Measuring saropenia

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Disclosure

There are no relevant financial relations interfering with this presentation.

Objective of today

In a glance

Overview of current sarcopenia screening

In two glances

Overview of where and why ultrasound can be of help herein

Keep it simple and logical

Content

- Introduction
- Screening
- Muscle mass
- Ultrasound
- Future
- Take home messages

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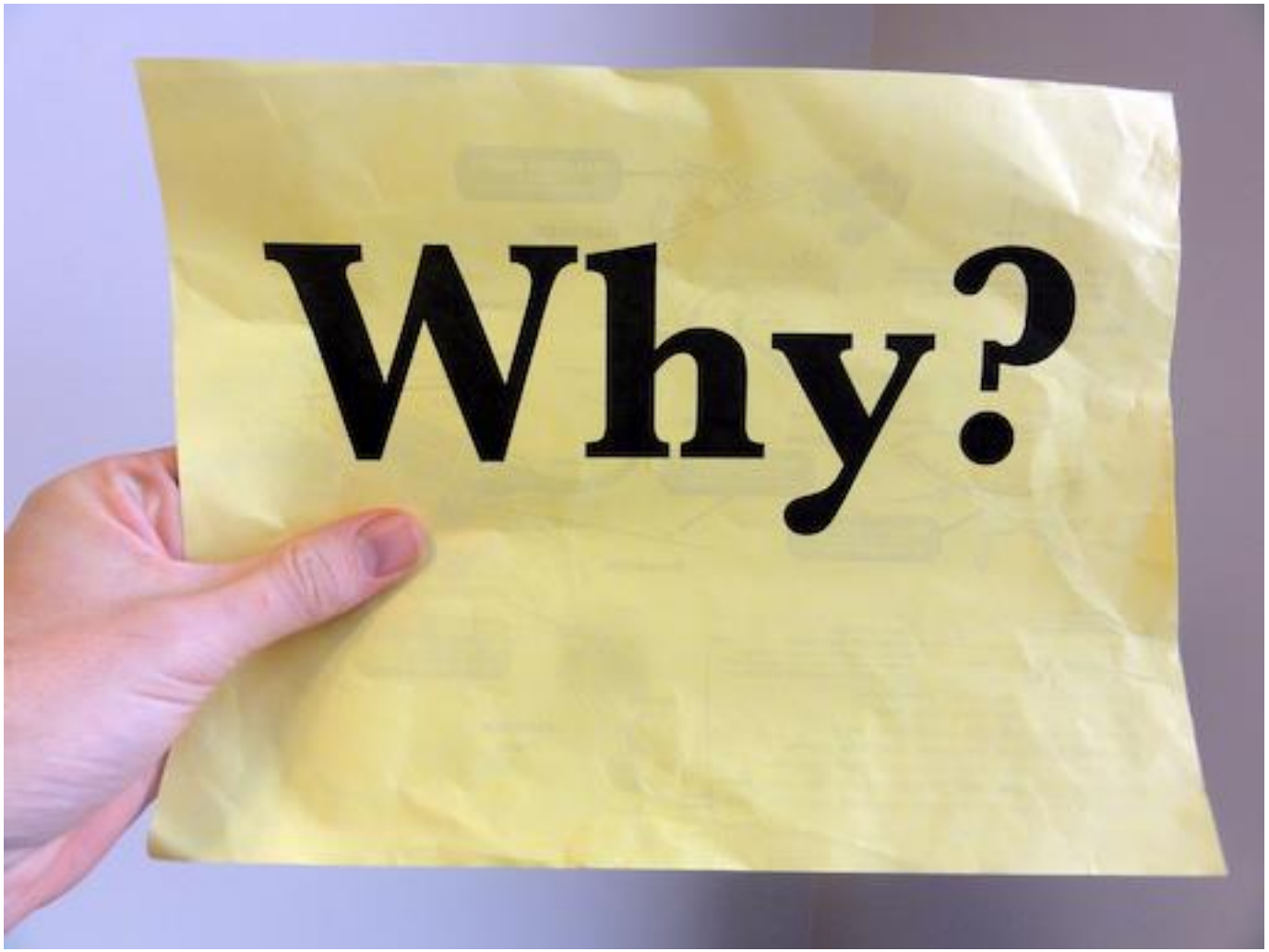
Screening for sarcopenia?



