Identifying more economical approaches to medical imaging for the rehabilitation of traumatic military injuries

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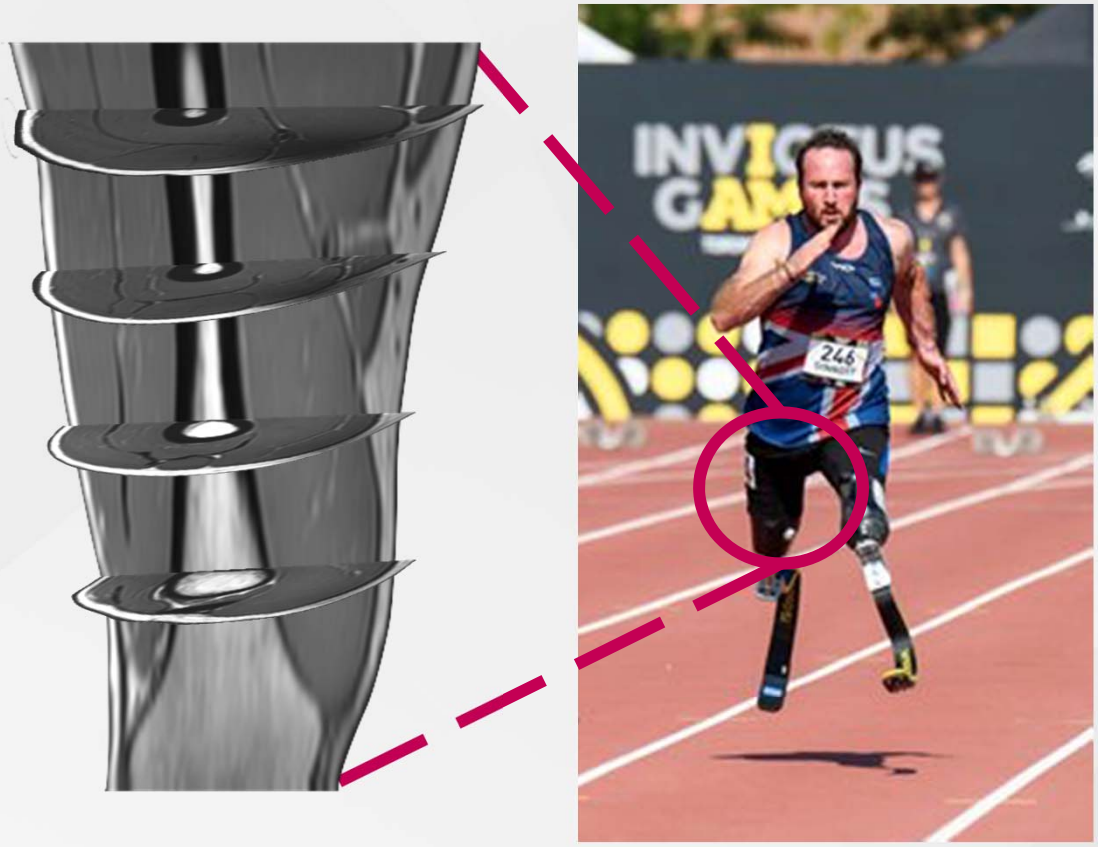
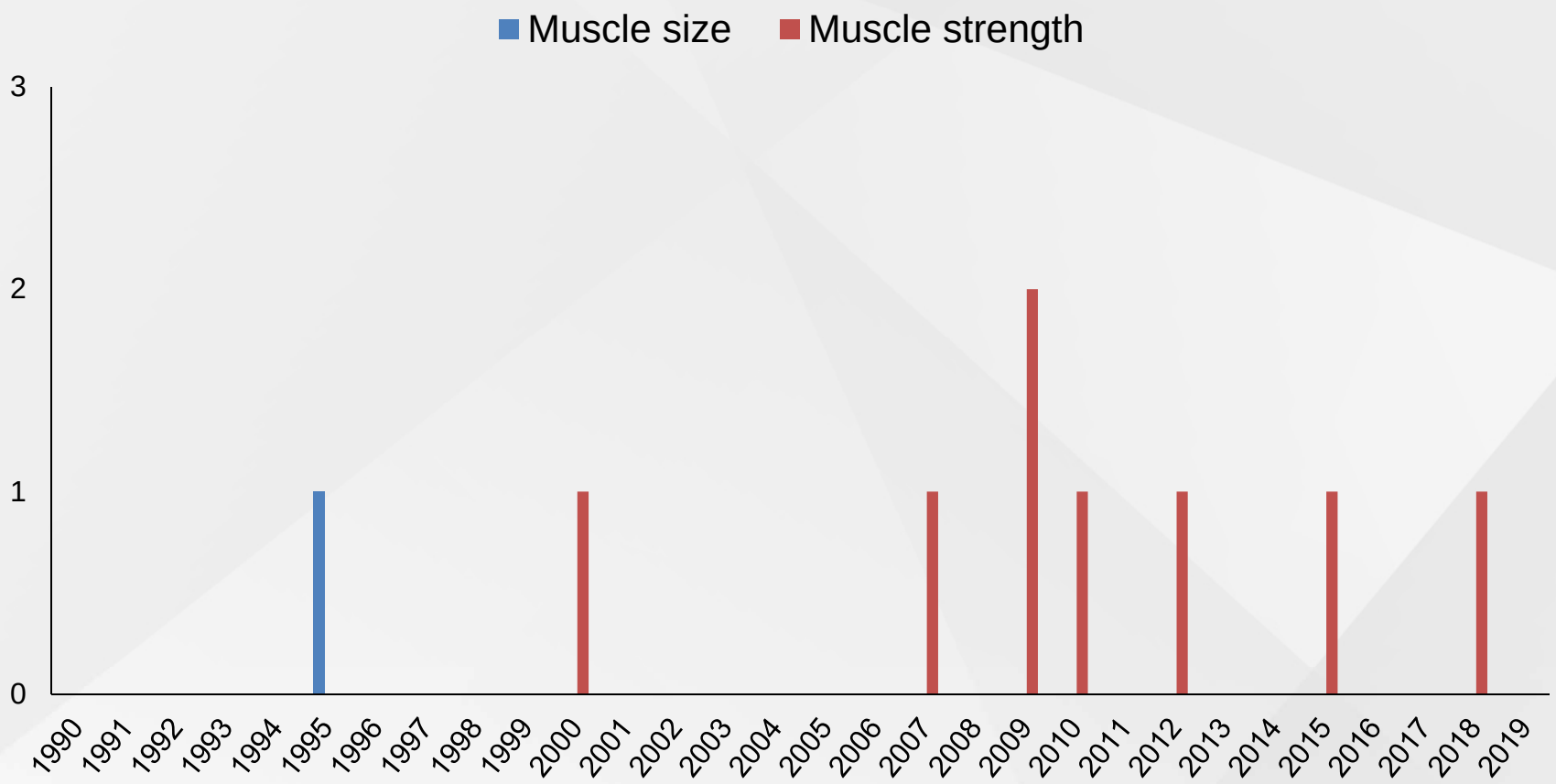


