BodyMetrix™

By IntelaMetrix™

An introduction to Ultrasound and the BodyMetrix System

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Ultrasound technology

- Ultrasound imaging is used routinely in medicine and has a long history of safety and accuracy.
- Conventional Imaging is B-mode ultrasound. BodyMetrix is A-mode ultrasound, single “Beam”.
- Large volume of literature showing that ultrasound can be effective in measuring fat thickness and %BF.
- Beyond %BF ultrasound can be used to measure muscle thickness and “quality”.

The Lancet - 12/17/03

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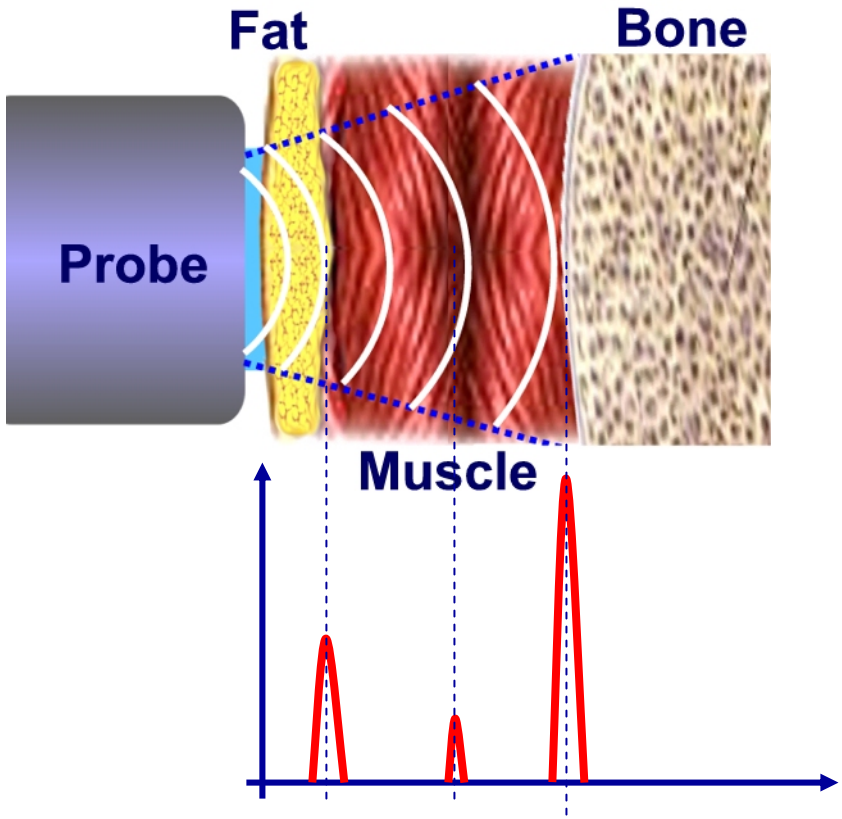
Ultrasound signal and contrast

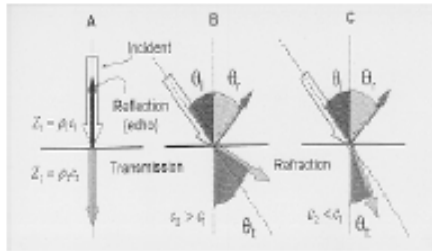


Strong signals appear at tissue boundaries.
(e.g. fat-muscle, muscle-bone)

Acoustic Reflection and Impedance

- Electrical analogy - impedance mismatches result in reflections
- Impedance = Z ~ Density x velocity = ρc
- Fraction reflected

$$R = \frac{|(Z2-Z1)|}{|(Z2+Z1)|}^2$$



Fat - Muscle	R = 0.012
Muscle - Bone	R = 0.22

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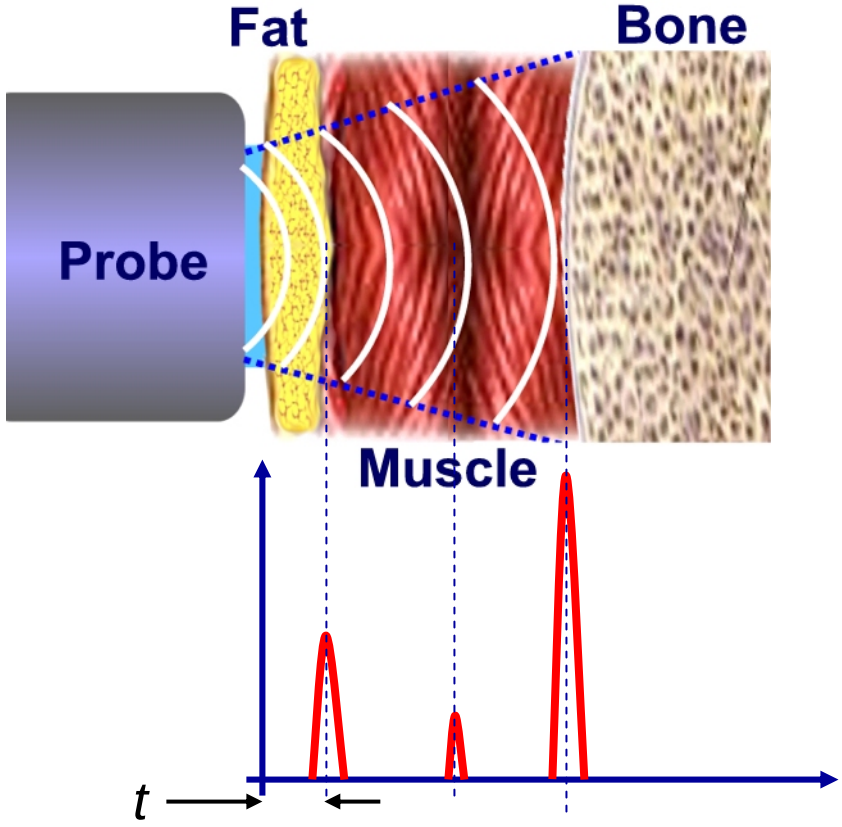
Thickness Measurement



