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Best Practice & Quality
DXA pitfalls and errors

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–Clinical Lead Quality Improvement

21 May 2019

Topics

- Introduction- why?
- Re-cap Best Practice in DXA technique
  - Acquisition
  - Analysis
- Case studies
- Discussion

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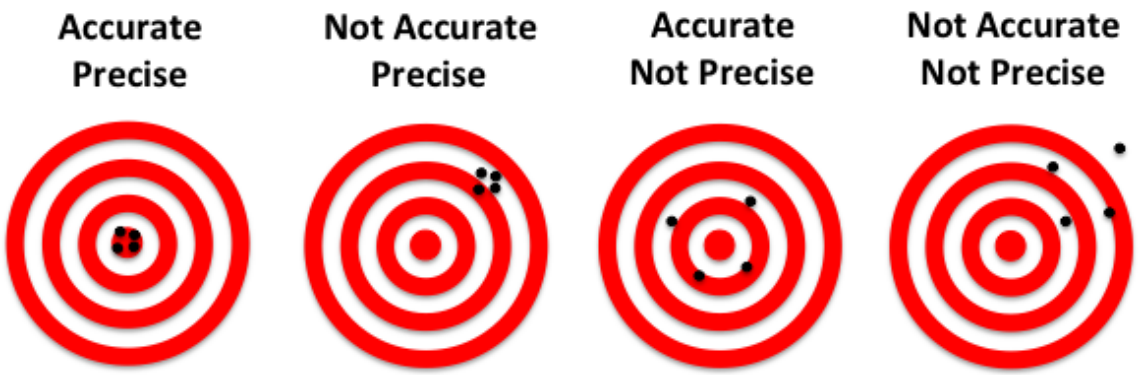
WHY?

Best practice WHY?

PRECISION
PRECISION
PRECISION



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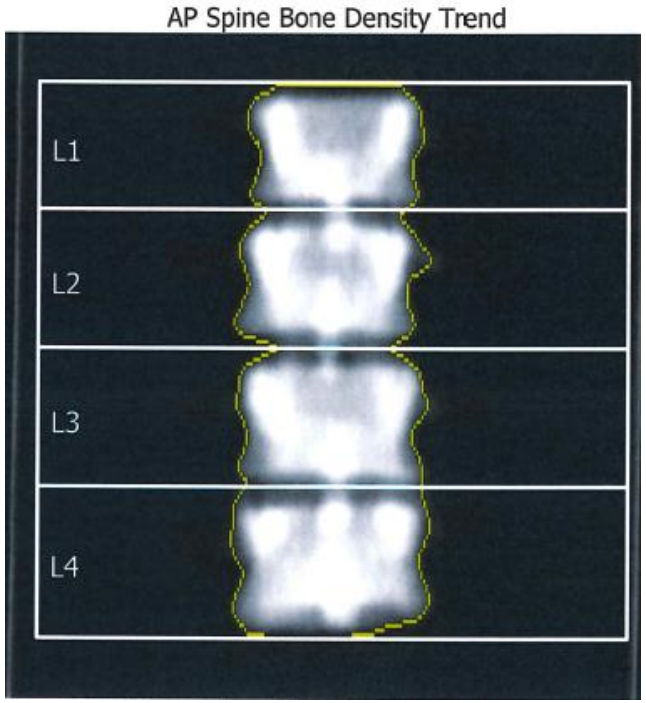
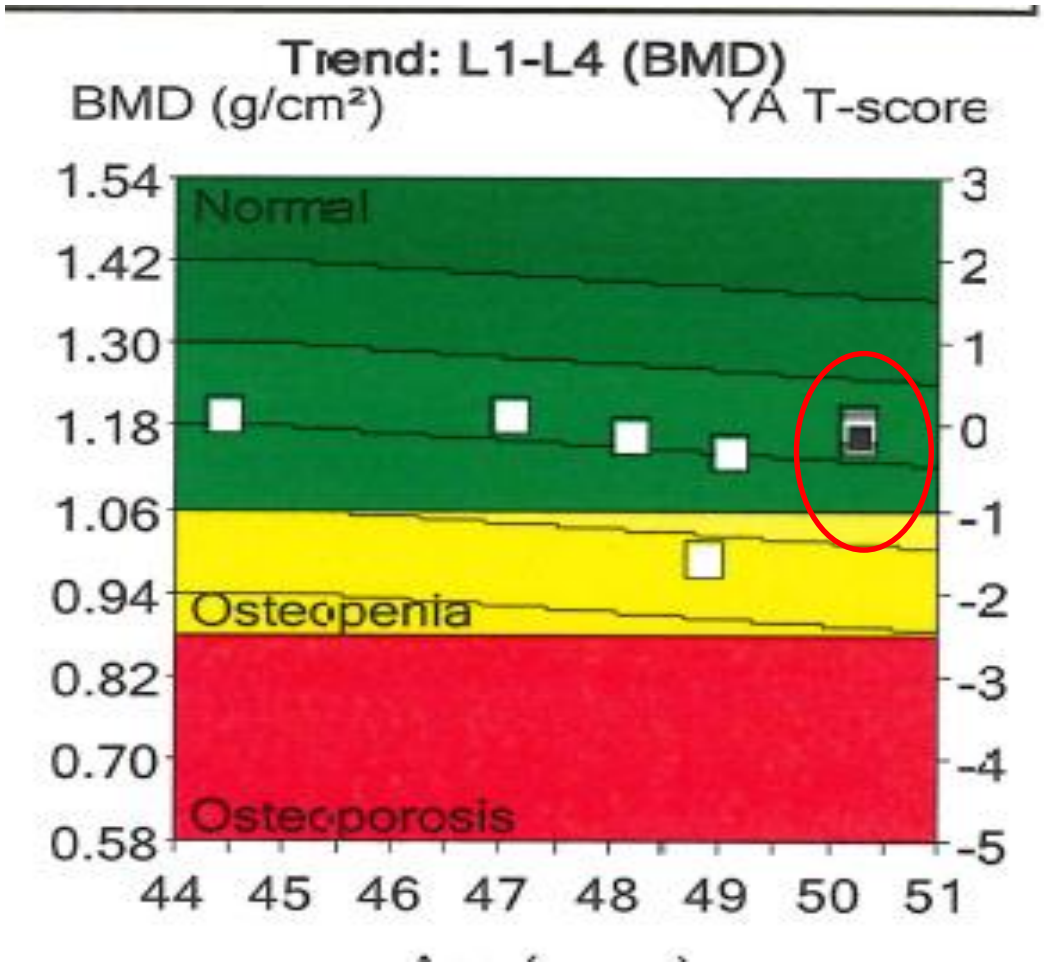