Background

- Improved trauma care has decreased the mortality rate of severe military casualties
- 265 casualties suffered 416 amputations in Afghanistan – projected cost = £288 million (Edwards et al., 2015)
- Maintaining independent mobility can prevent this cost rising
- Limited muscle function research available

Muscle function research



Objectives

- Quantify time demand and measurement reliability of manual MRI image analysis
- Evaluate and improve a semi-automated method for reducing the time demand
- Explore the application of ultrasound imaging as a rapid assessment tool

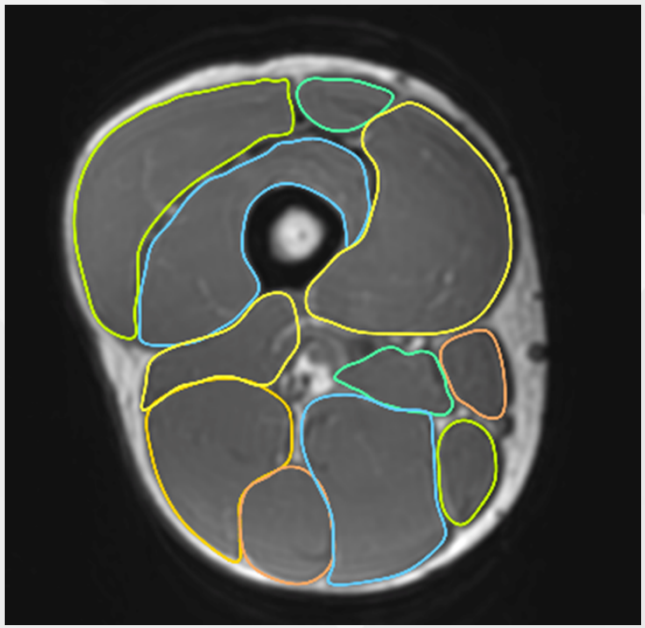
Methods

- 33 healthy males (age: 28.2 ±5.2 years, height: 1.81 ±0.08 m, body mass: 80.0 ±11.4 kg, body mass index: 24.4 ±2.7 kg/m^2)
- MRI images acquired of the lower limb (48 legs)
- Ultrasound images and anthropometric measurements acquired from 18 participants

