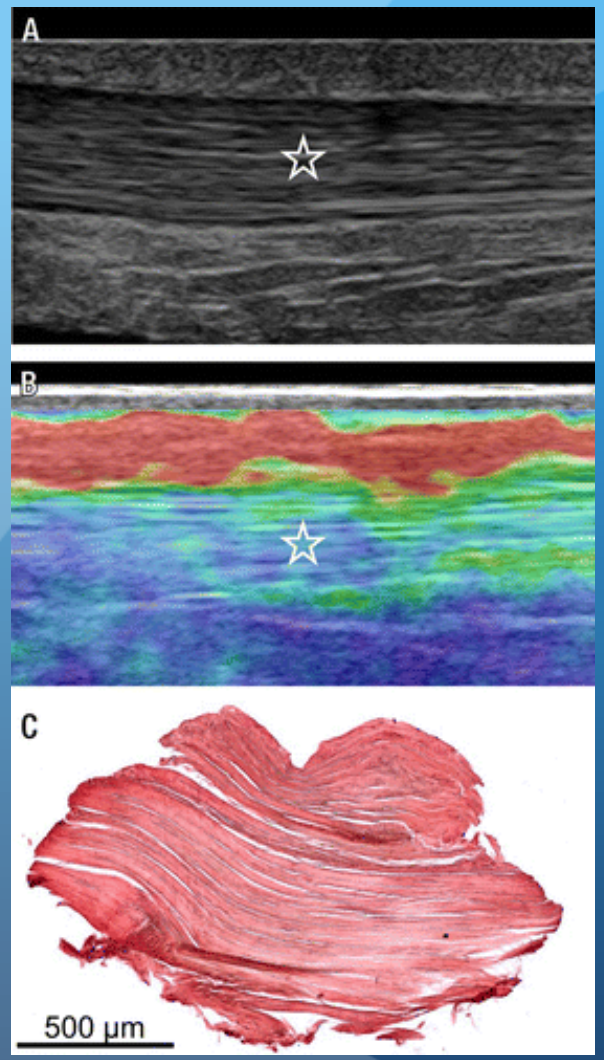

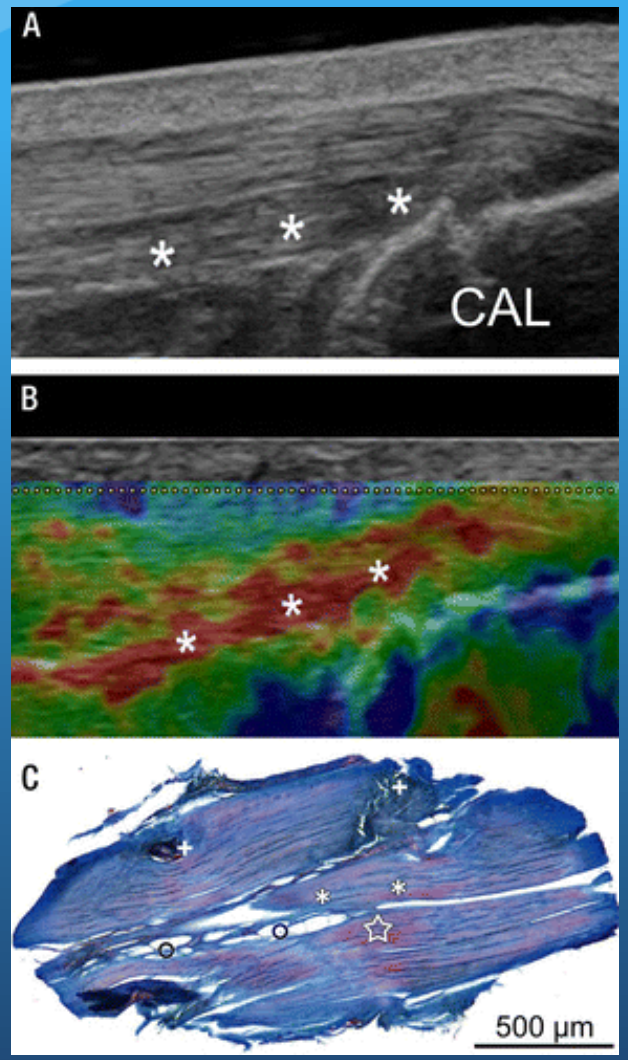

Klauser et al Radiol 267:3; June 2013

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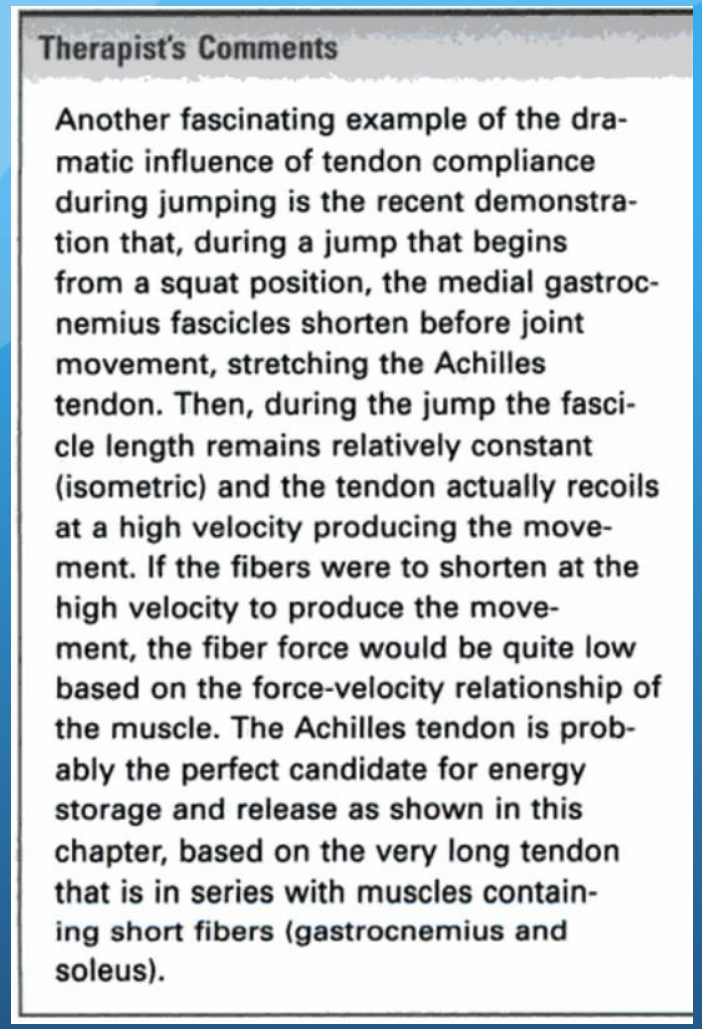