Tissue and Materials: Acoustic Characteristics

Material	Density Kg/m3	Speed of Sound mm/us	Impedance Million Rayls	Attenuation DB/cm@1mHz
Air	1.2	.33	.0004	100+
Lung	300	.6	.18	40
Fat	924	1.45	1.34	.5-1.8
Water	1000	1.48	1.48	.0002
Blood	1058	1.56	1.65	.18
Muscle	1068	1.6	1.71	.2-.6
Bone	1912	4.08	7.8	13-26

$$Thickness = \frac{C_{Fat}t}{2} = 0.725t\,[\text{mm}]$$

Error in $C_{Fat} = \pm 3.5\%$

(Example thickness error $10.0 \pm 0.35\,[\text{mm}]$)

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Sources of Thickness Error

- Errors in Sound Speed (± 3.5%) BUT less for same site and person (<1%)!!!!
- Compression of Fat (typically < 3%) (less then calipers)
- Errors in Electronics (Oscillator < 0.2%)

Total error in thickness measurement < 5%

The Resulting %BF errors are

5% error in Thickness → Δ%BF = ± 0.3% (@ 5%)

= ± 1.2% (@ 30%)

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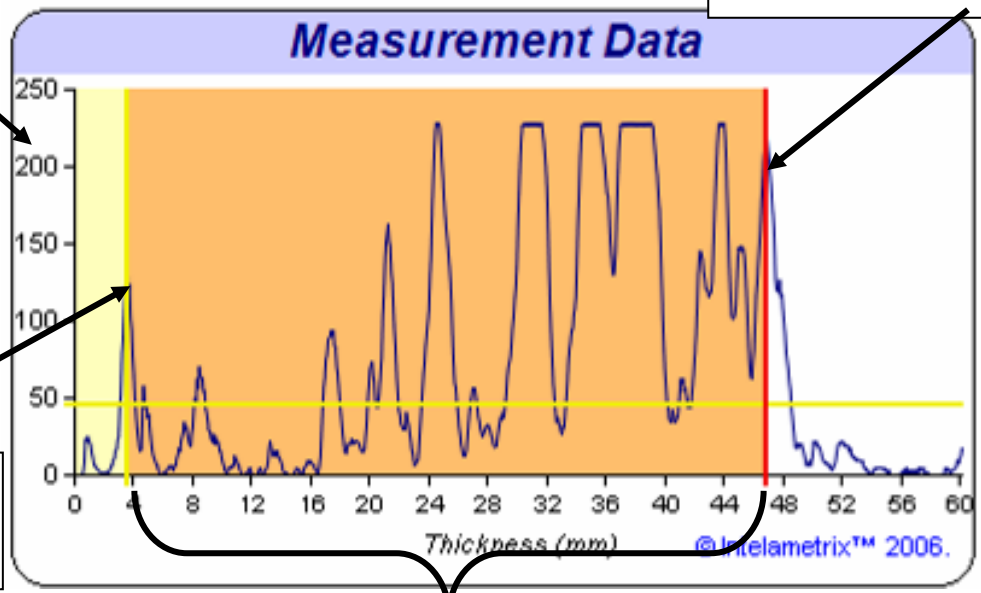
Interpreting BodyMetrix Graph

Y-axis is Signal Amplitude

High spikes are observed at tissue boundaries.

Last large spike is muscle-bone boundary



Generally first large spike is fat-muscle boundary

Spikes between fat-muscle and muscle-bone boundary are caused by tissue structure. Fatty muscle shows more spikes than lean muscle. Fascia, veins, arteries can also produce spikes

