Evaluating body composition: will routine L4-CT scans replace DEXA and BIA?

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PLAN

- Body composition basics
- L4-CT technique
- The future
- Answer the question!

Techniques for body composition

2-compartment model

Fat Mass

Fat Free Mass

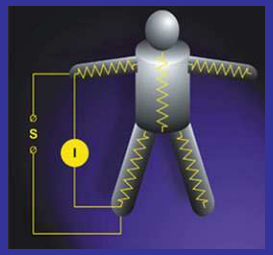
Body impedance analysis (BIA)

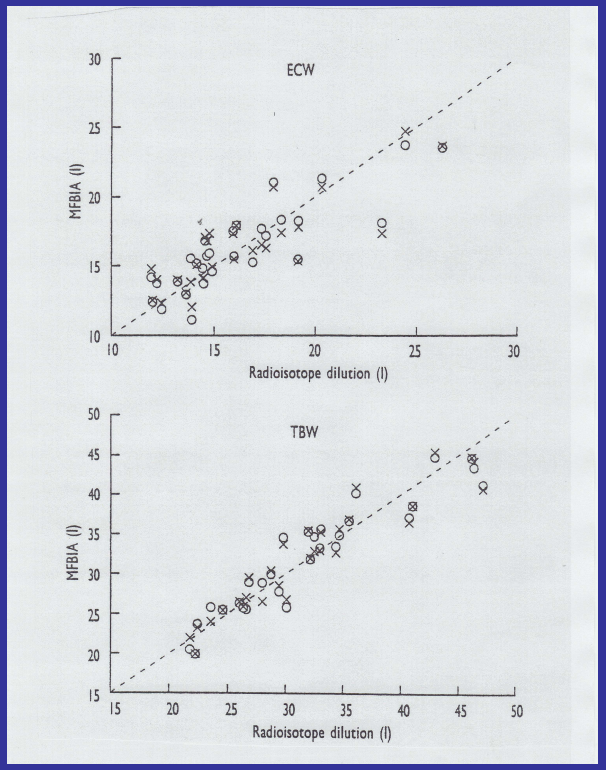
↓

Total body water

↓

Predict fat free mass





(Hannan et al Clin Sci 1995)