Manual analysis of MRI images

- Muscle CSA outlined every 15 mm and every 5 mm to evaluate time demand (n = 3)

- Repeated after 7 days to evaluate measurement reliability (n = 2)



Time demand

Difference = 0.7 ±0.7%

24 hours

8 hours

Measurement reliability

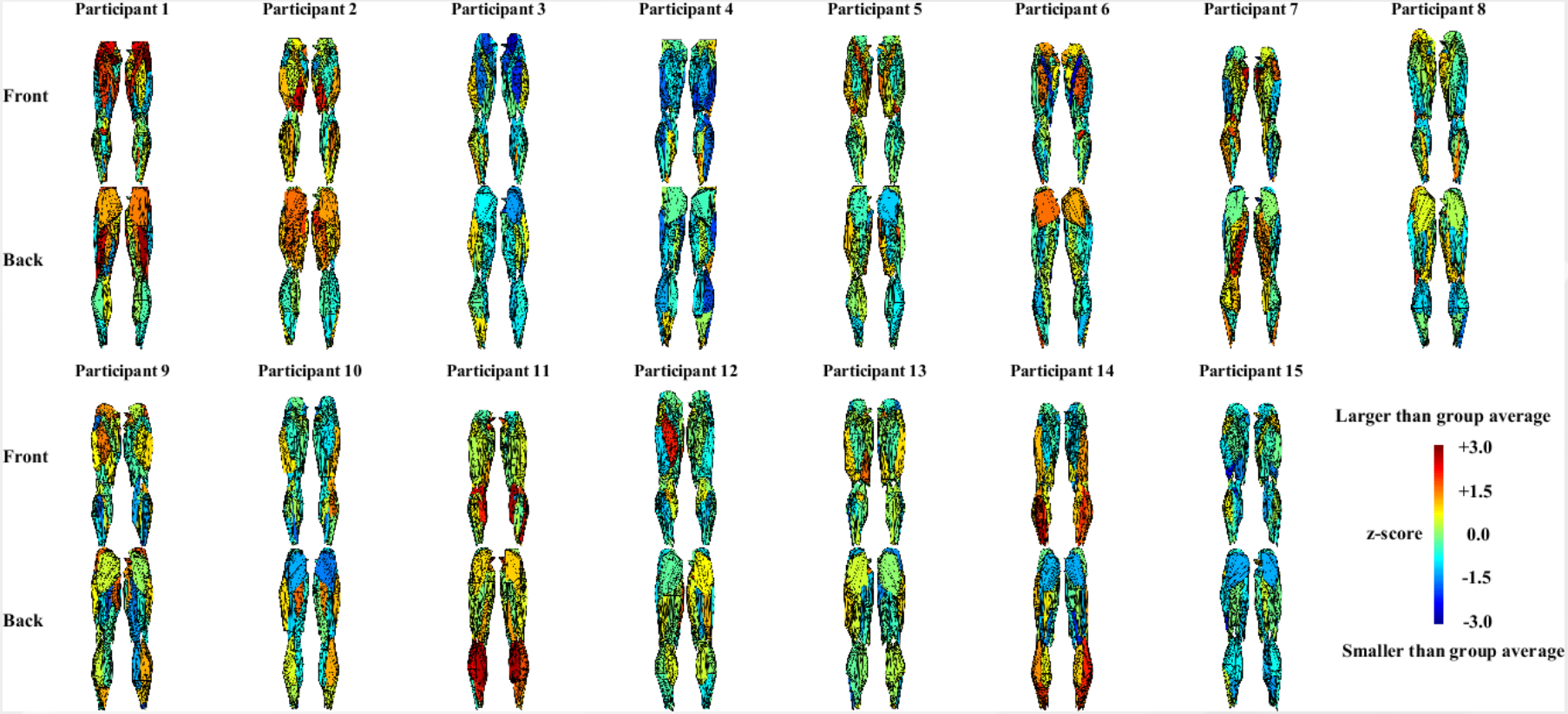
Mean difference = 5.1 ±5.6%

Typical error = 14.3 cm^3 (1.0%)