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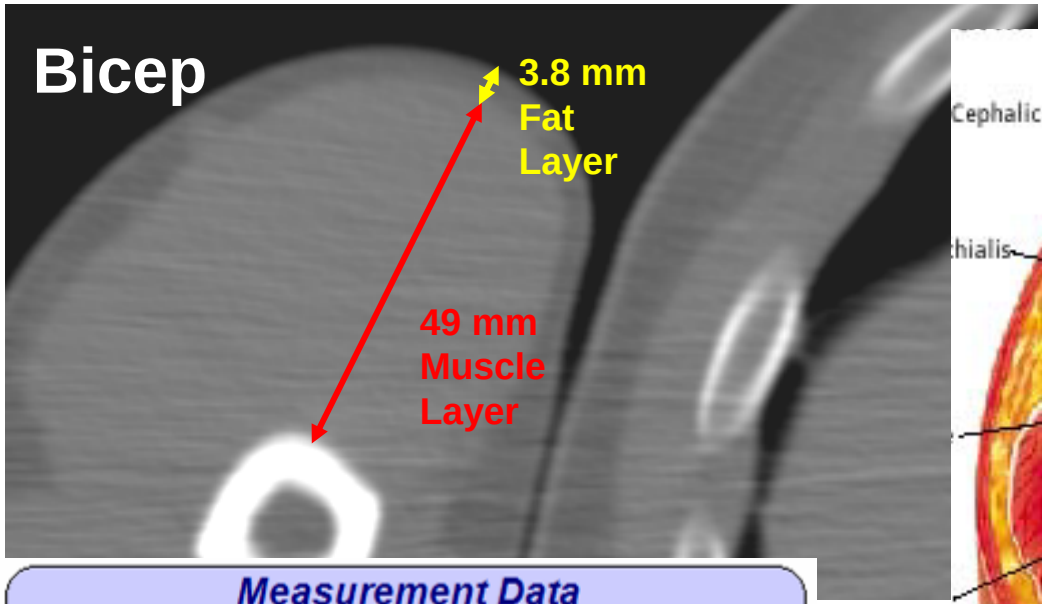
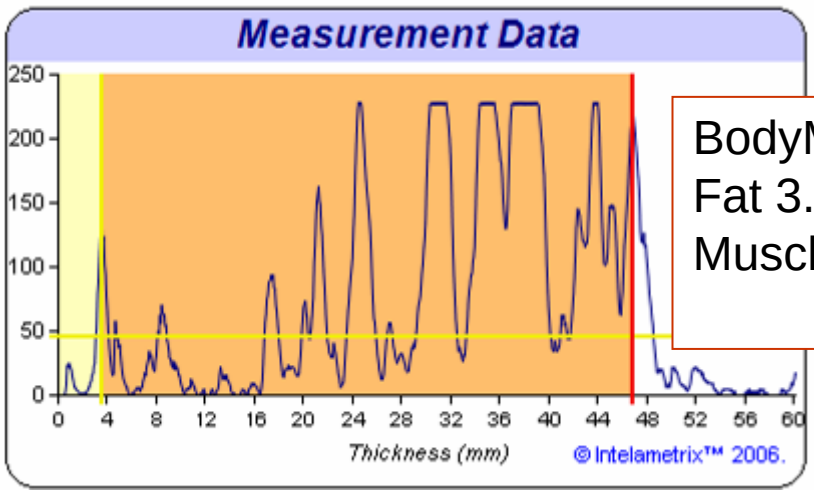
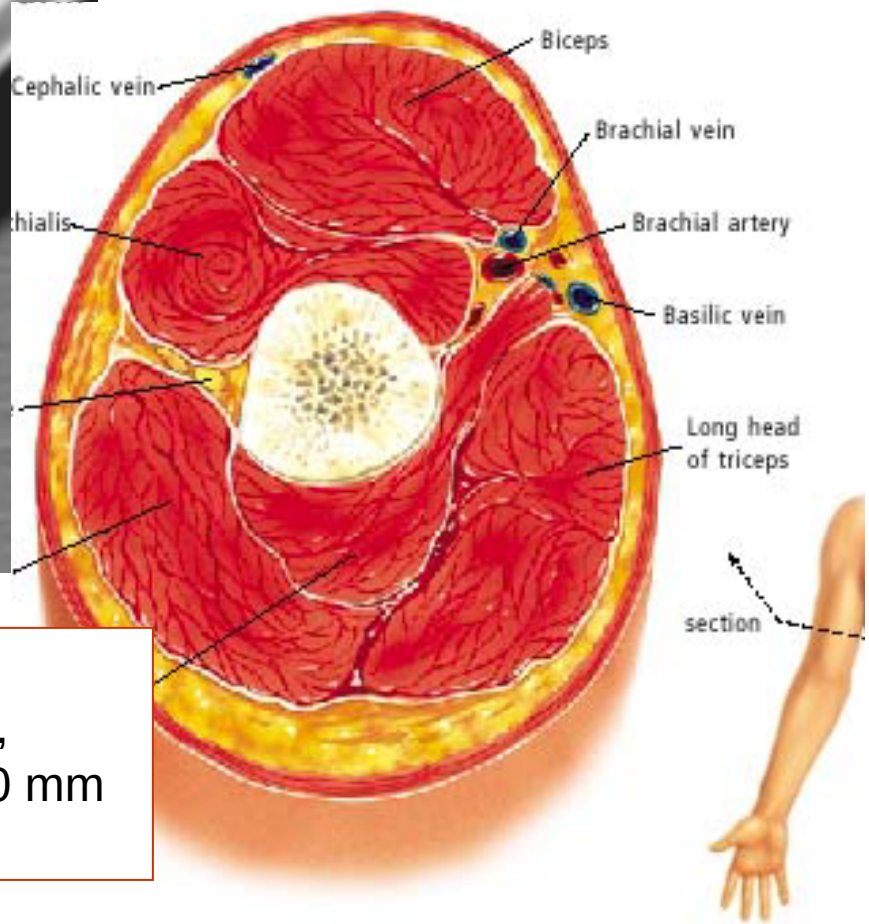
Comparison to X-ray CT





BodyMetrix
Fat 3.6 mm,
Muscle 48.0 mm



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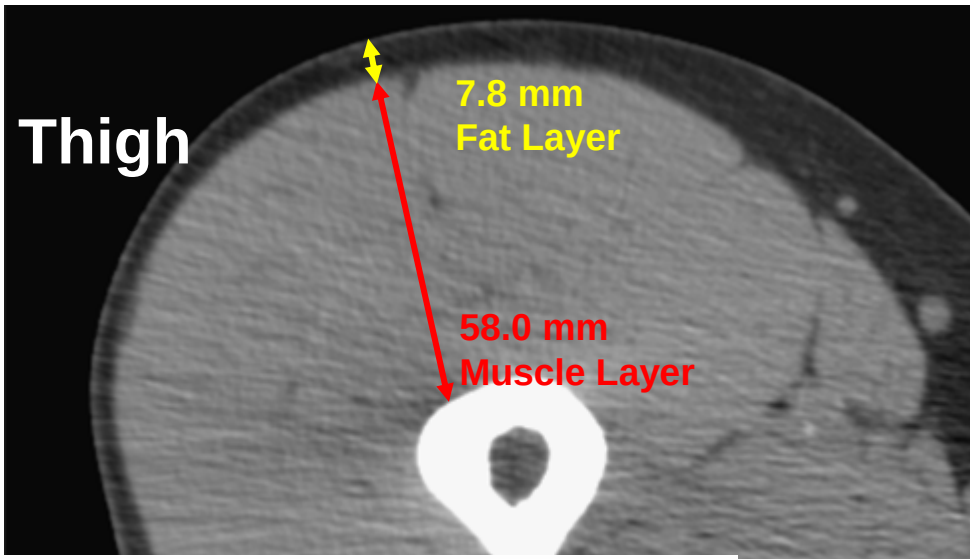
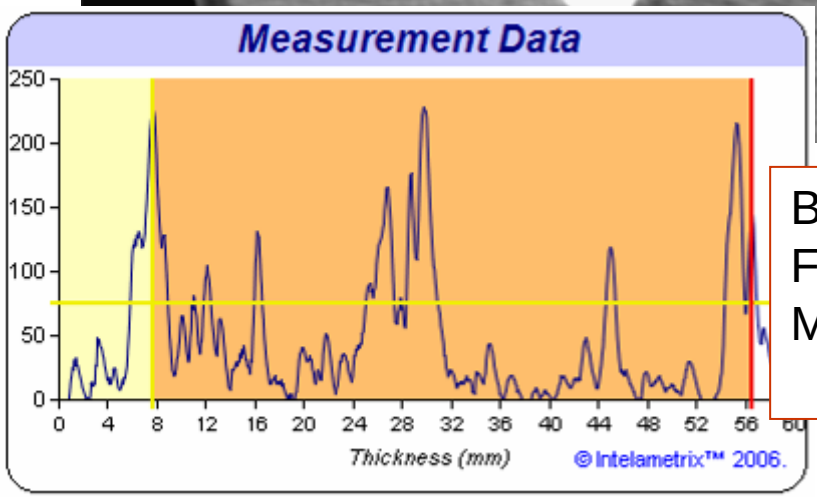
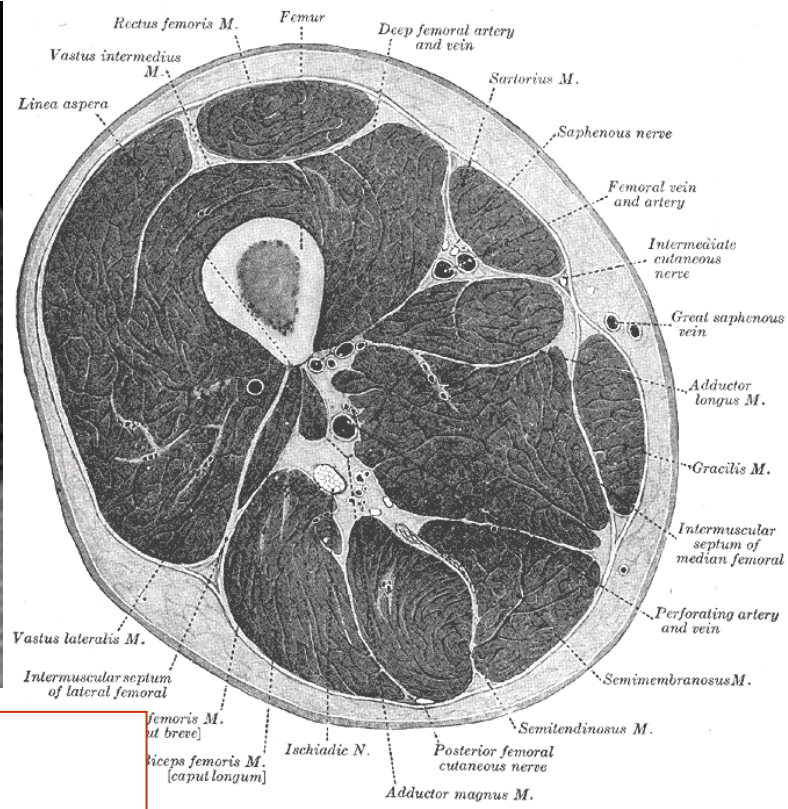
Comparison to X-ray CT