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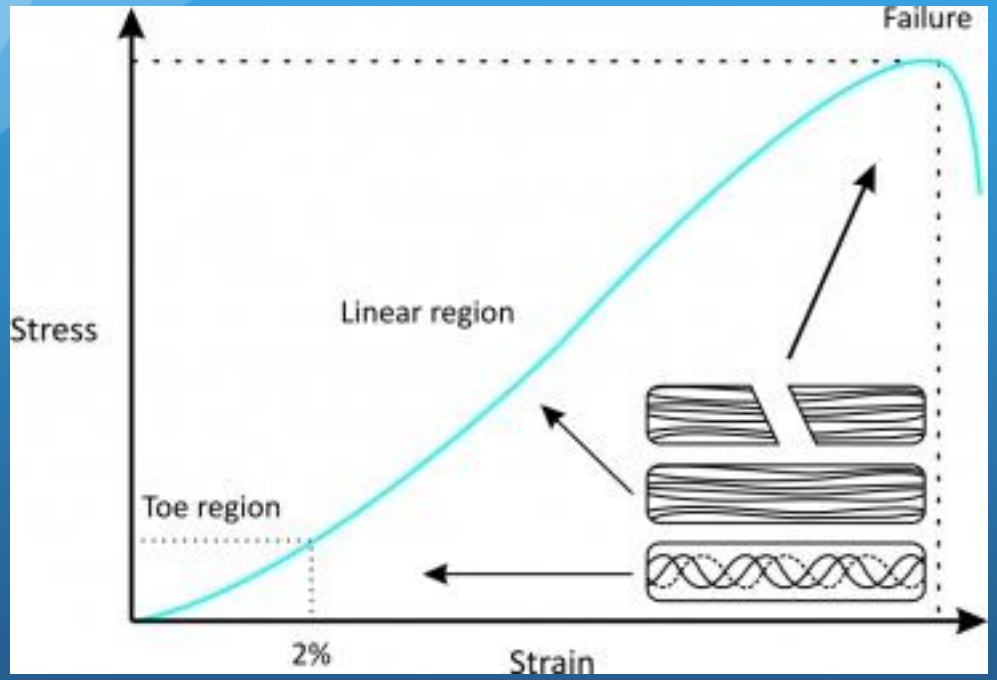
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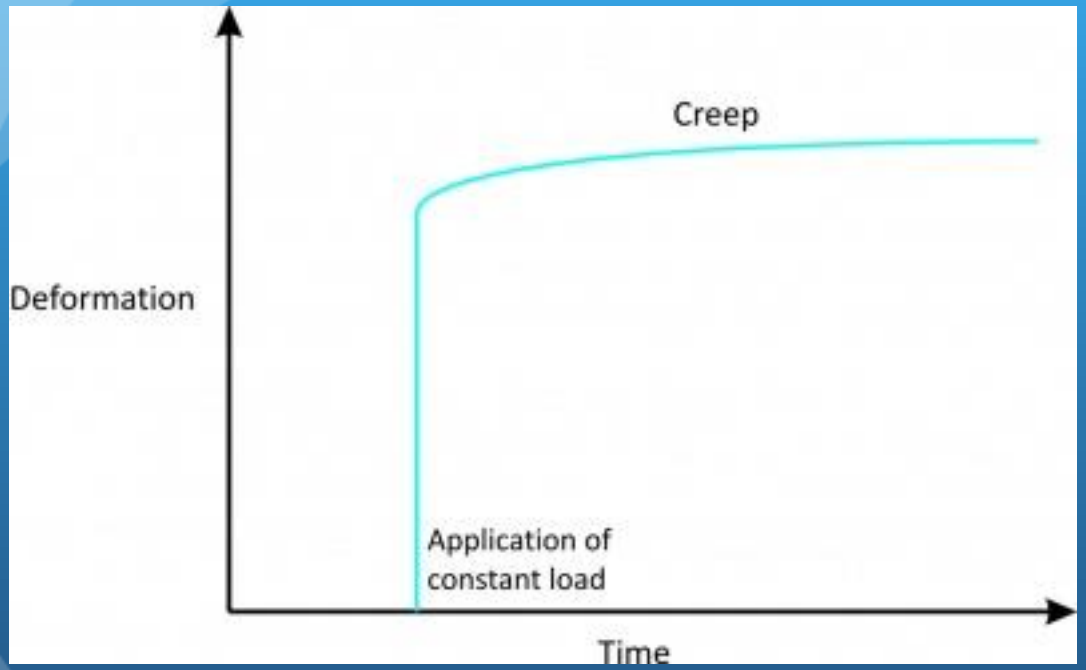