ICC > 0.99

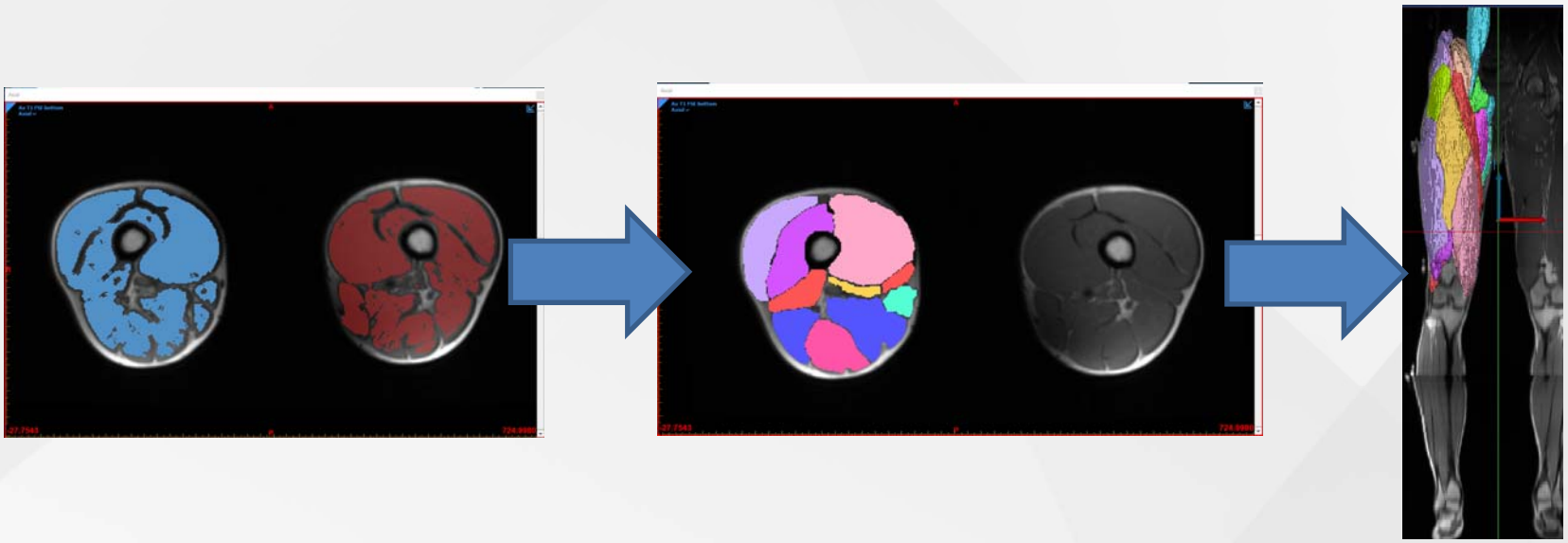
Muscle size distribution (Rothwell et al., 2019; Phys Meas)