BodyMetrix
Fat 7.6 mm,
Muscle 53.0 mm

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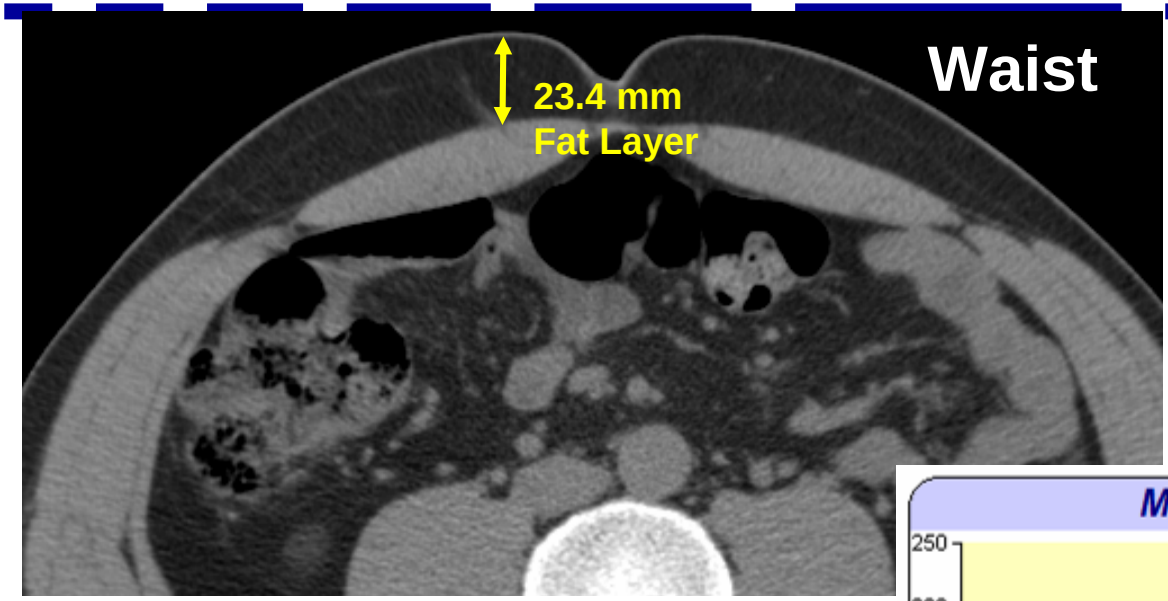
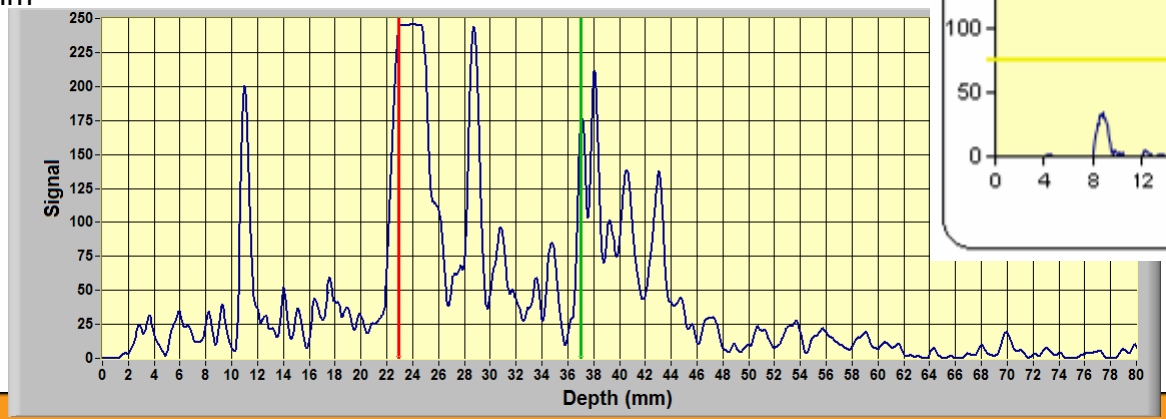
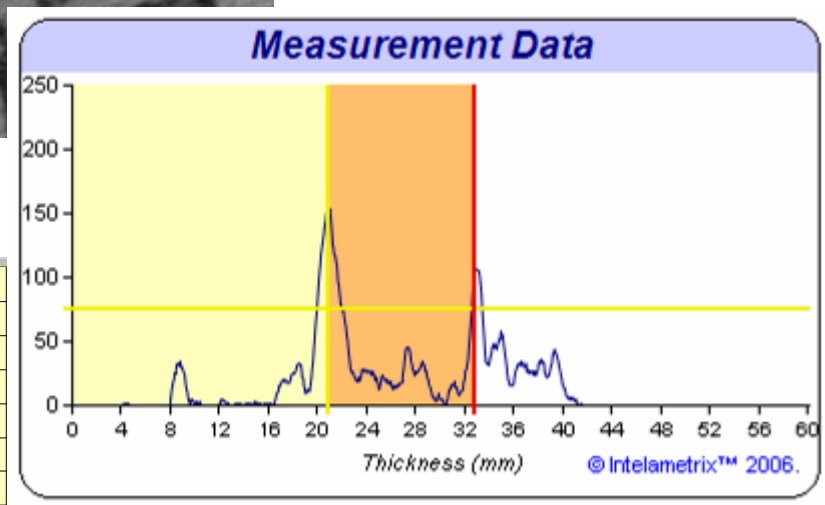
Comparison of X-ray CT