Body Impedance Analysis

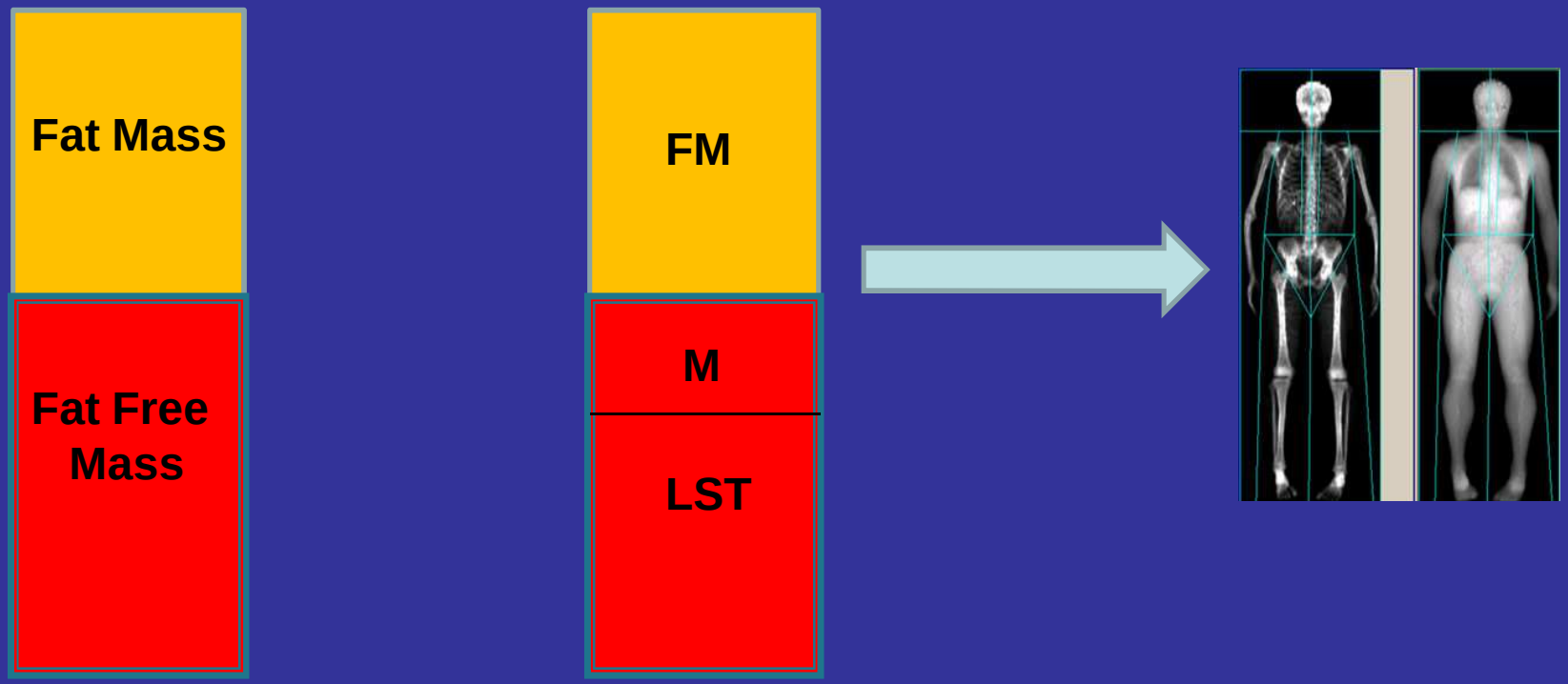
Anomaly

- Major site of impedance limbs
- Method not sensitive to changes in fluid volume in trunk (pleural effusion/ inflammation)

BIA in advanced cancer

- N=132 cancer patients (80% GI) BIS underestimates FFM by 15% compared with DEXA. Bias significantly correlated with CRP (Ellegard et al 2008)
- Data consistent with expansion of ECW due to Inflammation although no obvious signs of oedema in patients showing ↑ ECW/ICW
- N=51 lung/ colorectal cancer BIA substantially overestimated or underestimated FFM compared with DEXA and unable to detect changes over time (Mourtzakis et al 2008)

Techniques for body composition



BIA

Dual Energy X-Ray Absorptiometry (DEXA)