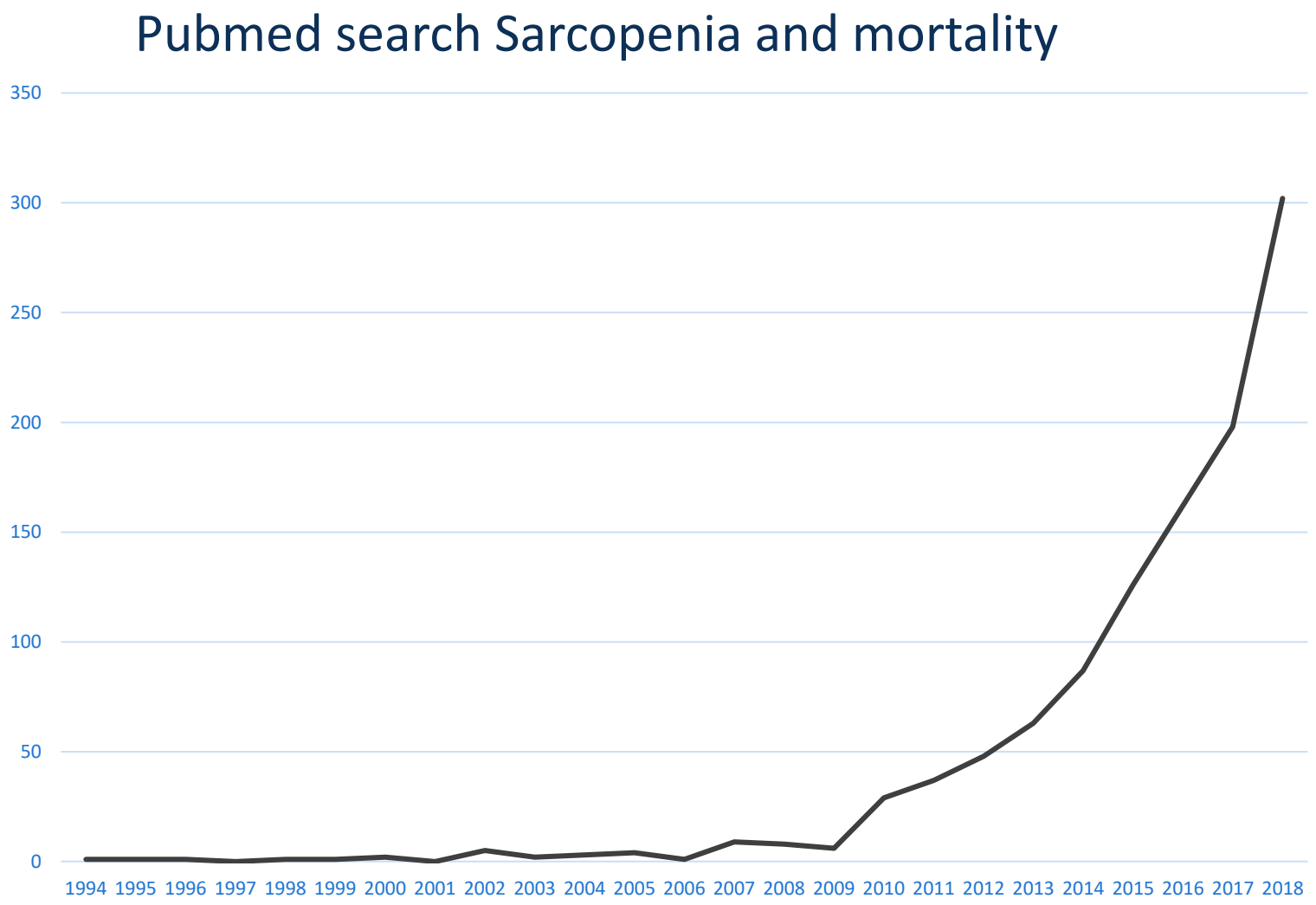
Screening for sarcopenia

Why would we want to screen?

What would we want to screen?

How will we do the screening?

Why screening?



Sarcopenia: why screening?

Mortality	OR	3.60
Functional decline	OR	3.03
Falls	HR	3.45
Fractures (men)	HR	3.79
Fractures (women)	HR	2.27
Length of hospital stay	OR	1.84
Hospitalization	OR	1.57

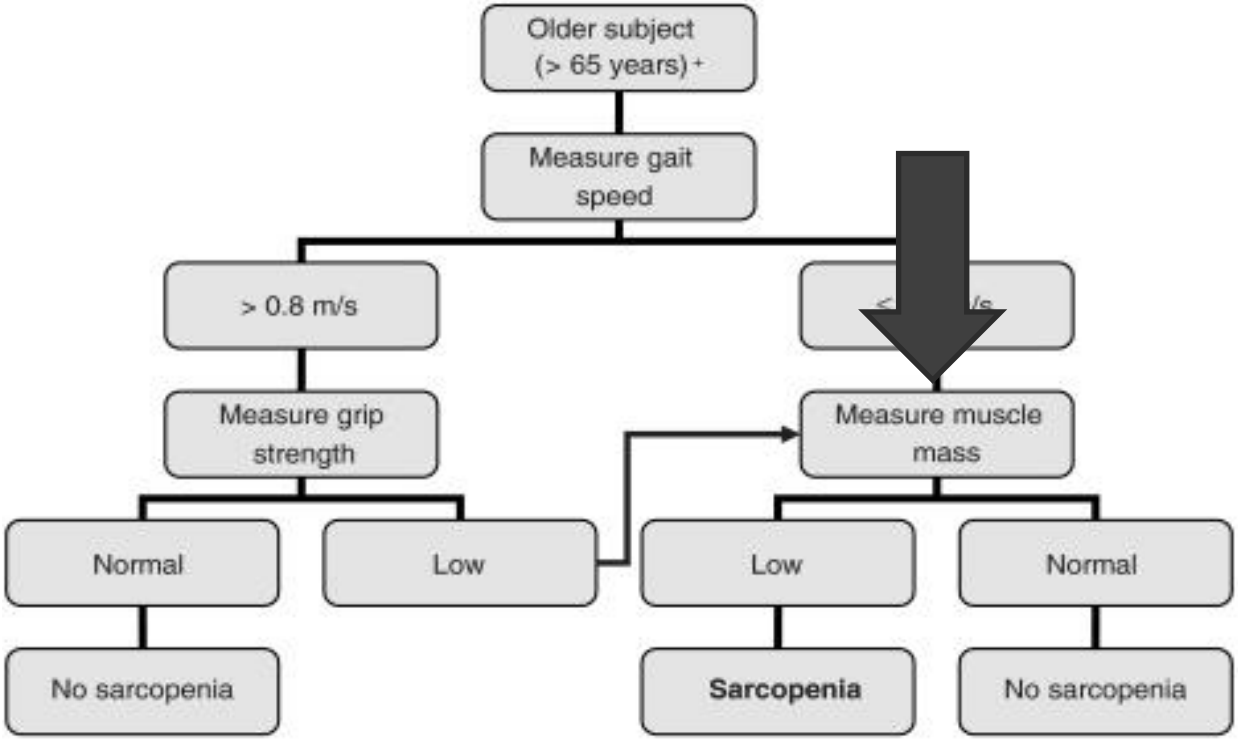
Beaudart C, Zaaria M, Pasleau F, Reginster J-Y, Bruyère O (2017) Health Outcomes of Sarcopenia: A Systematic Review and Meta-Analysis. PLoS ONE 12(1): e0169548.

What to screen in 2010?