Measured with BodyMetrix 22.9 mm, Muscle 14.1 mm





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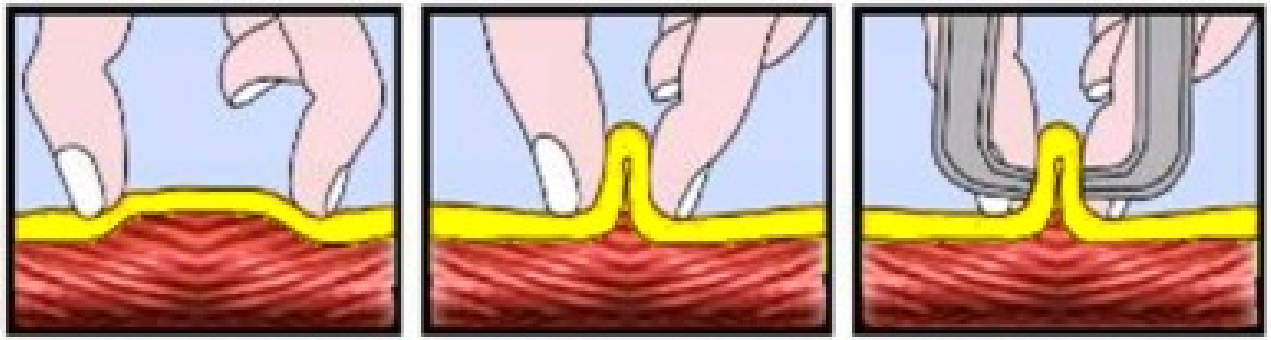
BodyMetrix compared to Calipers



- Calipers measure Skin Fold. NOT FAT THICKNESS
- Caliper measurement can be 1.5 – 3 X Fat Thickness
- In order to calculate %BF with BX-2000 we use a modified caliper formula.

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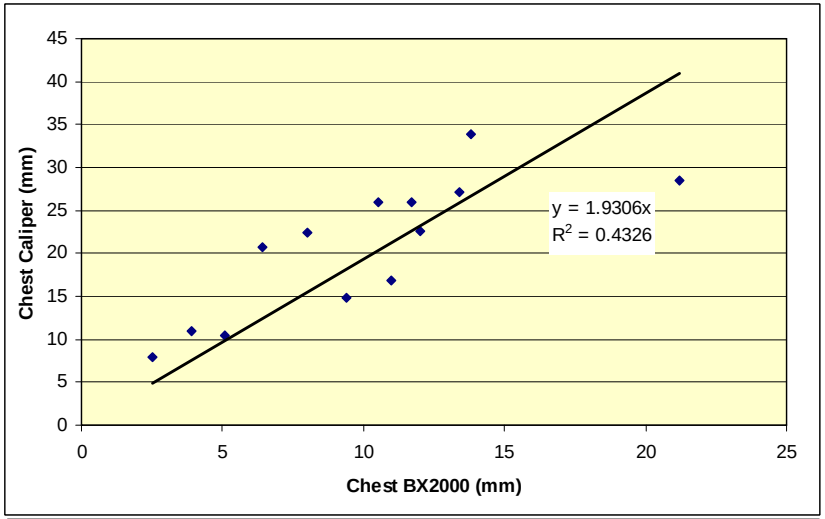
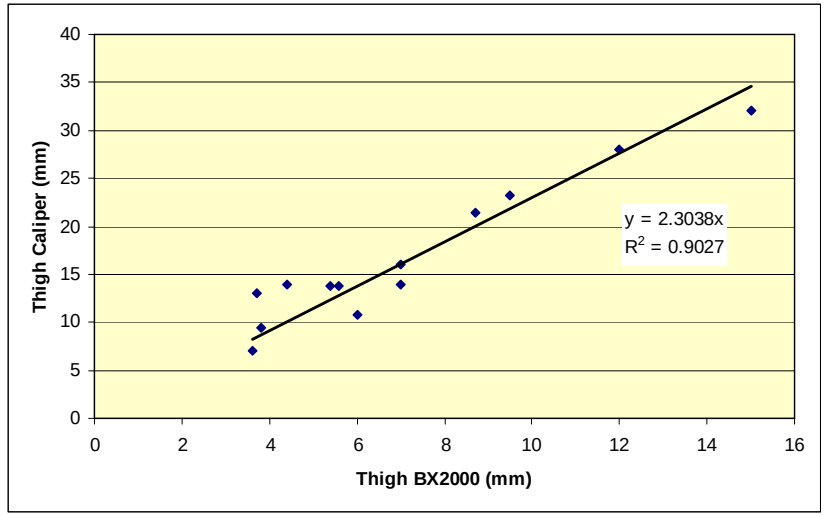
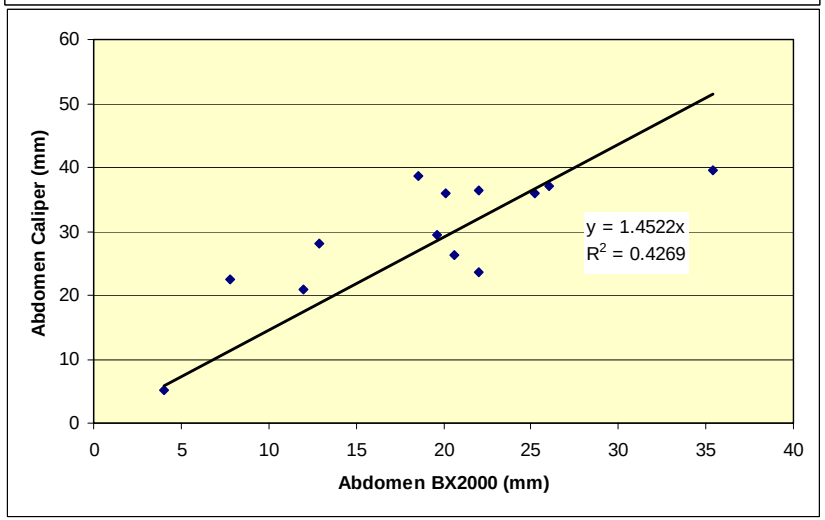
BodyMetrix Compared to Calipers Pepperdine & Firemen Study