DEXA

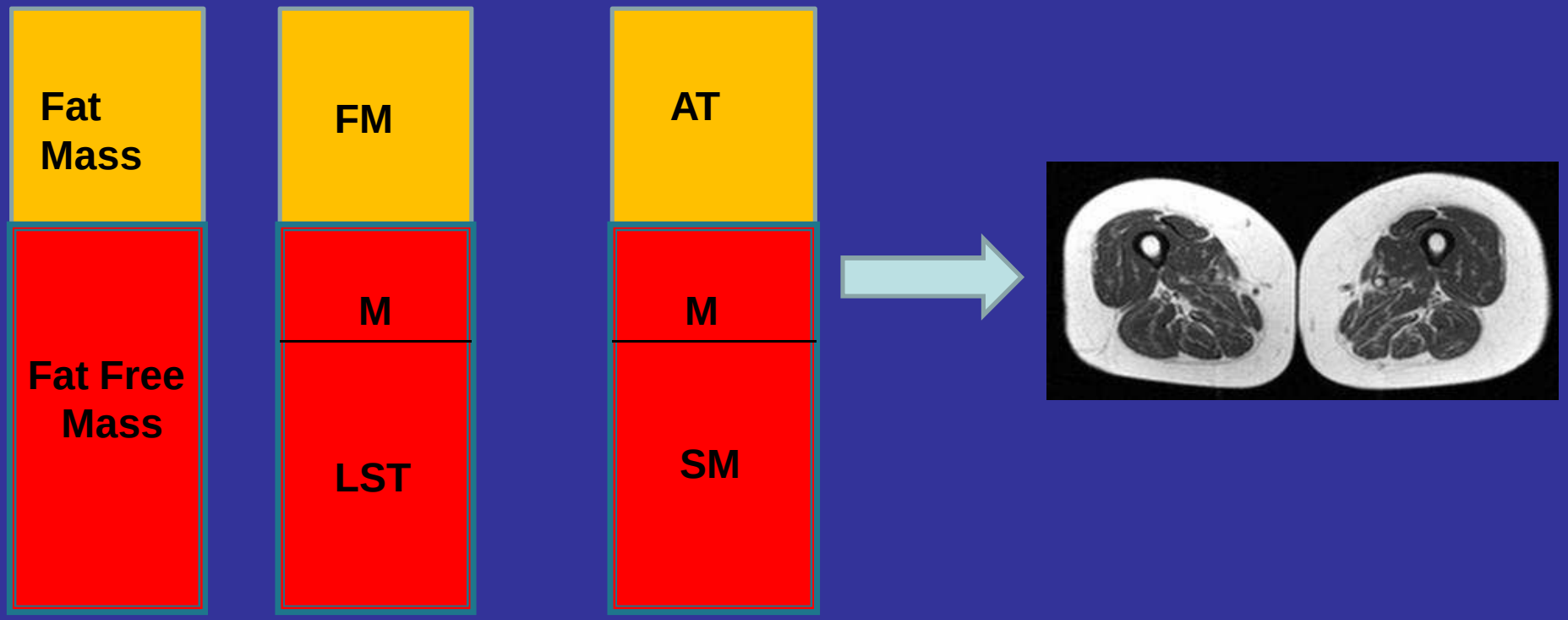
Limitations:

- Trying to measure 3 components with 2 energies!
- Assume a constant fat/ lean X-ray attenuation characteristic
- Differences of up to 10% (FM), 6% (LST) and 3-6% (%BF)

DEXA

- Measurements of appendicular skeletal muscle (ASM) derived from ALST
- Accurate measurement of skeletal muscle (SM) requires different methods