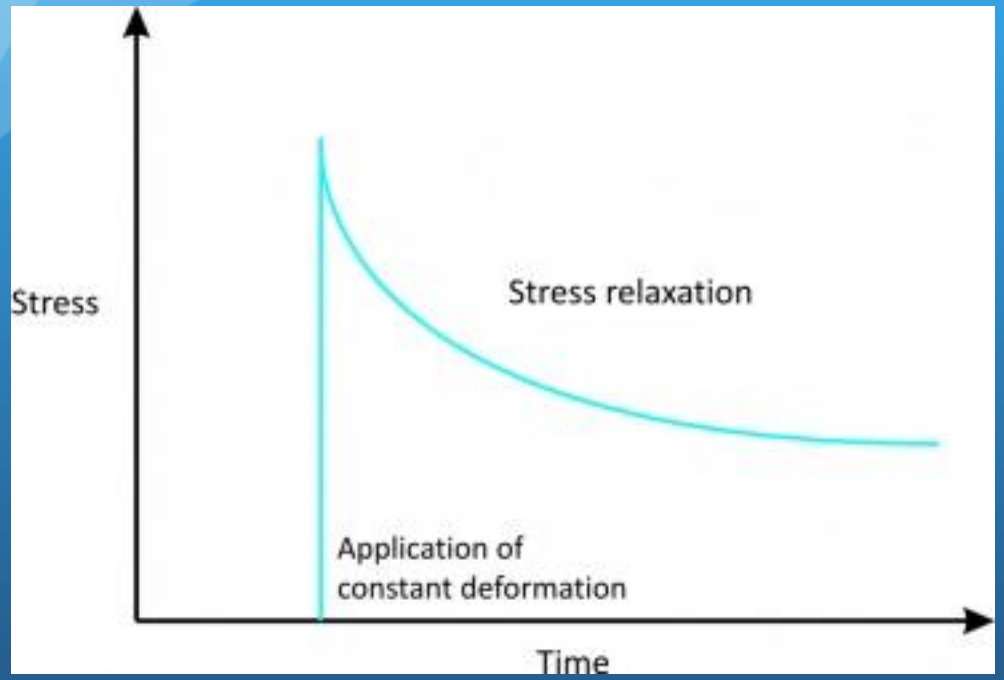
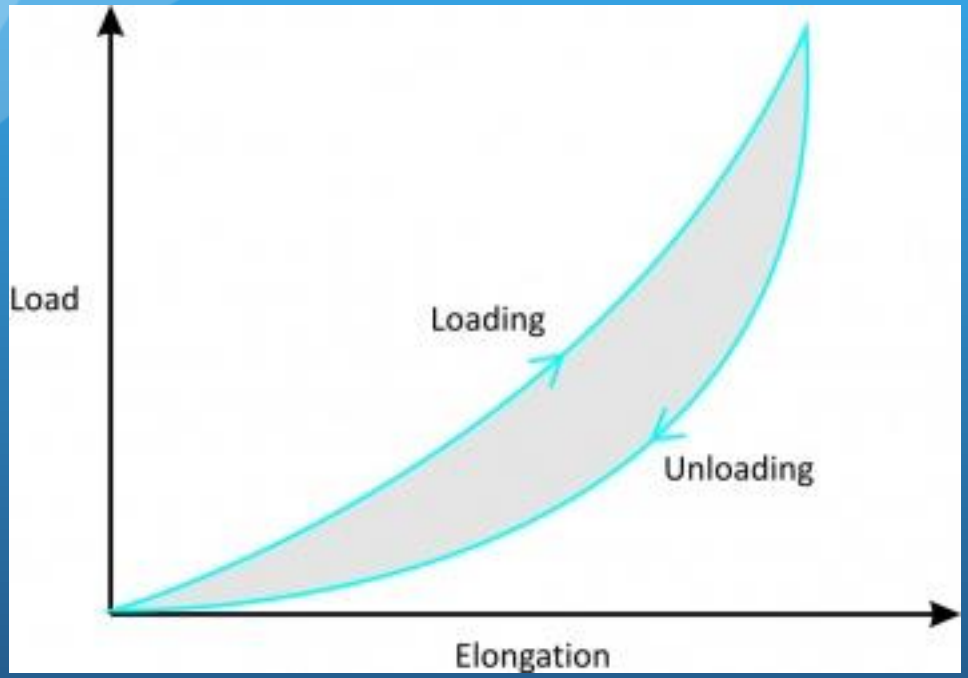
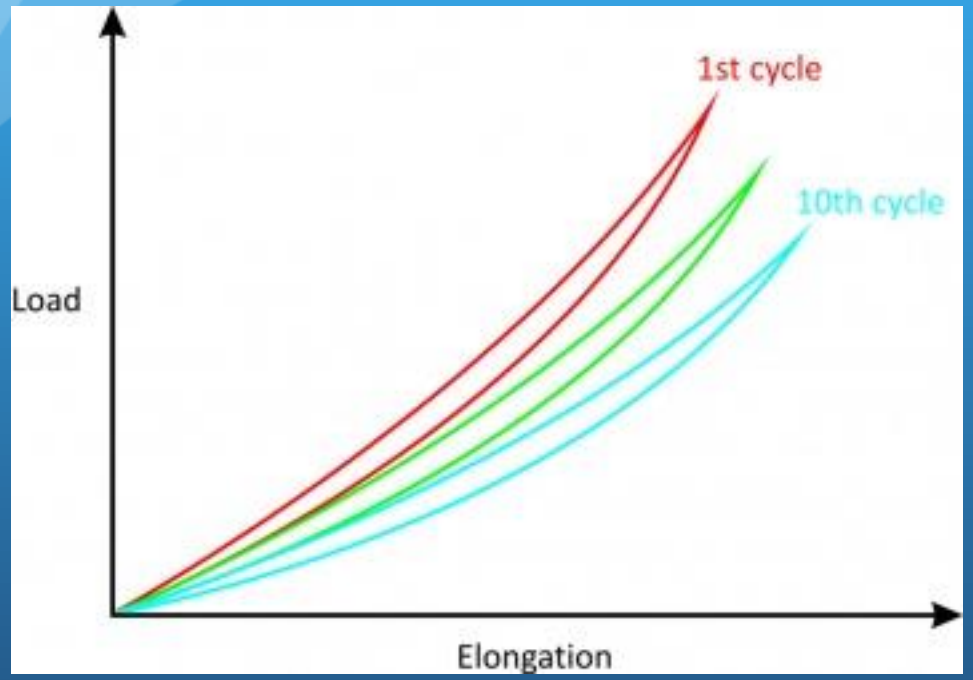
Viscoelasticity