Summary

%BF < 10% Difference ± 0.5%

13% < %BF < 20% Difference ± 0.8%

25%< %BF < 30% Difference < 3 %

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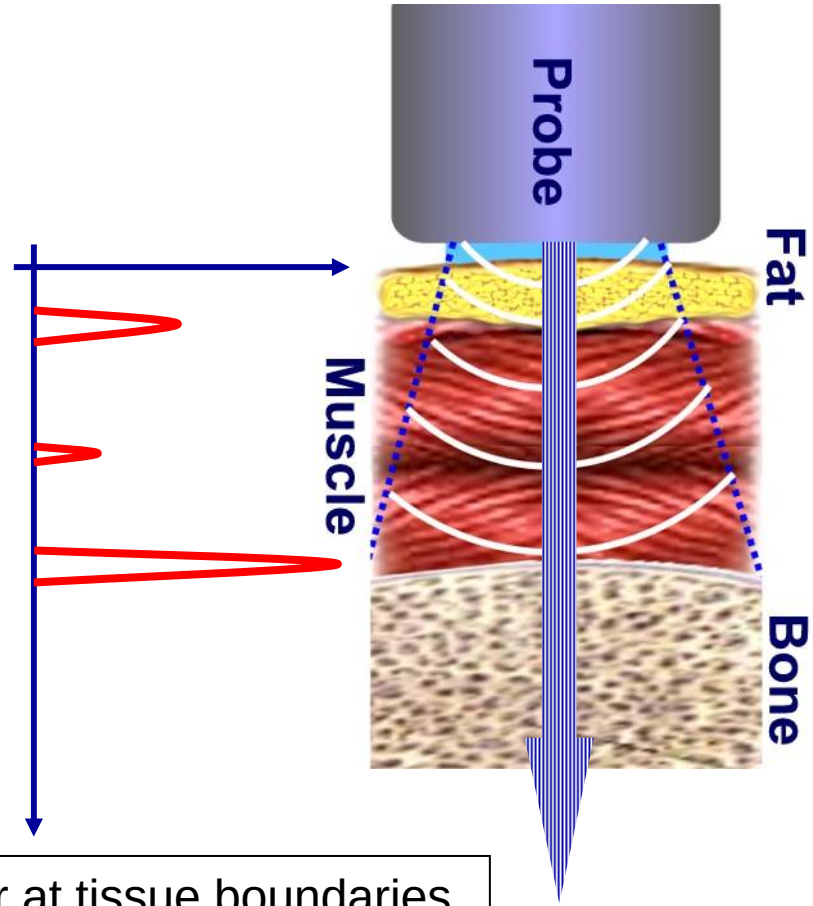
Measurements with BodyMetrix (Normal 1-dimensional mode)

- When used in it's normal mode the BodyMetrix Device is similar to traditional A-mode ultrasound. This simply means that the device gets tissue structure along one line.



Strong signals appear at tissue boundaries.
(e.g. fat-muscle, muscle-bone)

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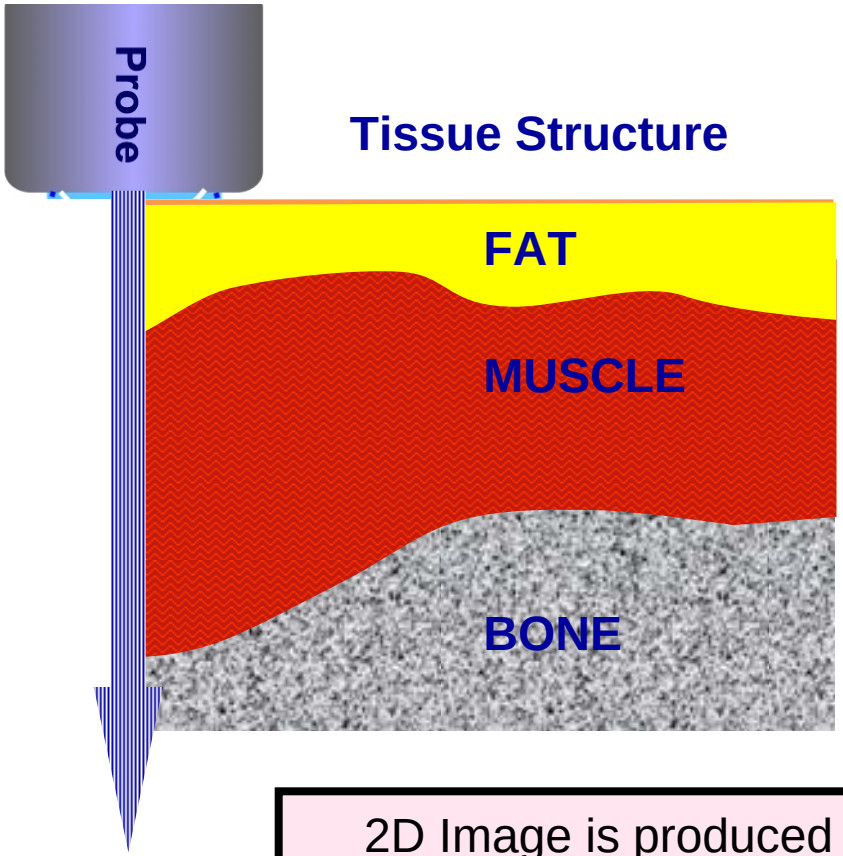
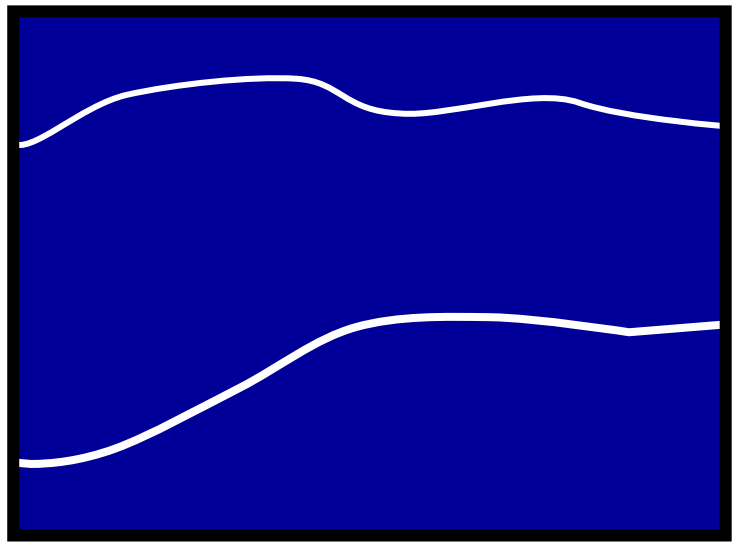
BodyView 2D – Cross-Sectional Imaging