Techniques for body composition

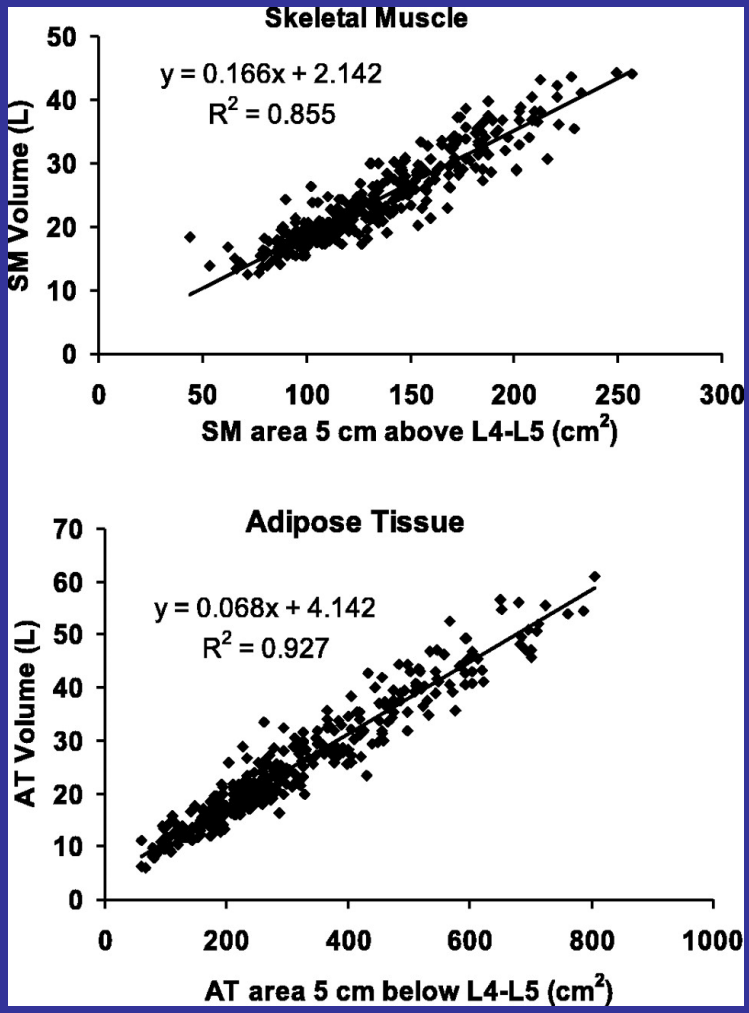


L4-CT technique

Rationale: Single CT images at specific lumbar landmarks relate significantly to whole body fat and skeletal muscle tissue in healthy adults

The L4-CT technique

- n=328 healthy adults (mean age 42y)
- BMI normal/ overweight
- CSA of muscle and adipose tissue at level of L4/ L5 intervertebral disc



(Shen et al 2004a; 2004b)

Technique

- Landmark – 3rd Lumbar vertebrae
- Two consecutive images extending from L3 analysed using image analysis. (SliceOMatic software).
- Skeletal muscle and adipose tissue quantified using respective Hounsfield units (pixel histogram technique)