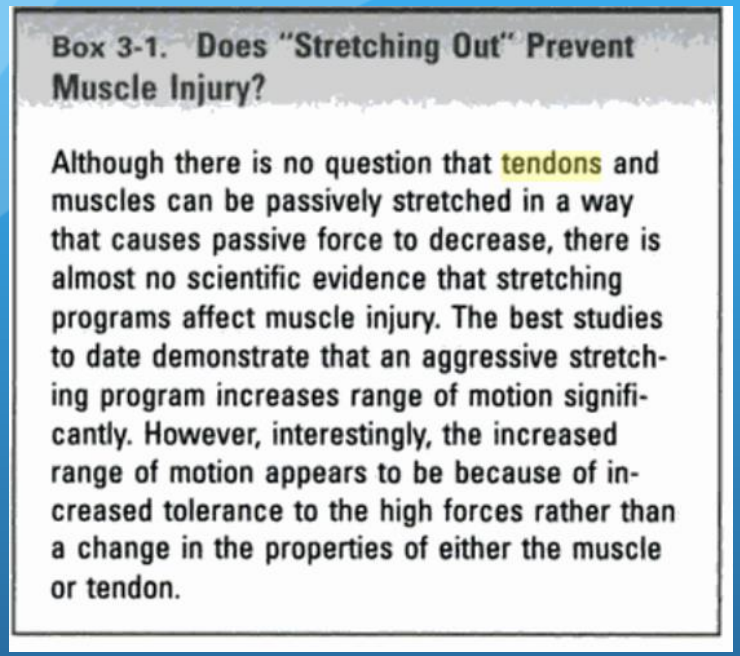



Stress
Stress relaxation
Application of
constant deformation
Time



Hysteresis Curve


1st cycle
10th cycle
Load
Elongation



Box 3-1. Does "Stretching Out" Prevent Muscle Injury?

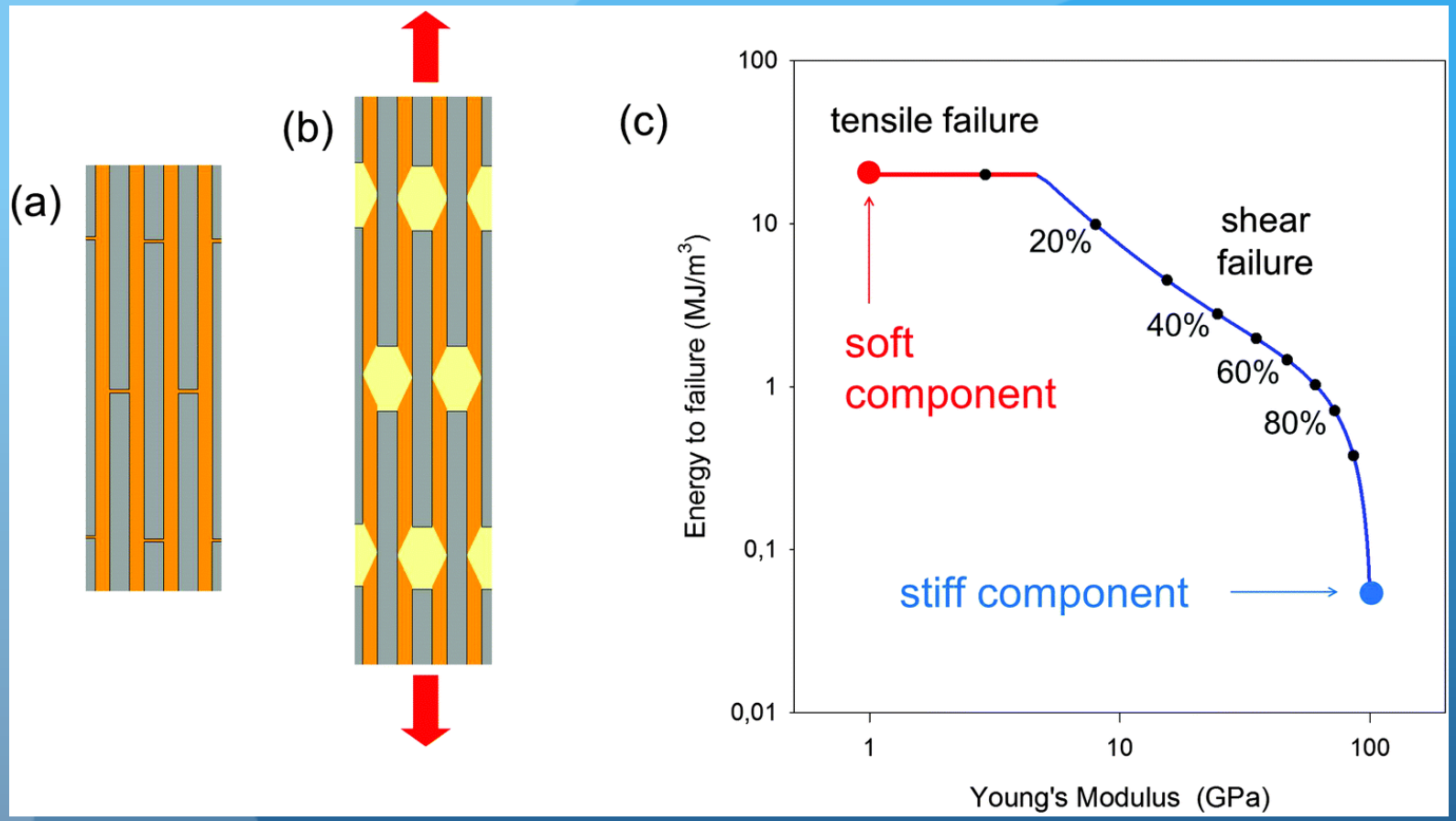
Although there is no question that tendons and muscles can be passively stretched in a way that causes passive force to decrease, there is almost no scientific evidence that stretching programs affect muscle injury. The best studies to date demonstrate that an aggressive stretching program increases range of motion significantly. However, interestingly, the increased range of motion appears to be because of increased tolerance to the high forces rather than a change in the properties of either the muscle or tendon.