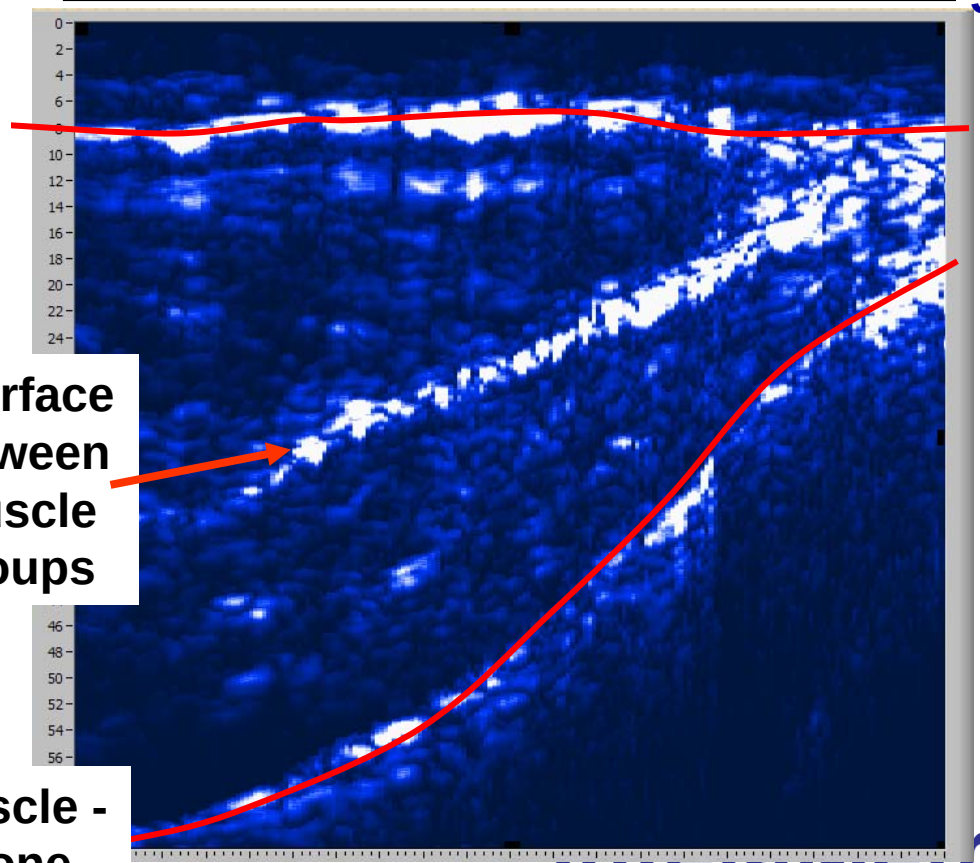


2D Image is produced by building up 1D information.
In the 2D IMAGE white is High Signal blue is Low Signal.
So white is generally seen at tissue interface.