- Cross-sectional area of tissue (cm^2) of each slice calculated and mean value of two slices taken.

L3-CT

Lumbar muscles Subcutaneous fat Intermuscular fat Visceral fat

Studies in cancer patients

- N=31 lung/ colorectal cancer patients
- L3-CT fat/ fat free tissue CSA highly correlated with whole-body Fat/ FFM using DEXA (r=0.88-0.83; p<0.001).

(Mourtzakis et al 2008)

Application of L4-CT

- Identification and characterisation of clinically important phenotypes e.g., sarcopenic obesity
- Natural history of pancreatic cancer
- Identified thresholds for toxicity to chemotherapy

Obese sarcopenic patient

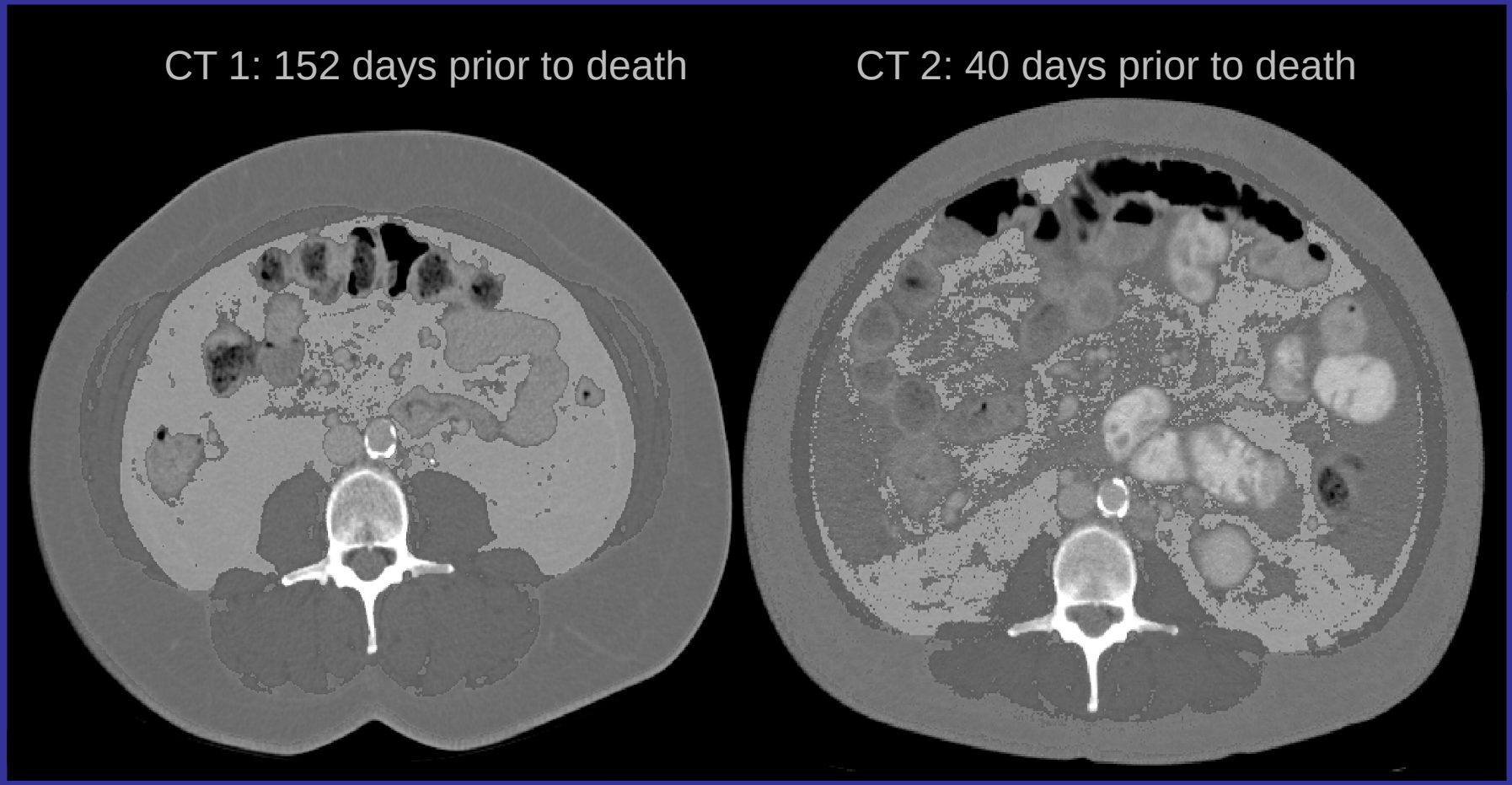
- Prevalence of sarcopenia in lung/ colorectal/ pancreatic cancer >50% (Prado et al, 2008; Tan et al 2009).