EWGSOP Working Definition of Sarcopenia

Stage	Muscle mass	Muscle strength	Performance
Presarcopenia	↓		
Sarcopenia	↓	↓	Or ↓
Severe sarcopenia	↓	↓	↓

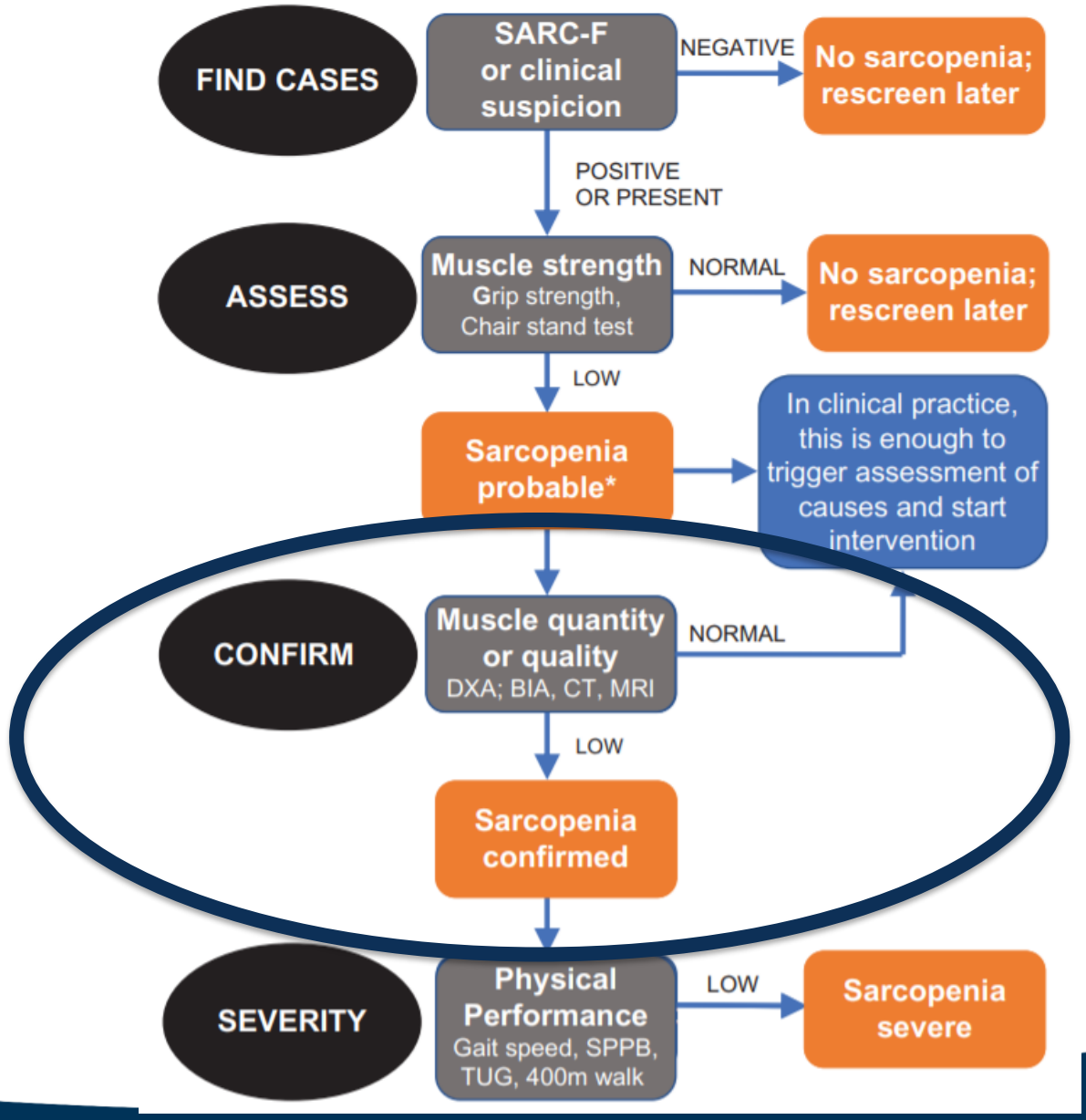
What to screen in 2010?



Cruz-Jentoft AJ et al. Sarcopenia: European consensus on definition and diagnosis. Report of the European Working Group on Sarcopenia in Older People. Age Ageing 2010

What to screen in 2018?

Sarcopenia: revised European consensus on definition and diagnosis



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Muscle mass

Largest organ of the body - 40% bodyweight

Largest protein reservoir

Muscle mass and quality

- regarded as biomarkers
- patient's physiologic reserves

Muscle assessment

Simplified current muscle assessment

	Quantity	Quality	Availability	Standardization	Reference values
DEXA	+	-	+/-	+	+
BIA	+	-	+/-	+	+/-
CT	+	+	+	-	-
MRI	+	+	+/--	-	-
Ultrasound	+	+	+	+/-	-

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- Ultrasound
  - Advantages
  - What is there to measure

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Ultrasound: advantages

Cheap

fast

easy

- Low cost/maintenance
- Quickness of execution, no preparation time
- Easy to use, availability at bedside

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Ultrasound: what can we measure?

Regional assessment of muscle quantity (size/mass) and quality (echo intensity)