Skeletal Muscle Structure, Function and Plasticity
Richard Lieber
Wolters Kluwer 2002

Stiffness of tendons reduces with age

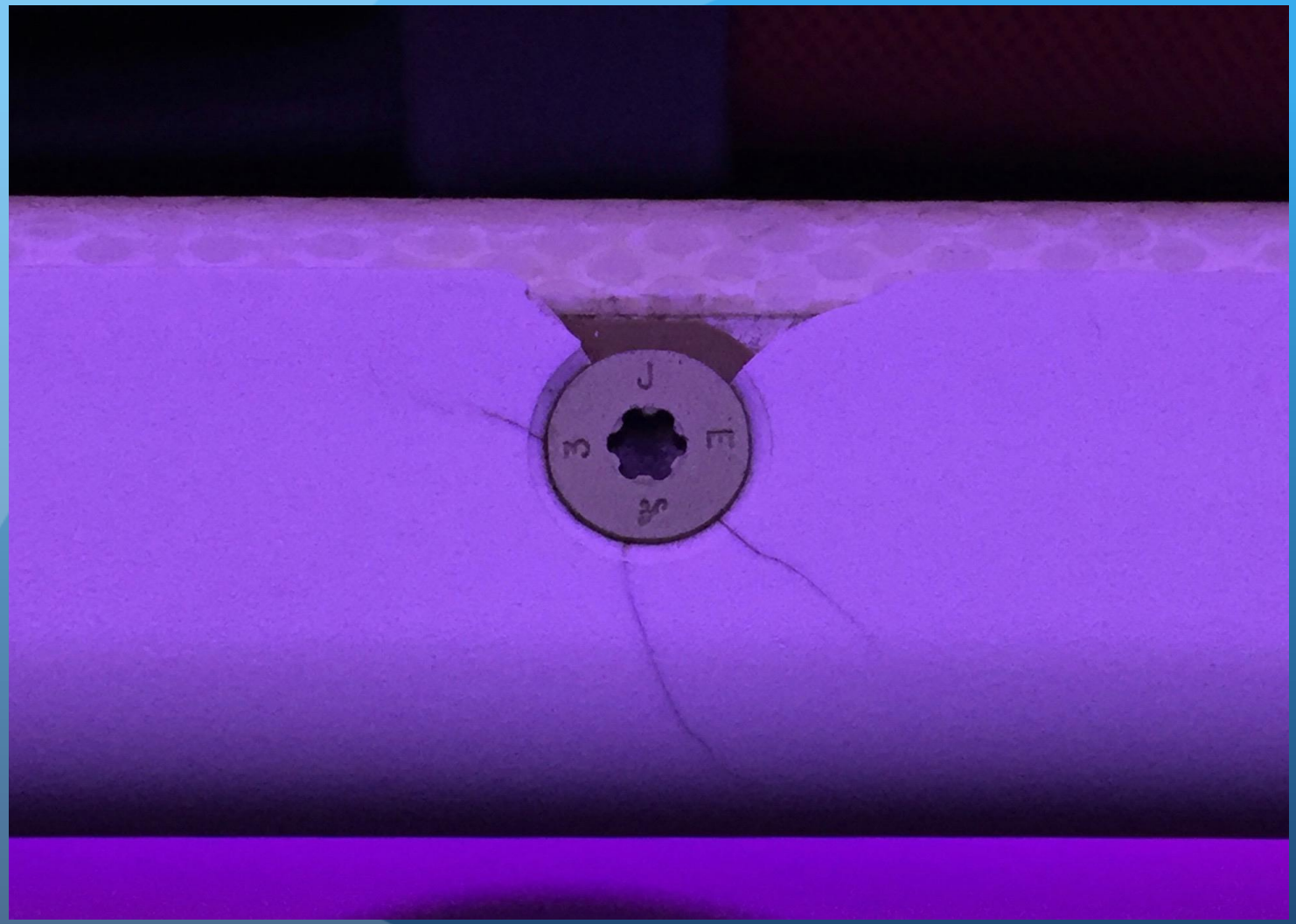
Does this predispose to injury?

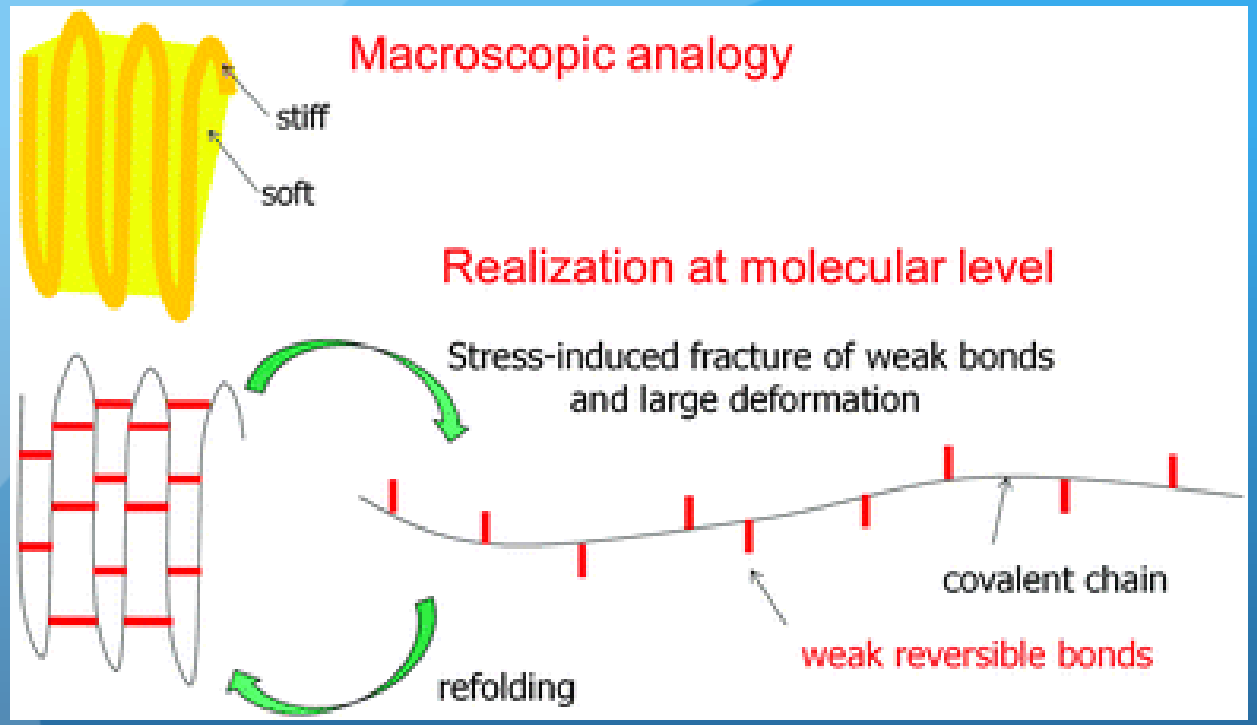
Either
1. repetitive injury
2. instantaneous failure
3. vibration/impaction