- BMI ≥30 kg/m2 in the presence of sarcopenia (prevalence ~15%) predictive of morbidity and mortality in both malignant and non-malignant disease (Honda et al 2007; Prado et al 2008).

- Risk of mortality for pancreatic cancer patients with sarcopenic obesity 2½ times greater than those who were neither sarcopenic nor obese (Tan et al 2009)

- Confound conventional measures used to target nutritional support

Worst case scenario!



Lumbar muscles Subcutaneous fat Intermuscular fat Visceral fat

Muscle and adipose tissue loss in pancreatic cancer

	First CT scan	Second CT scan	Δ	*P**
Appendicular skeletal muscle (ASM) (kg)	17.30 ± 3.81	16.07 ± 3.13	**-1.23 ± 1.52**	<0.0001
Whole body adipose tissue (FM) (kg)	24.04 ± 7.92	17.30 ± 6.10	**-6.74 ± 5.00**	<0.0001

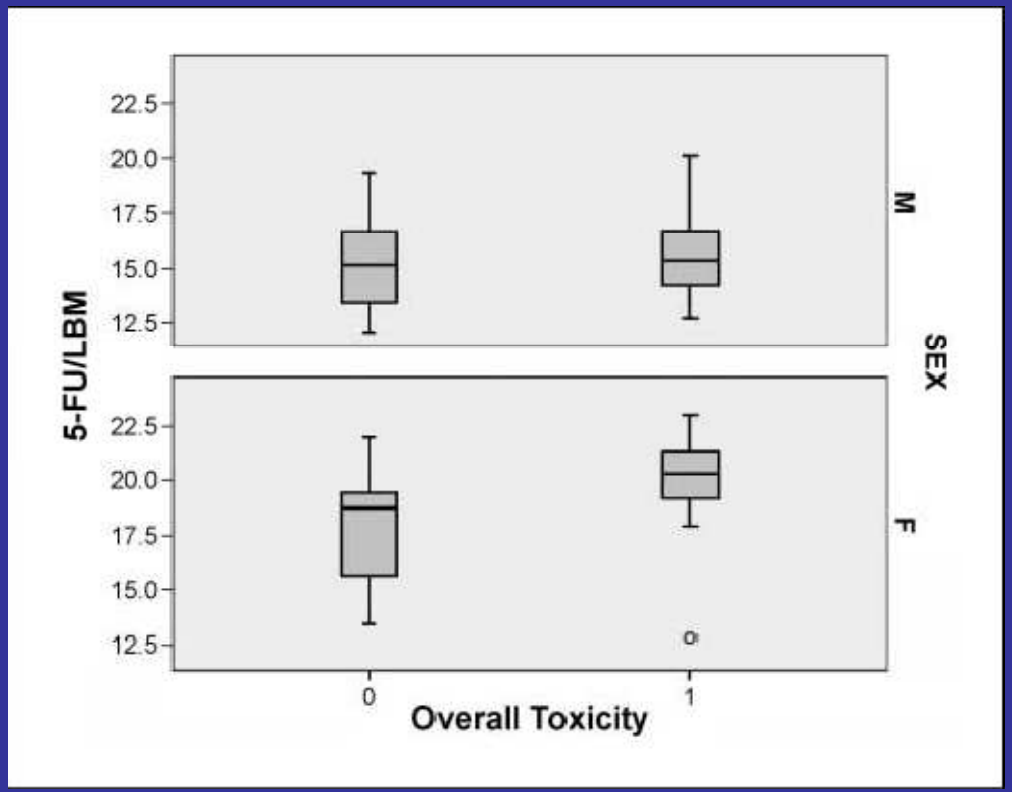
*Values are mean ± SD. * Student t-test*

Chemotoxicity

LBM estimated from L3-CT

5-FU/LBM significantly associated with toxicity in women

20mg 5FU/LBM threshold for toxicity

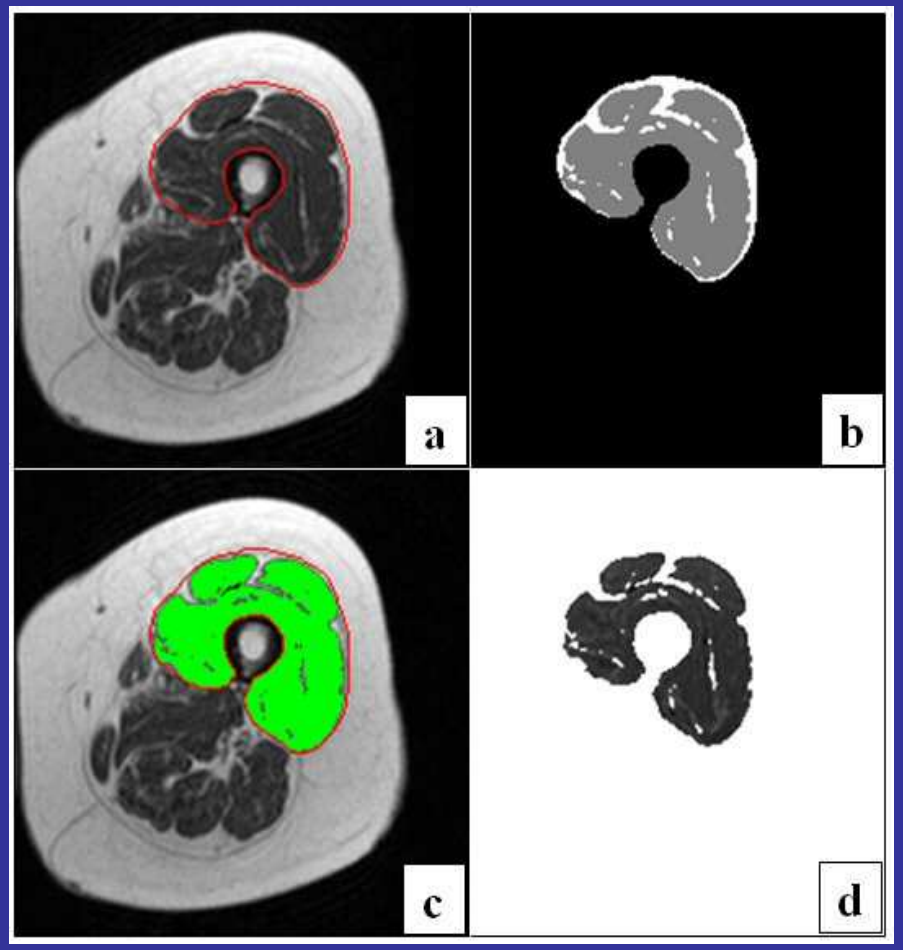


(Prado et al 2007)