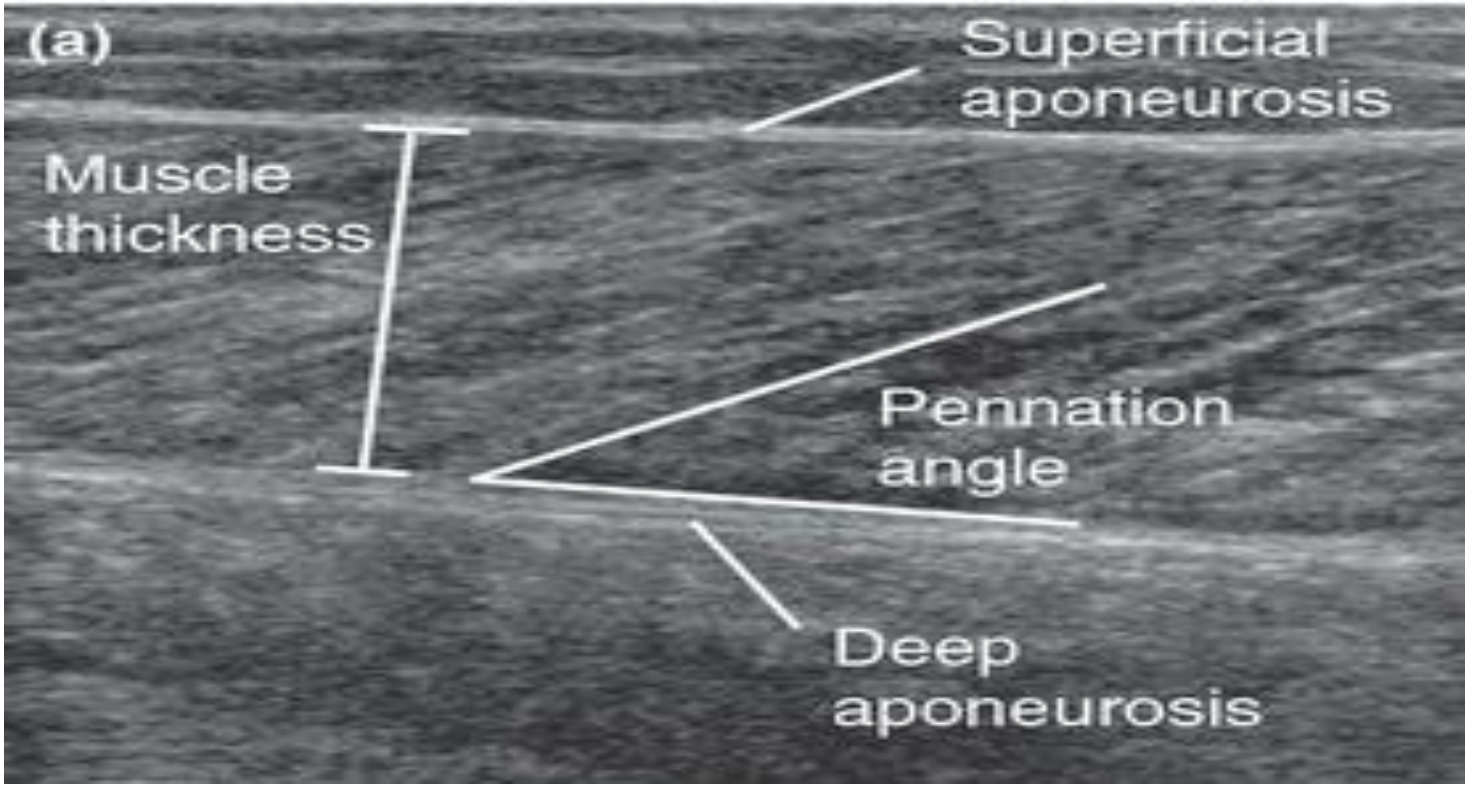
Five main parameters + 1 extra

- Muscle thickness
- Muscle cross-sectional area
- Fascicle length
- Pennation angle
- Echo-intensity

+

- Muscle stiffness

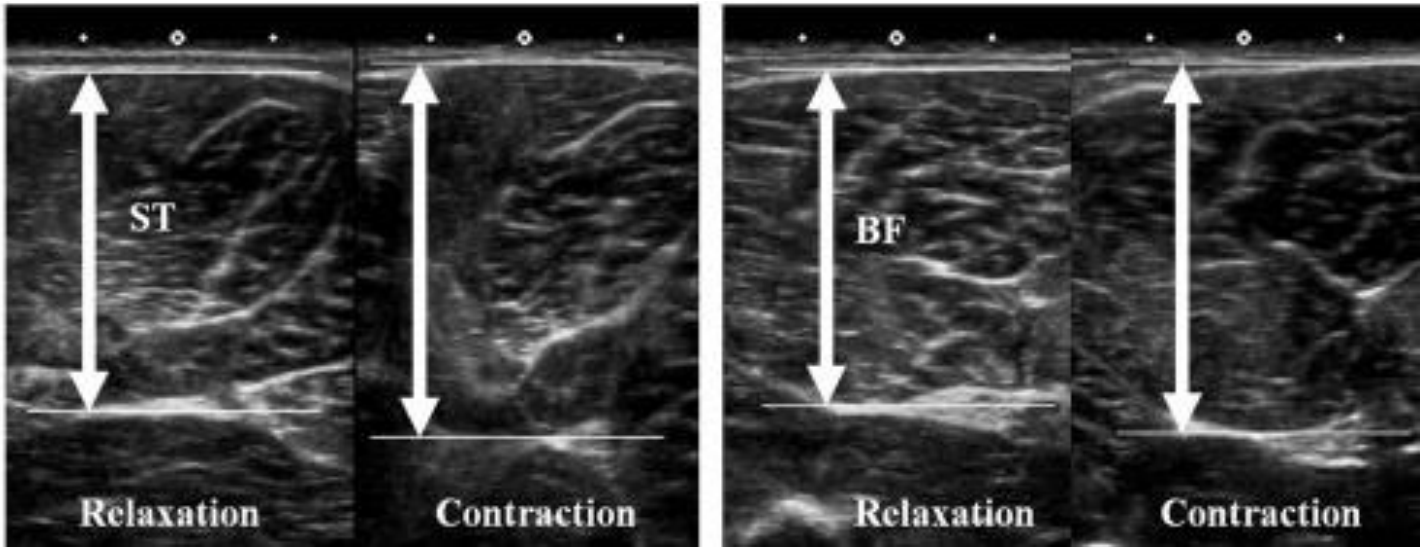
Muscle thickness



Muscle thickness

- Muscle thickness is highly correlated with maximum voluntary contraction force
- Total skeletal muscle may be estimated using muscle thickness, with a strong correlation with both MRI and DEXA.
- Changes can be measured after 6 weeks of training