The mechanics of tessellations – bioinspired strategies for fracture resistance
Peter Fratzl,*a Otmar Kolednik,b F. Dieter Fischerc and Mason N. Deana

Chem. Soc. Rev., 2016, 45, 252


J
E
C



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Chem. Soc. Rev., 2016, 45, 252

(2) On a smaller but still large scale, the tendon is modular, composed of protofibrils (10–15 nm) which, in unstressed tendon, follow a helical path along the axis of the fibril (Scott, 1990). Part of the extension of the tendon fibre under stress may be due to the straightening of this helix (Castellani et al. 1983), as in the straightening of a spring. This could account for reversible extension in the linear region of the stress–strain curve. It is relevant that sometimes there is axially oriented PG between the protofibrils (Scott, 1990), which could act as both lubricant and elastic deformation space to facilitate movement among the protofibrils. When helical straightening is complete, further extension may entail damage to the tendon.

Both mechanisms 1 and 2 would give thinner fibrils under tensile stress, as was observed.

Tendon Response to Tensile Stress:
An Ultrstructural Investigation of collagen:
Proteoglycan interactions in stressed tendon

Cribb and Scott
J. Anat. (1995) 187, 423-428

What might predispose to injury?

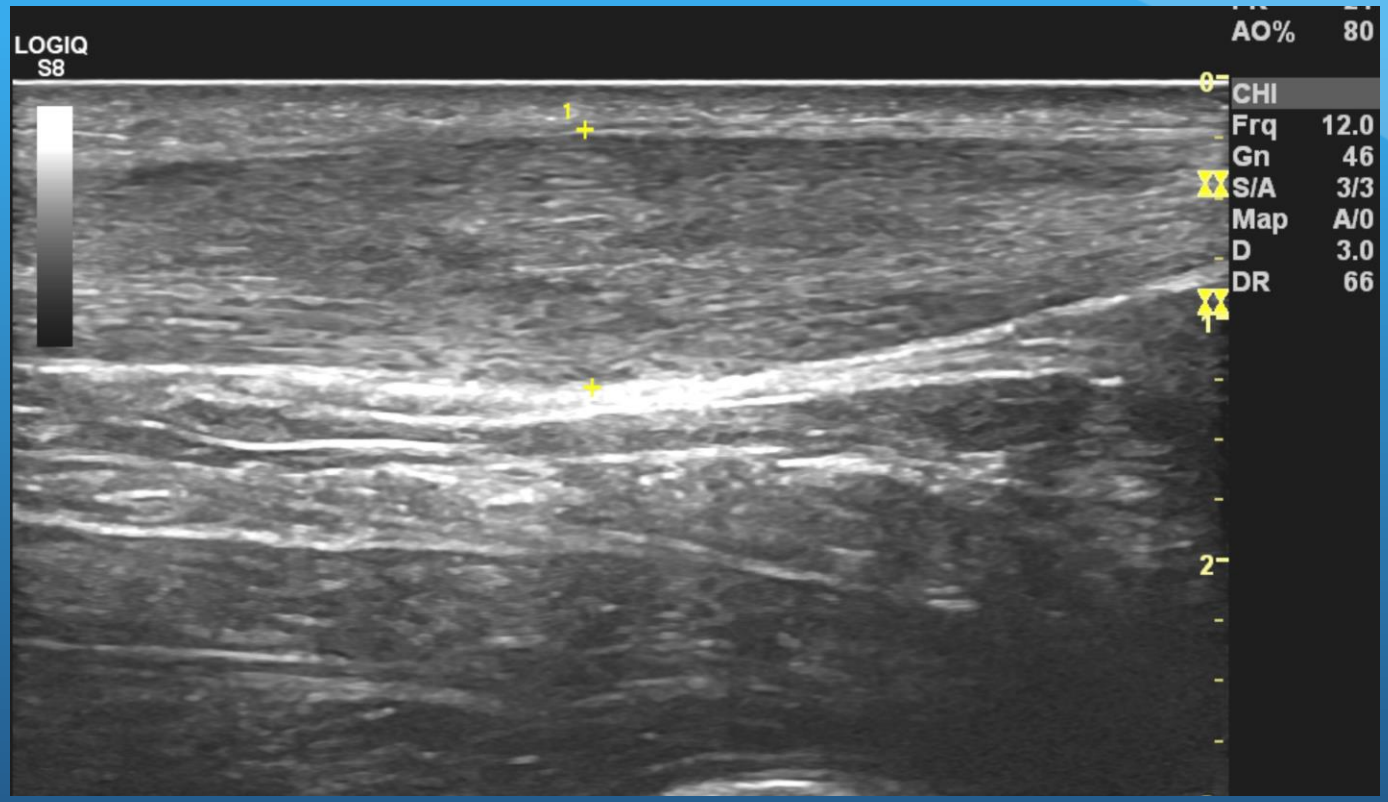
OVERUSE?

Over stretching?