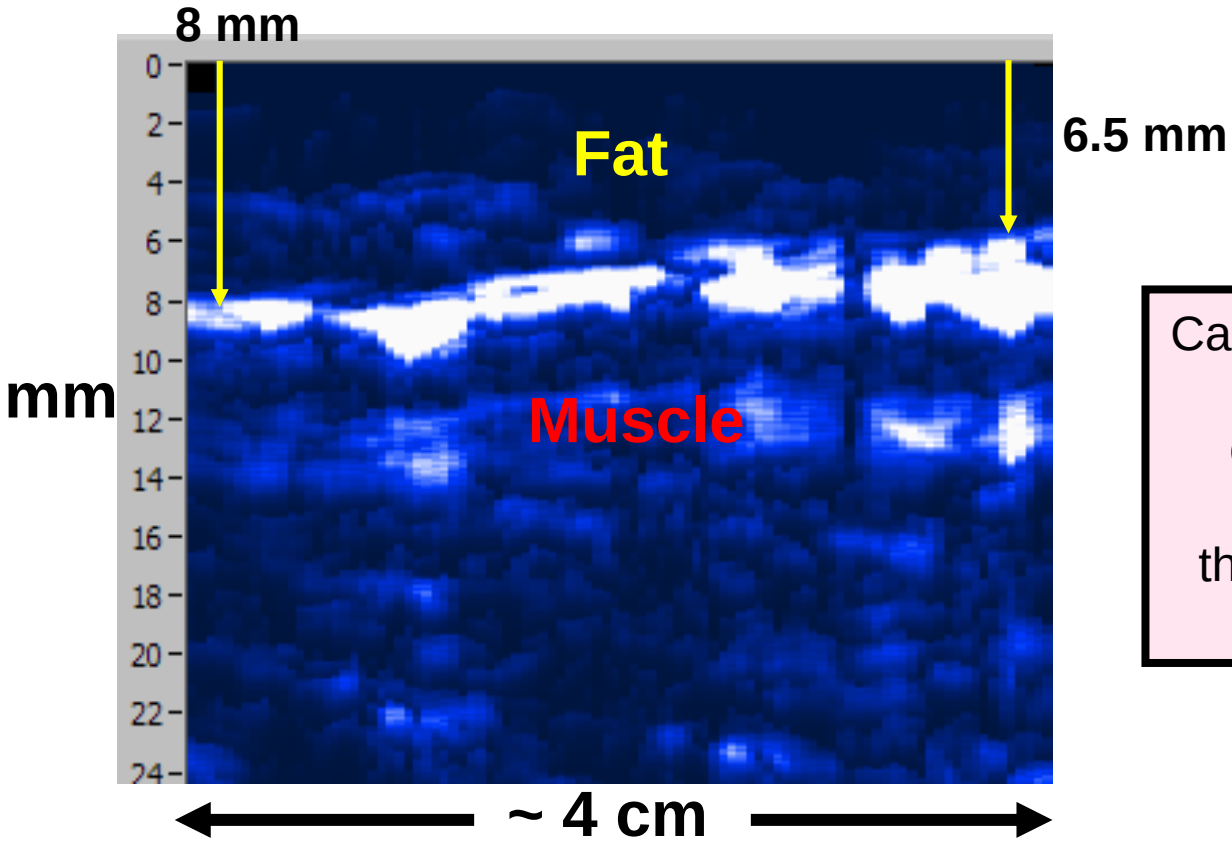
BodyView 2D Image

- BodyView 2D images shows the structure in tissue
- White represents Hig Signal ultrasound reflection, which occurs at tissue boundaries. (e.g. Fat-muscle, Muscle-Bone, Muscle Fascia, Muscle-artery, etc..)
- Intra-muscular fat can also produce strong reflections and white spots inside muscle.

2D Image of Male Thigh, scanning from mid-thigh to knee



BodyView 2D Image



Can be used to see change in Fat Thickness. For example along a 4 cm region on thigh fat thickness varies from 6.5 mm to 8.5 mm

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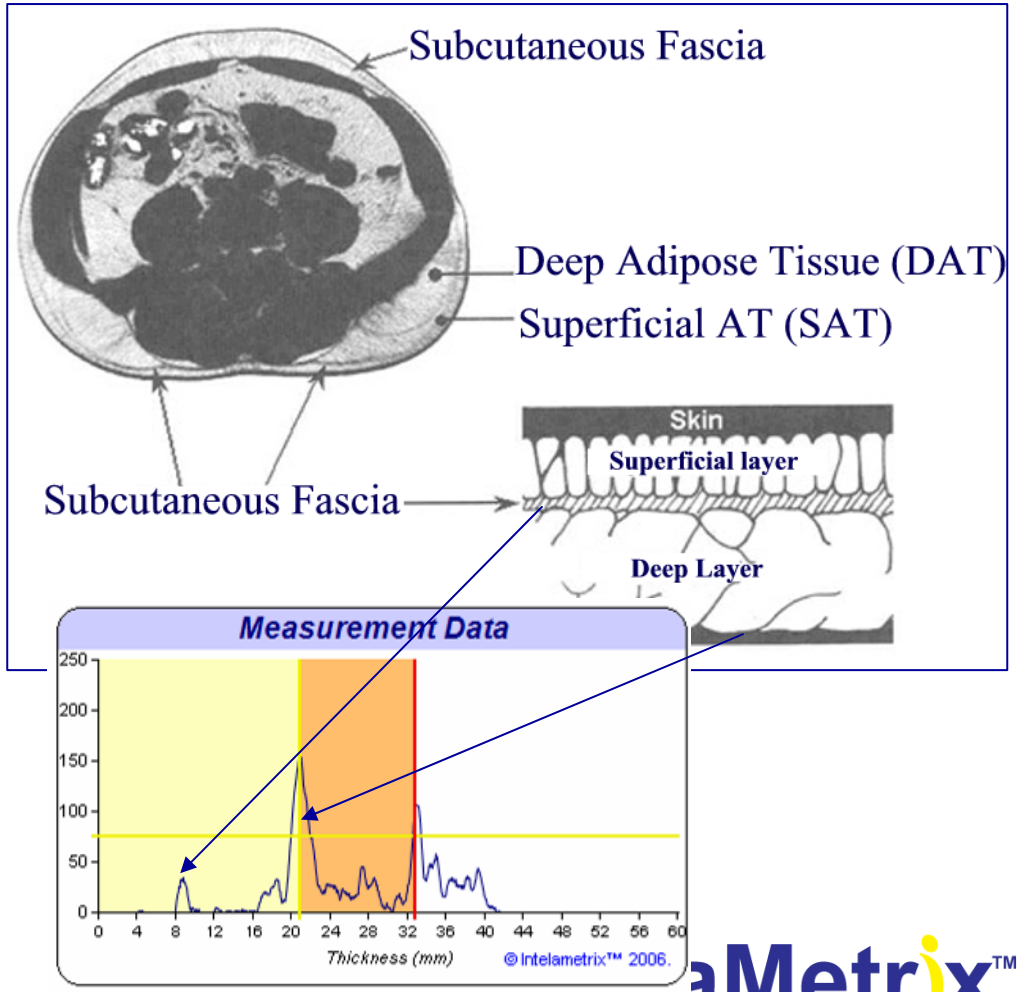
Beyond %BF, Health Risk

- %BF and BMI have weak correlation to Health Risk
- Waist circumference, and Waist to Hip Ratio show good correlation
- Measuring abdominal subcutaneous to detect Superficial AT and Deep AT could provide better diagnostic.



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Validation Studies

- Studies performed at Pepperdine University and Appalachian State University have shown the BX2000 ultrasound measurements to be accurate when compared to Hydrostatic and BodPod measurement.
- Ultrasound has the unique potential to evaluate fat-muscle structure and muscle quality.

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