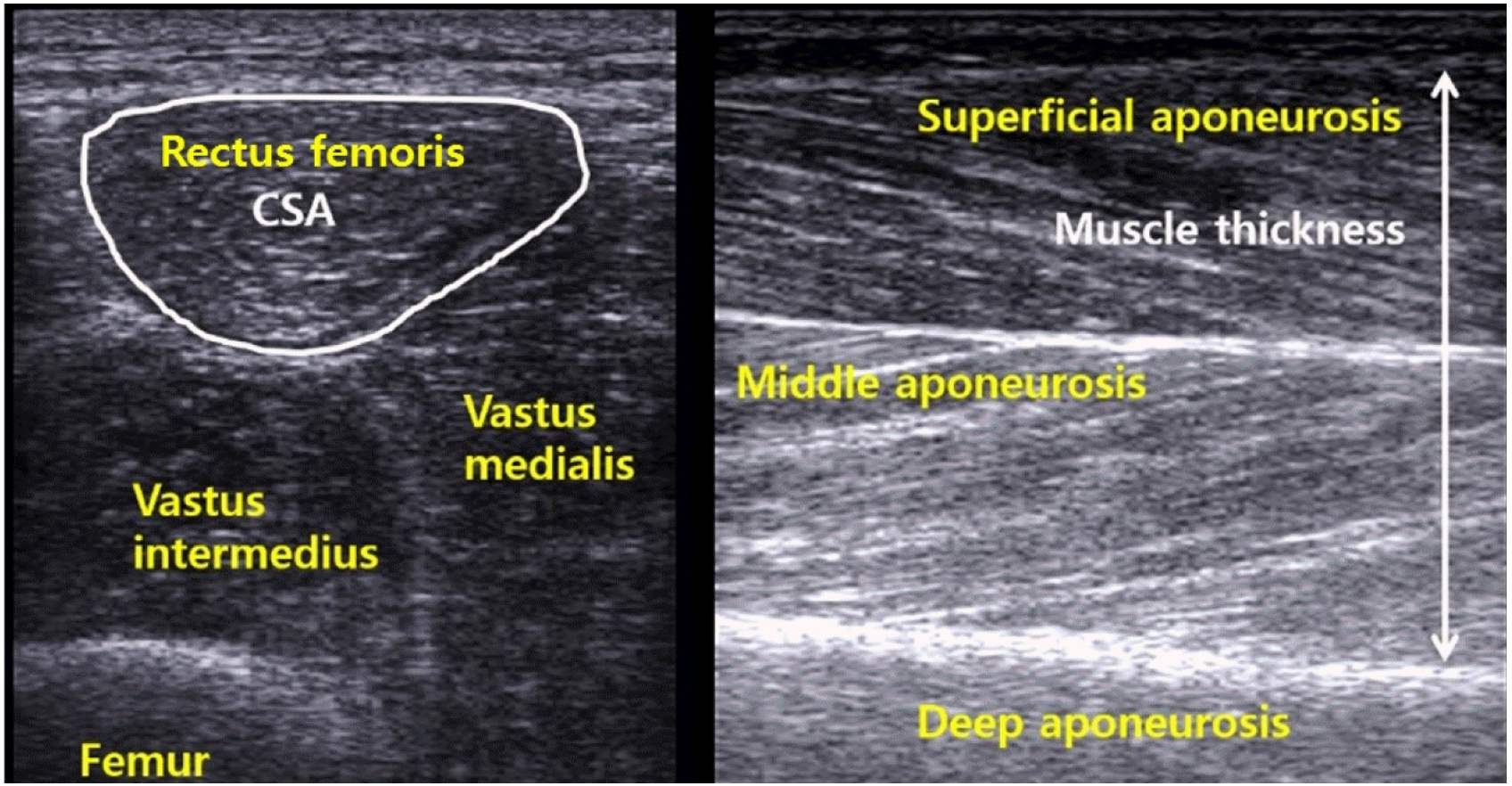
Muscle thickness: pitfall



BF = biceps femoris; ST = semitendinosus

Change in muscle thickness under contracting conditions following return to sports after a hamstring muscle strain injury—A pilot study. Yasuharu Nagano et al.

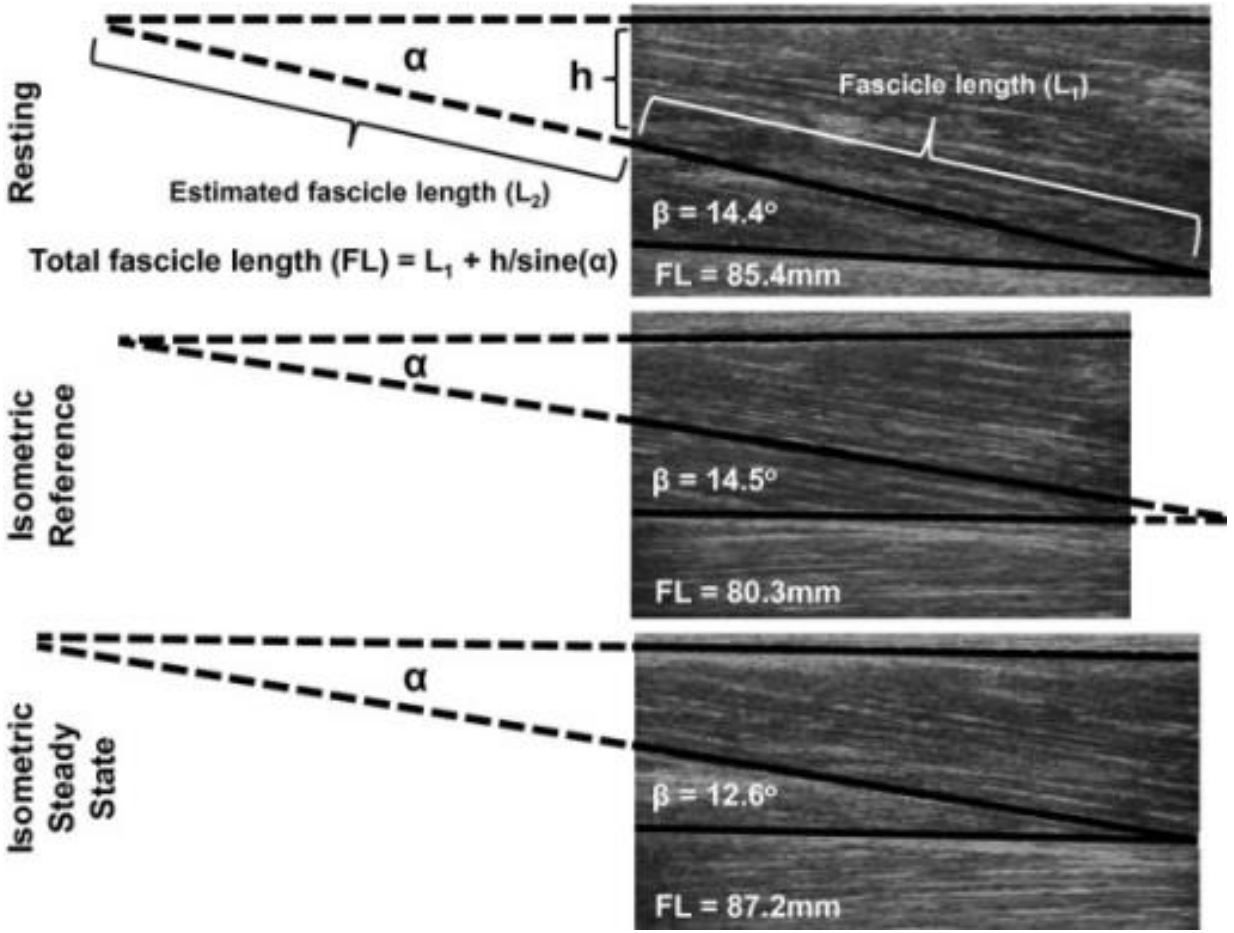
Muscle cross-sectional area



Muscle cross-sectional area

- CSA: inter- and intrareader reliability similar to those for MRI
- Correlated with postoperative complications
- Changes can be measured after 6 weeks of training