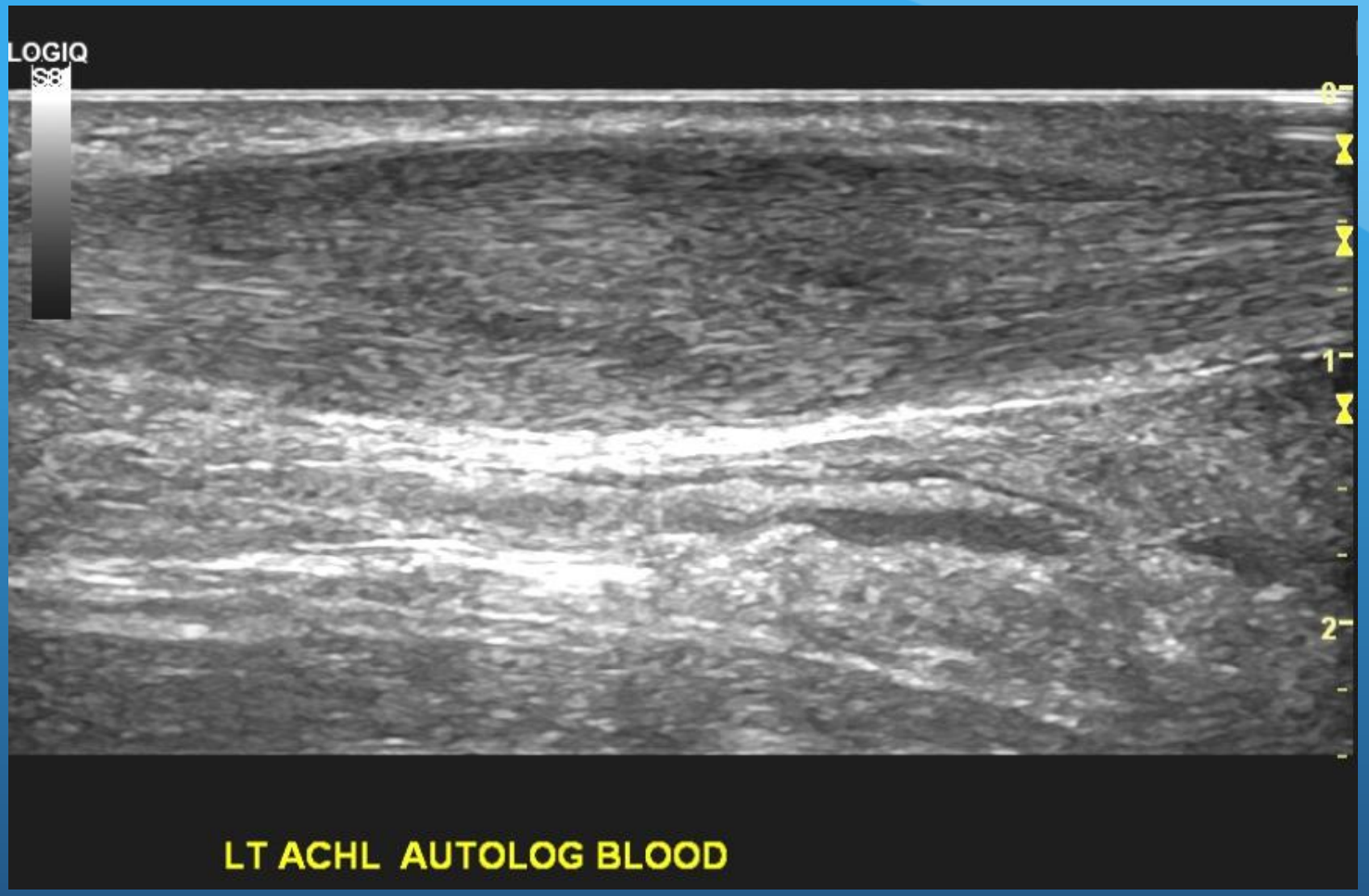
Short tendon?

Overweight?