Advantages of L4-CT

- Allows visualization, separation and quantification of different tissue types
- Precise
- CT scans routinely used for staging and evaluation of cancer patients.
- Immensely practical technique/ reduces the patient burden.

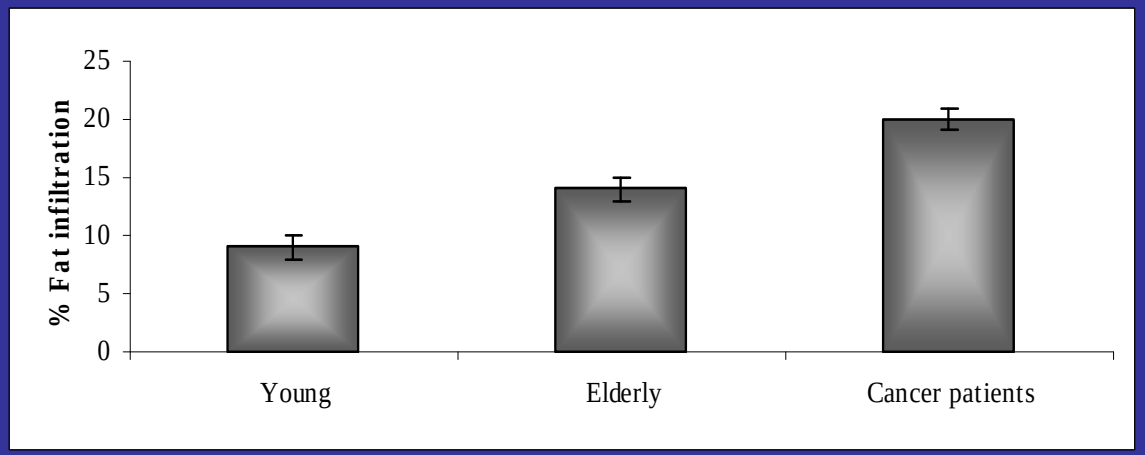
The future

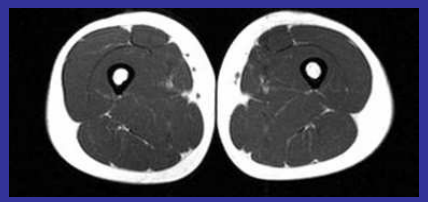


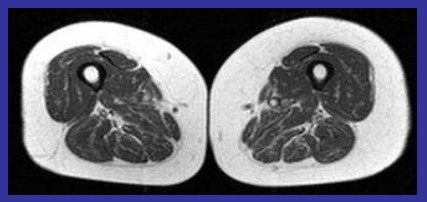
Measurement of absolute muscle volume

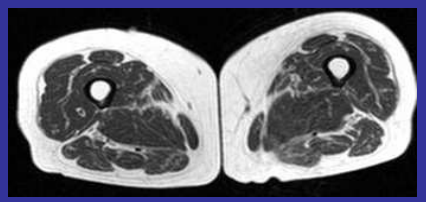
For each **MR** image, the quadriceps muscle group is manually outlined (a). Volume optimization is applied to the region of interest to determine fat infiltration (b). This image is superimposed on to the original MRI slice (c) to determine the lean muscle area (d). Process repeated for all slices, and summed to give absolute muscle volume.

Sensitive biomarkers of muscle frailty









Summary

- L4-CT is practical, feasible and informative
- Advantages over BIA/ DEXA
  but will not replace!
- Representative of new wave technology

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‘Nothing is measured with greater error than the human body’…

Beneke 1878