Fascicle length

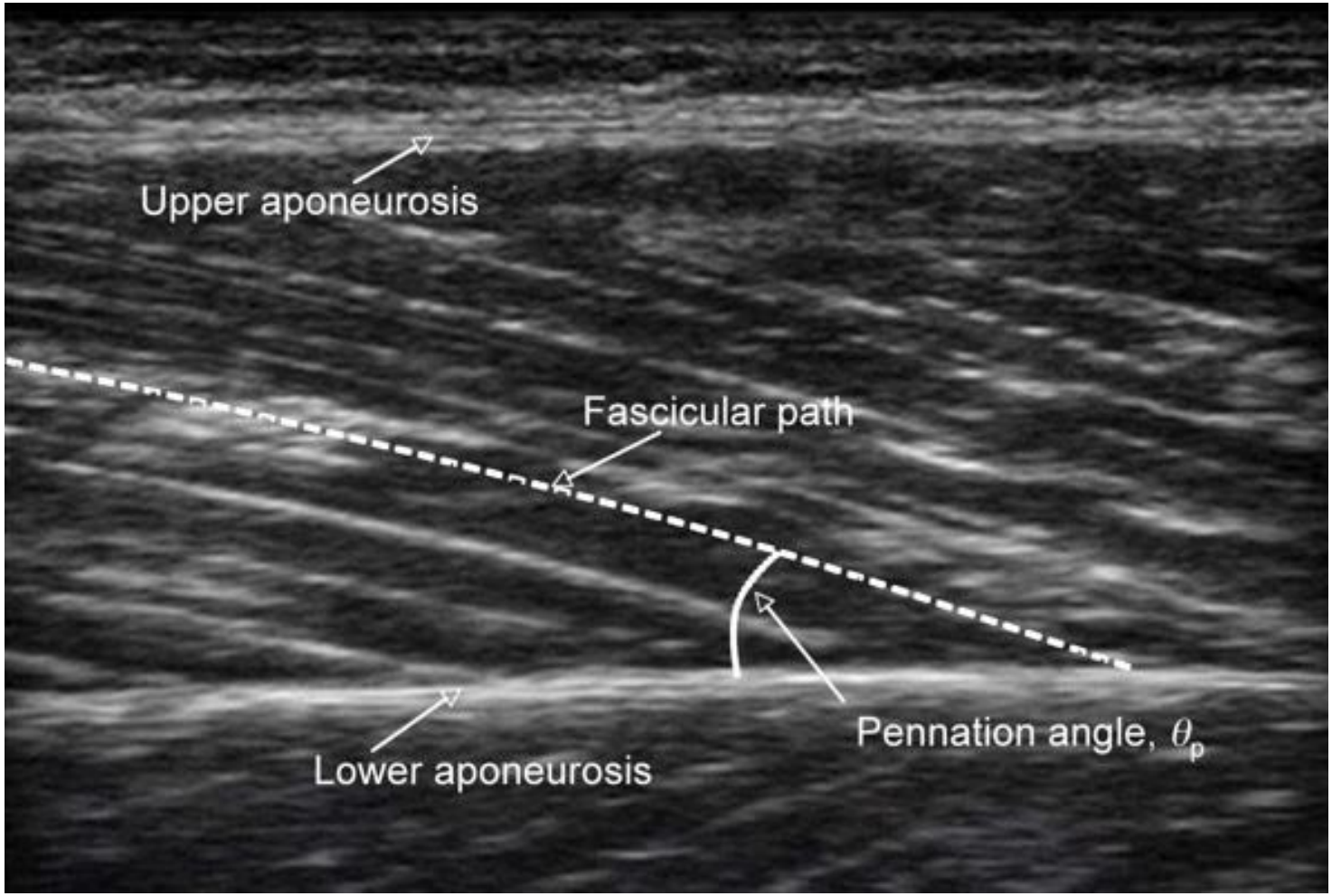


Fascicle length

- Increases with training (sprint versus endurance)
- Contractions can be measured
- Difficult to measure strength of contraction
- Fascicle length affects motor-unit recruitment

Change in Muscle Fascicle Length Influences the Recruitment and Discharge Rate of Motor Units During Isometric Contractions. Pasquet et al.