IMPACT

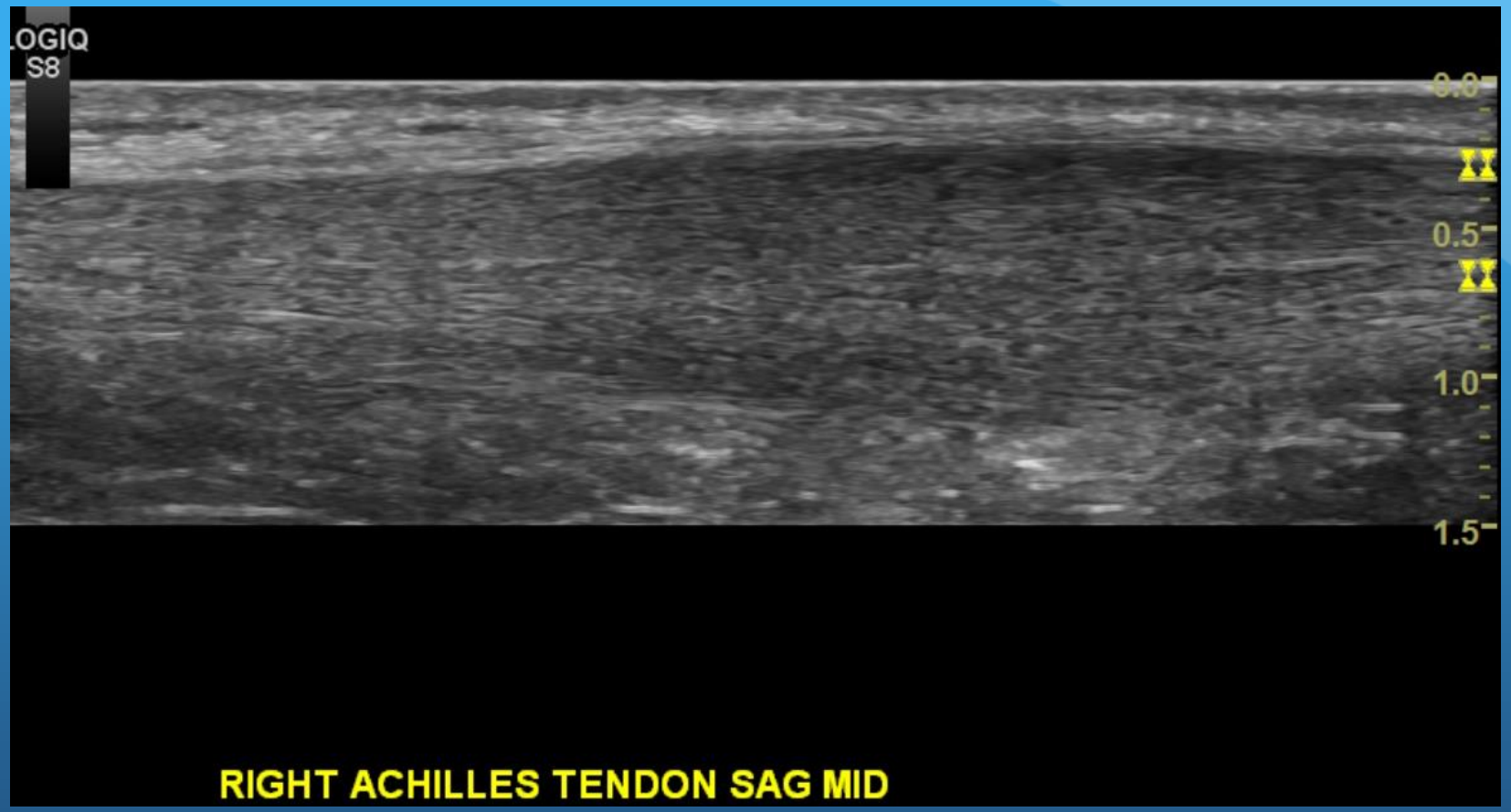


Achilles Tears Pre ABI , Pt A

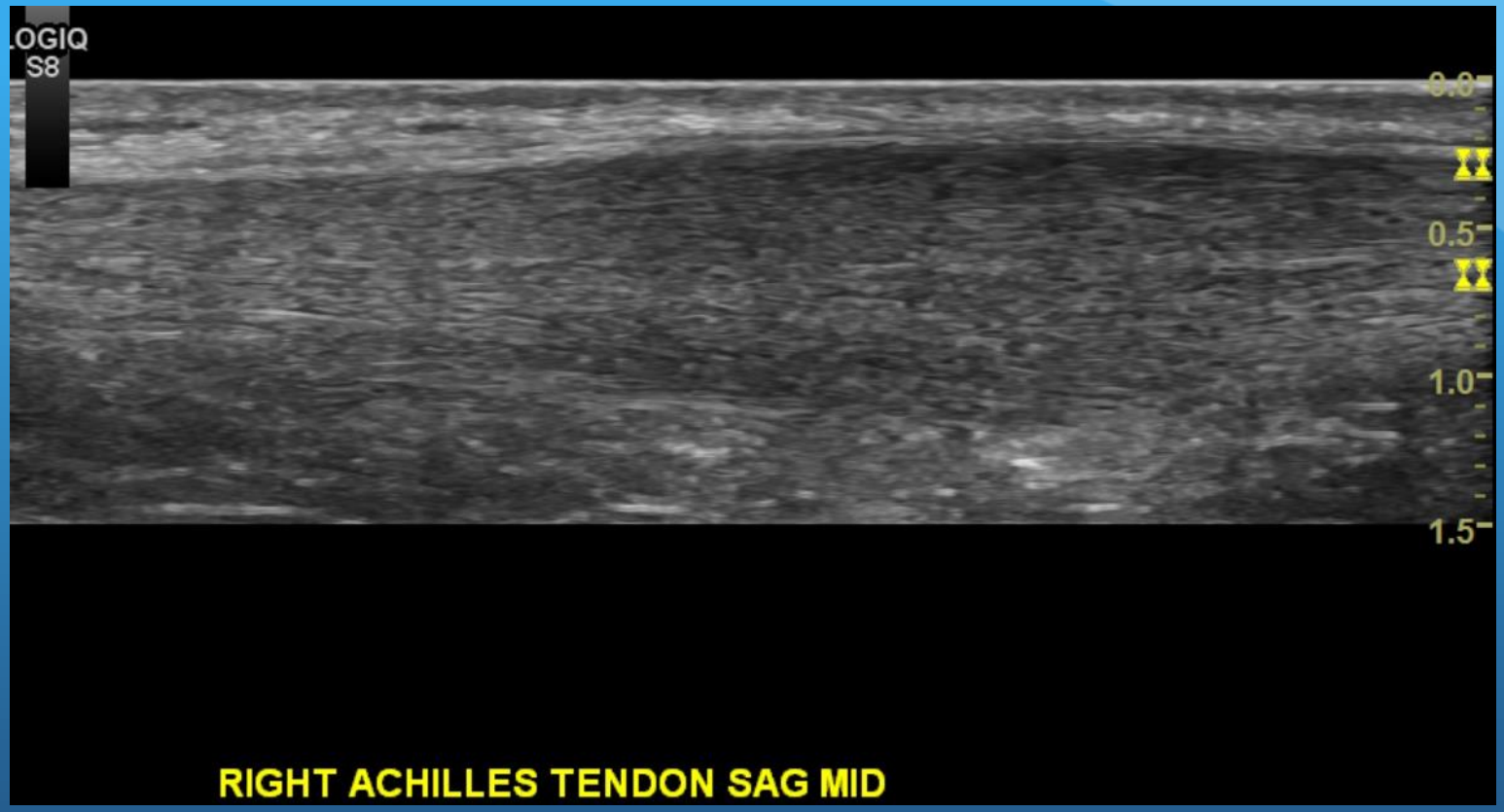


Pt A Post ABI Immed

Pt A post ABI 1 M



Post ABI 1 Yr



Post ABI 24 M Pt A

THANK YOU FOR YOUR ATTENTION