Individual = 12.6 ±2.6% | Groups = 4.7 ±1.8%



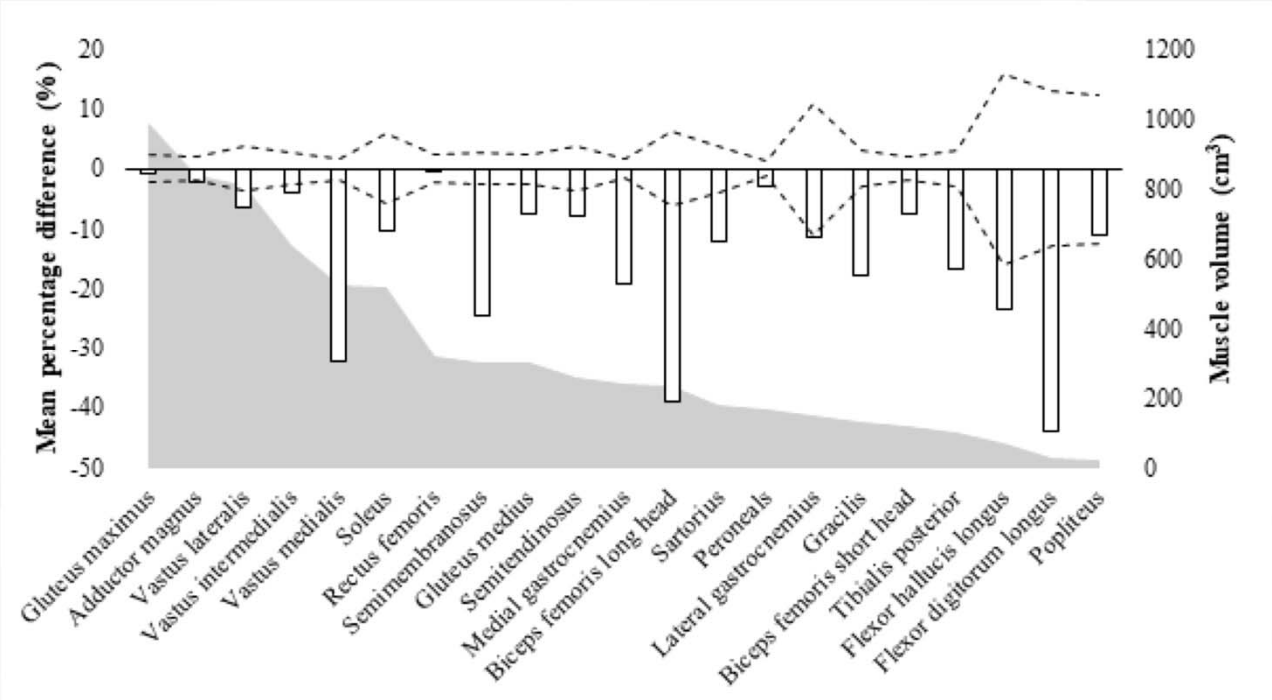
Semi-automated MRI image analysis

- Muscle masks manually created
- Automated segmentation using reference atlases in Mimics®
- 3D shape and muscle volume calculated



Time demand and difference versus manual

- Time demand = 3.0 [manual] + 1.2 [computation] vs 8.0 hours [manual]
- Mean difference compared to manual = 11.1%



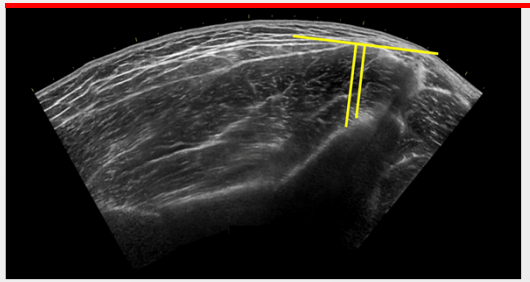
Ultrasound image analysis

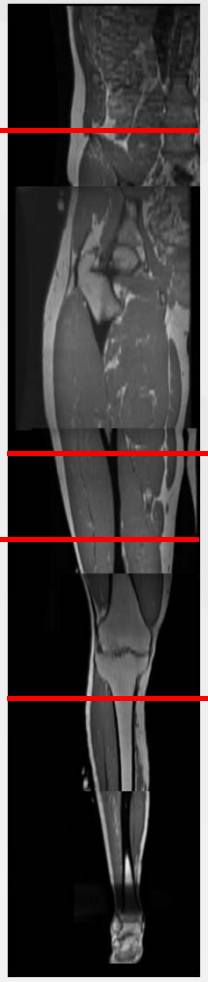
- Anthropometric measurements:
  - Body mass
  - Height
  - Thigh length
  - Shank length