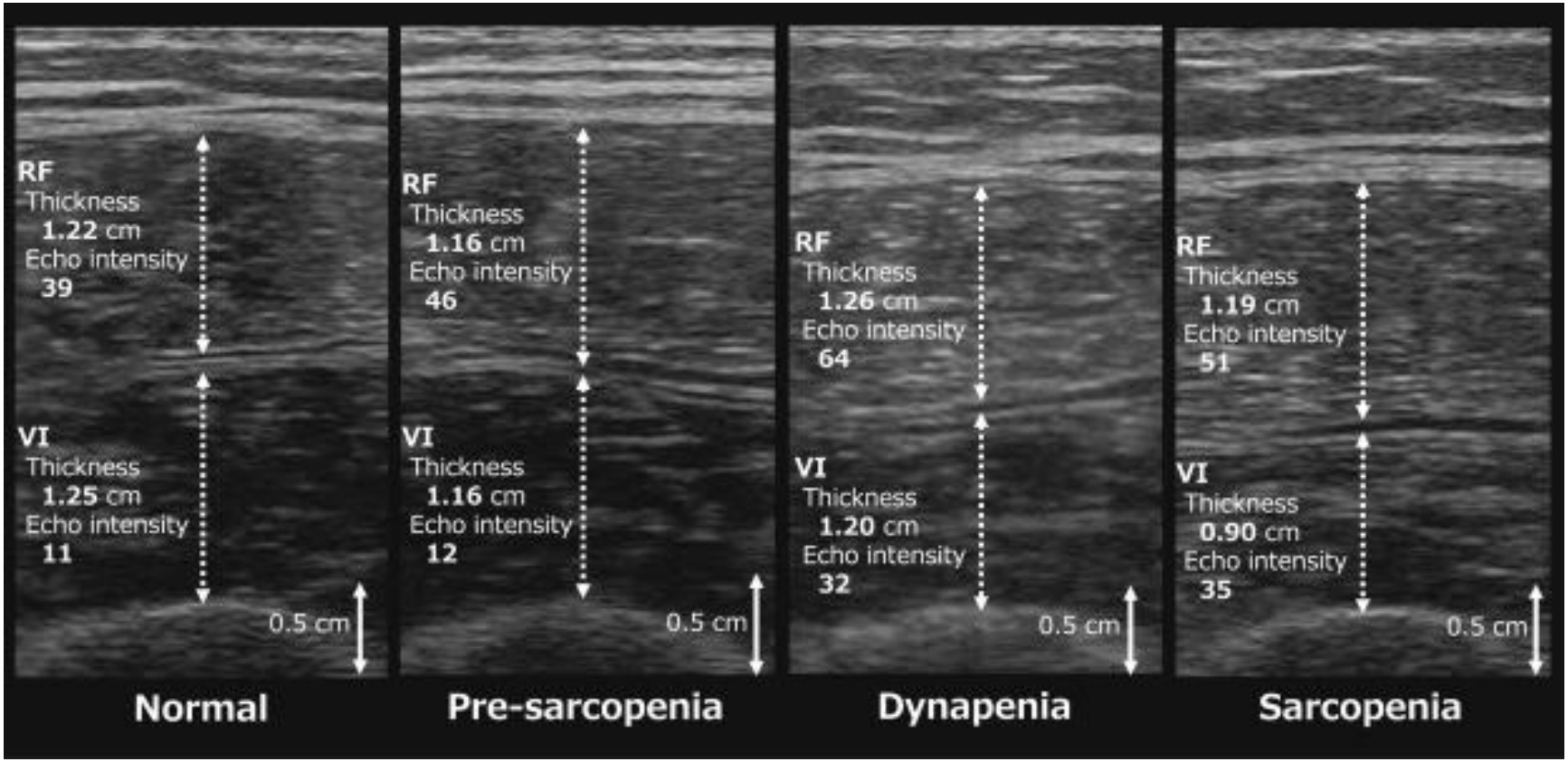
Pennation angle



Pennation angle

- Line of pull of a muscle fiber towards the tendon
- Pennation angle is linked to the force generating potential of a muscle
- Influenced by
  - tendon properties
  - fat infiltration of the muscle
- Is seen in pennate muscles

Echo-intensity



Differential Characteristics of Skeletal Muscle in Community-Dwelling Older Adults. Minoru Y et al. JAMDA September 2017.

Echo-intensity

Quantative gray scale analysis, marker of muscle quality (fat, fibrous)

Negatively correlated with

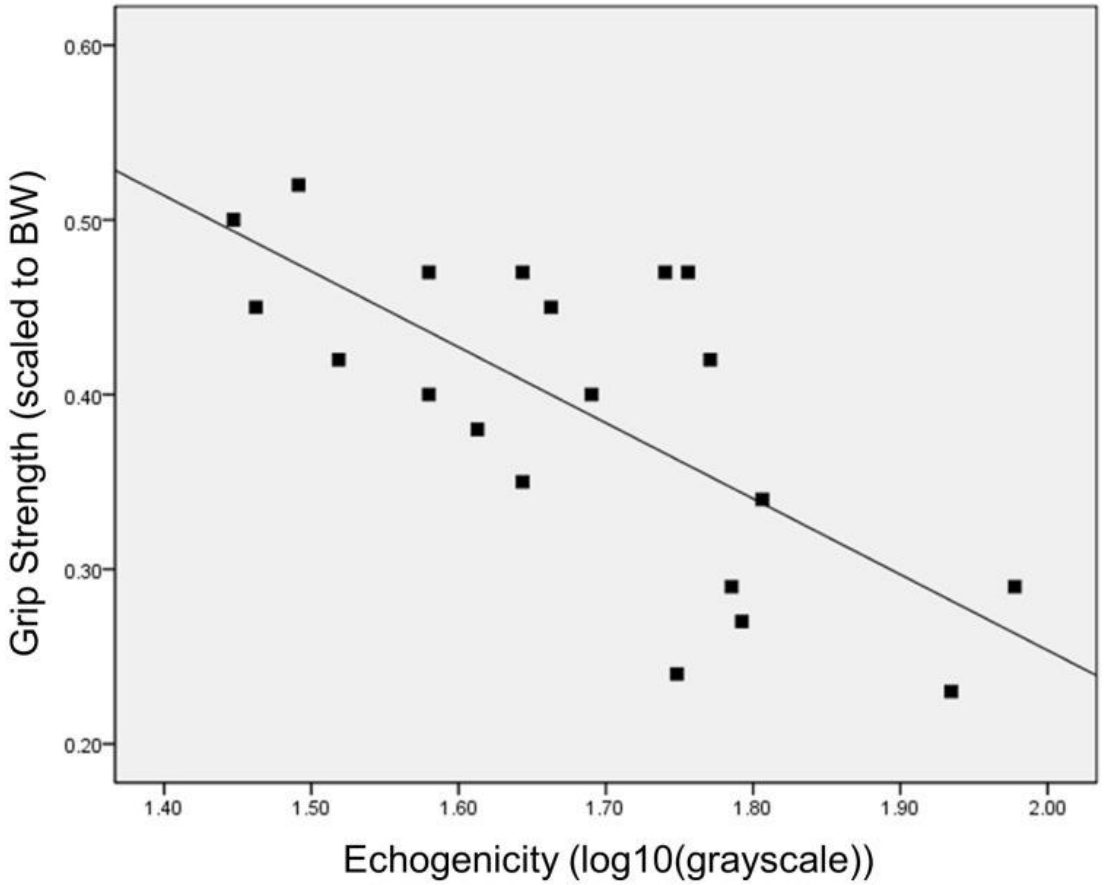
- Muscle thickness
- Muscle strength (independent of age or muscle thickness)

Caveat:

- Low inter- and intra-operator reproducibility (compression)

- System settings will strongly influence values
  - Gain (more gain = whiter ≠ less muscle mass)
  - Time gain compensation (TGC)

Echo-intensity



Diagnostic ultrasound estimates of muscle mass and muscle quality discriminate between women with and without sarcopenia. Catheeja et al. Front Physiol. 2015; 6: 302.

