SLICES REQUIRED TO DETERMINE LEAN MUSCLE AND FAT MASS ON LOWER EXTREMITY COMPUTED TOMOGRAPHY SCANS

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BACKGROUND

- Muscle atrophy following spinal cord injury (SCI) can be quantified by measuring changes in the lean muscle cross-sectional area (LM-CSA) on computed tomography (CT) scans.
- LM-CSA is often quantified using a single-slice thigh or shank CT, as measuring LM-CSA on a whole lower extremity CT scan requires considerable time and effort.[1–3]
- However, this method may be inadequate given the non-uniform morphology of the thigh and lower leg.

OBJECTIVES

- To determine if LM-CSA can be well represented with a single-slice thigh or shank CT in people with SCI.

METHODS

- Participants: **24** (AIS A=8; B=3; C=4; D=7; 7 females; 44.5 ± 15.5 yrs.).
- Four CT scanners: two Siemens SOMATOM, a GE, and a Toshiba Aquilion.
- Image acquisition parameters: KVP: 120 kV, pixel spacing of 0.98×0.98 mm (rows: 512, columns: 512).
- Spiral CT imaging from L2 to toes.
- Six axial slices were extracted from 30 to 80% of the femur length and 14% to 64% of the tibia (relative to the proximal end, every 10%, Fig. 1).
- Image processing was performed offline with MATLAB-based software.[4,5]
- A **k-nearest-neighbor algorithm** was deployed to segment all tissue from air and bone.
- Hounsfield-unit threshold between -29 and 150 was used to calculate LM-CSA.[6]
- A repeated linear mixed-effect model was used to compare the LM-CSA at different slices for the left and right thigh, shank, and between the right and left sides.

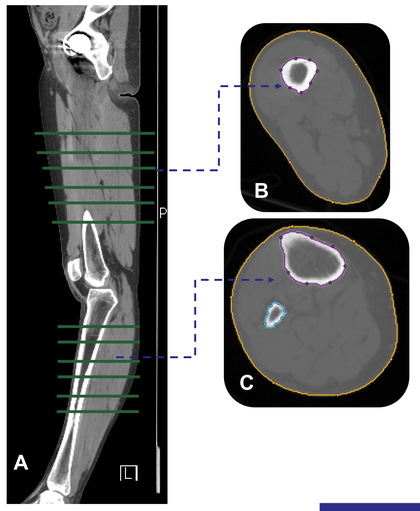

Fig 1. A) Axial Slice Extraction Locations, B) thigh CSA at 50% of femur length; and C) Shank CSA at 34% of shank length

A single slice alone cannot accurately represent muscle cross-sectional area in the thigh or shank following spinal cord injury intervention.

RESULTS

- A total of 576 slices were analyzed, 288 from side of the right and left thigh and 288 from of the right and left shank.

Table 1. Mean Muscle CSA for Thigh and Shank per Slice

Slice	Femur		Tibia	
	Left	Right	Left	Right
1	107.8±30.1	109.5±26.9	42.2±11.6	43.7±9.7
2	110.2+26.9	109.7±25.0	54.7±13.5	55.5±13.7
3	107.0±27.5	104.9±25.28	61.3±15.9	60.5±15.7
4	96.1±25.2	94.9±23.2	55.8±16.4	54.5±15.0
5	80.4±21.5	77.1±18.9	44.2±13.5	42.7±11.5
6	62.5±17.3	59.1±15.0	33.9±9.8	33.0±8.8

- As hypothesized, LM-CSA was a function of slice location.
- The average LM-CSA variation on consecutive slices was 13% and 20% for the thigh and shank slices, respectively.
- A statistically significant difference (***p<0.001***) was observed between the femur LM-CSA at 50% and the other slices.
- A statistically significant difference (***p<0.001***) was observed between the tibia LM-CSA at 34% and the other slices.
- The difference between the reference slices was more on the lower thigh and the shank.
- No significant differences (***p>0.05***) were observed bilaterally.

DISCUSSION & CONCLUSION

- Muscle CSA could not be reliably measured using a single slice extracted from 50% of the femur length or 35% of the tibia length.
- More slices are needed to accurately estimate muscle CSA for clinical or research purposes.
- As no difference was observed between the right and left sides, quantification of muscle CSA could be limited to only one side, preferably the dominant side before the injury, in order to minimize the required time and effort for segmentation.

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