- Ultrasound images acquired at 4 sites

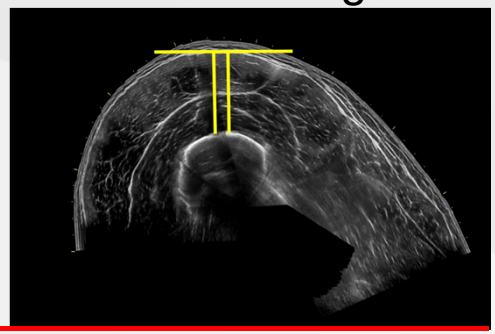
Ultrasound image analysis

Mid-hip

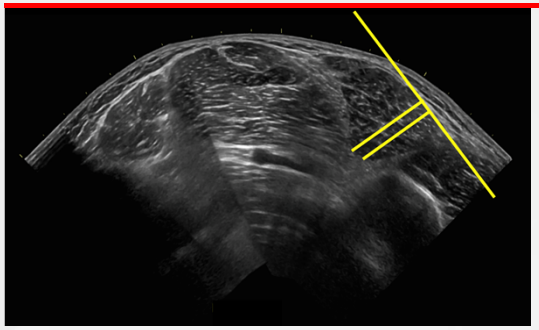




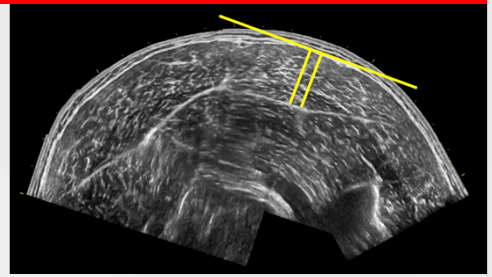
Anterior mid-thigh



75% posterior thigh

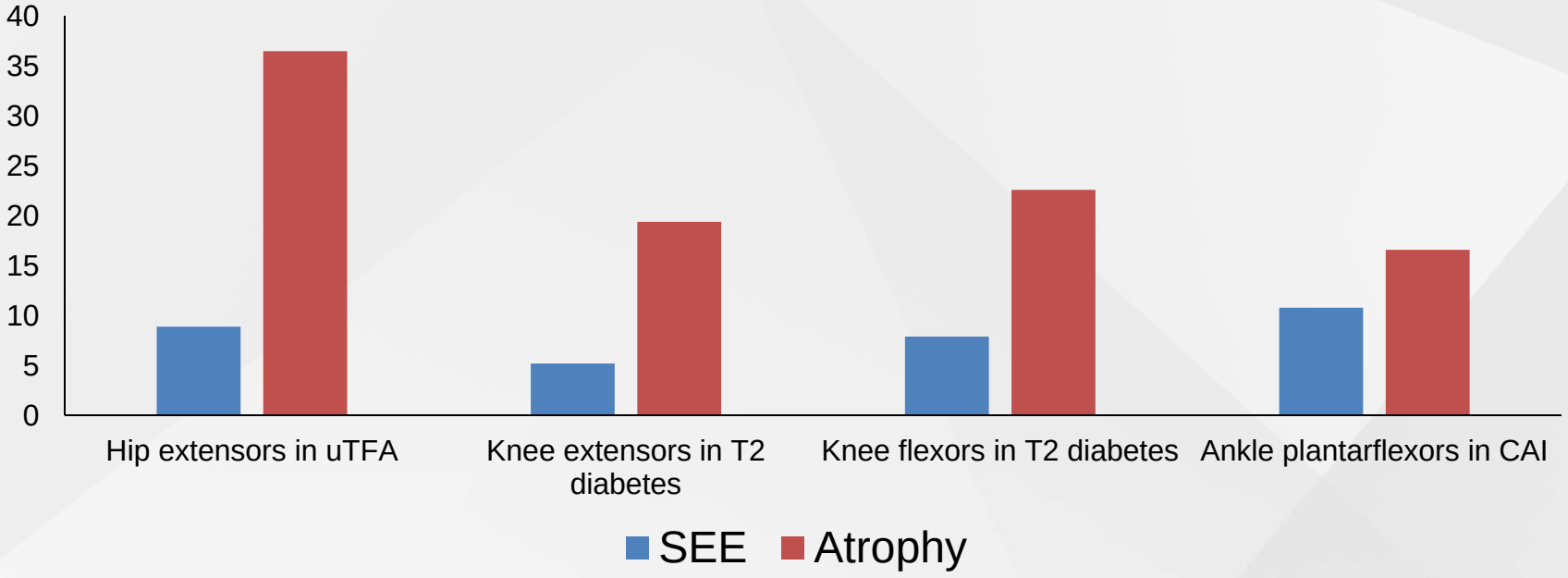


25% posterior shank



A rapid, straightforward method
(Rothwell et al., 2019; EJAP)

- Less than 5 minutes to measure key lower limb muscle groups
- Not able to measure individual muscle volumes



Conclusions

- Semi-automated is much faster than manual analysis of MRI images but differences exist between methods
- Reliability of semi-automated analysis is currently being evaluated
- Ultrasound imaging is the most clinically applicable method at present

Current and future work

- Application and modification of the methods developed in a lower limb amputee population
- MoDREC application submitted in collaboration between LU, ICL, RCDM, DMRC
  - Muscle size, strength, gait mechanics
  - Reviewed by DSTL SAC
- Further investigations into the clinical utility of ultrasound imaging for military trauma management

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