Muscle stiffness / hardness

Muscle stiffness = resistance of a muscle tissue against perpendicular pressure

Muscle stiffness is correlated with pennation angle & muscle thickness

Elastography: different techniques (e.g. shear wave)

Much discussion about which techniques are useful

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Not the future but the present
Where are we now?

Ultrasound

High concordance with DXA, CT and MRI

High sensitivity and negative predictive value in detecting sarcopenia

Still a need for standardisation!

Where do we need to be in 5 years?

Further assessment and validation of ultrasound as a standard imaging algorithm for sarcopenia

Use of ultrasound in **screening** and **prevention**

International collaboration versus mushroom working

Enter … SARCUS


SARCUS

Standardization effort!

Application of ultrasound for muscle assessment in sarcopenia: towards standardized measurements

Stany Perkisas[1,18] · Stéphane Baudry[2,18] · Jürgen Bauer[3] · David Beckwée[4,5] · Anne-Marie De Cock[1] · Hans Hobbelen[6,19] · Harriët Jager-Wittenaar[6,20] · Agnieszka Kasiukiewicz[7] · Francesco Landi[8] · Ester Marco[9,10,11] · Ana Merello[12] · Karolina Piotrowicz[13] · Elisabet Sanchez[12] · Dolores Sanchez-Rodriguez[11,14,15,16] · Aldo Scafoglieri[17,18] · Alfonso Cruz-Jentoft[12] · Maurits Vandewoude[1,18]

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SARCUS

Resulted in recommendations for

Patient positioning pre-investigation

System and system settings

Components

Anatomical landmarks

Consensus proposition, shortcomings in knowledge and protocol listings for patient positioning pre-investigation.

Consensus proposition:

- **No exercise 30 minutes before investigation.**
- **Preferably minimum 30 minutes (maximum 60 minutes) in the same position before investigation, for measurements in recumbent position.**
- **Muscle should be assessed in a relaxed state.**
- **If the patient is placed in a recumbent position, it is recommended to use the full extension position (either supine or prone).**

Shortcomings in knowledge:

- **Exact influence of (minor) muscle exercise on measurements**

To be mentioned in the protocol:

- **Preparations in advance of the investigation (amount of minutes rest, in which position).**
- **State of muscle being investigated (relaxed, contracted).**
- **Which position the patient is placed in, including the angles of the relevant joints, clearly describing which angle is meant exactly.**
- **Whether left/right side was taken and whether this was the dominant/non-dominant side.**
- **Sex and age of patient.**

Consensus proposition, shortcomings in knowledge and protocol listings for system and system settings.

Consensus proposition:

- **All types of ultrasound machine can be used, as long as B-mode is present.**
- **Extended field of view is not necessary but recommended.**
- **A linear transducer probe is recommended. A minimum length of 5 cm is advised.**
- **Inclination of the probe should be neutral, which is perpendicular to the skin.**
- **Using a generous amount of transmission gel is recommended.**
- **Maintaining the most minimal pressure possible between transducer and skin is recommended.**

Shortcomings in knowledge:

- **Exact influence of different system settings on measurements of echo-intensity**

To be mentioned in the protocol:

- **Manufacturer and type of US machine**
- **Type of probe, including length of probe**
- **Frequency of beam (other system setting, see “Components and measuring points: echo-intensity”)**
- **Any additional software used in post-production of images**

Consensus proposition, shortcomings in knowledge and protocol listings for components.

Consensus proposition:

- Five components can be measured: muscle thickness, pennation angle, fascicle length, echo-intensity and cross-sectional area.
- Measurements are ideally done at maximal muscle bulk.
- Depending on muscle anatomy, different techniques are advised for determining maximal muscle bulk.
- Panoramic vision and extended-field-of-view software are not absolutely necessary but recommended.
- In pennate muscles, measuring physiological CSA rather than anatomical CSA is recommended.
- When the fascicle length cannot be directly measured, it can be calculated using the standard formula.
- When measuring echo-intensity, all system settings need to be kept the same. Currently, no proposition for specific system settings based upon literature can be done for echo-intensity.

Shortcomings in knowledge:

- Exact point of maximal muscle thickness for each muscle.
- Changes of the main components (MT, CSA, FL, PA, EI) throughout the muscle bulk.
- A good measure for comparing echo intensity between different US machines/systems.

To be mentioned in the protocol:

- The muscle that is assessed, with inclusion of the anatomical landmarks that are used and the exact point in between the landmarks. If not the midpoint, clearly describe whether the proximal or distal end is meant.
- The components that are measured. If CSA is measured, define if anatomical or physiological CSA is meant.
- Total length of muscle (to calculate relative muscle thickness values).
- The technique that is used to determine the position of maximal bulk.

Proposed anatomical landmarks for each muscle discussed.

		Proximal landmark	Distal landmark
Lower limb	Rectus femoris	Greater trochanter	Proximal border of patella
	Vastus lateralis	Greater trochanter	Proximal border of patella
	Vastus medialis	Greater trochanter	Proximal border of patella
	Vastus intermedius	Greater trochanter	Proximal border of patella
	Biceps femoris (long head)	Ischial tuberosity	Proximal head of fibula
	Tibialis anterior	Lateral condyle (anterior) of tibia	US-measurement dependant
	Gastrocnemius (medialis)	Medial condyle (posterior) of the femur	US-measurement dependant
	Gastrocnemius (lateralis)	Medial condyle (posterior) of the femur	US-measurement dependant
	Soleus	Proximal head of fibula (posterior part)	Posterior superior part of calcaneus
Upper limb	Biceps brachii	Anterior part of acromion process (acromioclavicular joint)	Elbow crease where tendon can be palpated
	Triceps brachii	Most lateral distal part of acromion	Tip of olecranon

Disclosure

SARCUS is the first attempt to standardize US in muscle assessment

It is probably not perfect

Consider it as a baseline from where to start

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Take home messages

- Strong need for routine muscle mass screening
- Ultrasound: think ‘cheap – fast – easy’
- Correlated with DEXA, CT and MRI = reliable and valid tool
- Need for further standardization: think SARCUS


Thank you for your attention!
Questions?