Measurement date	BMD g/cm2	% change against previous
19.04.2019	1.172	0.4
19.04.2019	1.167	0.3
19.04.2019	1.163	-0.2
19.04.2019	1.165	-0.2
19.04.2019	1.167	-0.3



0.7% change

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Precision

Measurement date	BMD g/cm2	% change against previous
19.04.2019	1.188	-0.3
18.04.2019	1.192	-0.3
15.04.2019	1.196	0.6
14.04.2019	1.189	0.8
13.04.2019	1.180	-0.2

1.1% change over 5 samples

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Rates of Change

Least significant change:

The least significant change is the minimum change in BMD between two scans on the same individual that indicate a real increase or decrease in BMD.

It is calculated as 2.77 times the long-term precision error (co-efficient of variation) of the Equipment (3)

3. Glüer C-C. Monitoring skeletal changes by radiological techniques. J Bone Miner Res 1999;14(11):1952–62. http://dx.doi.org/10.1359/jbmr.1999.14.11.1952

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Rates of change

Long term precision errors- in a clinical cohort- for lumbar spine and total femur BMD = 1.6% (4)

LSC in clinical practice = 4.5%

(4) Patel R, Blake GM, Rymer J, Fogelman I. Long-term precision of DXA scanning assessed over seven years in forty postmenopausal women. Osteoporos Int 2000; 11: 68-75

Pitfalls

- **Precision errors can be increased by:**
- many operators/not following tight protocols- poor positioning for scans
- Equipment drift
- Patient condition
- Obesity
  - Spine – inhomogeneity
  - Hip – fat panniculus

Pitfalls

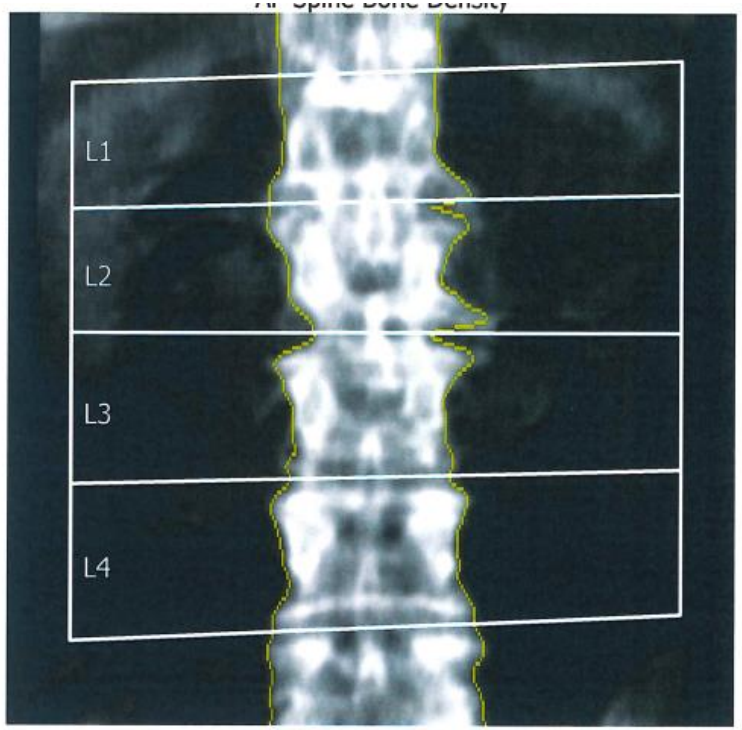
- **Precision errors can be increased by:**
- many operators/not following tight protocols- poor positioning for scans
- Equipment drift
- Patient condition
- Obesity
  - Spine – inhomogeneity
  - Hip – fat panniculus

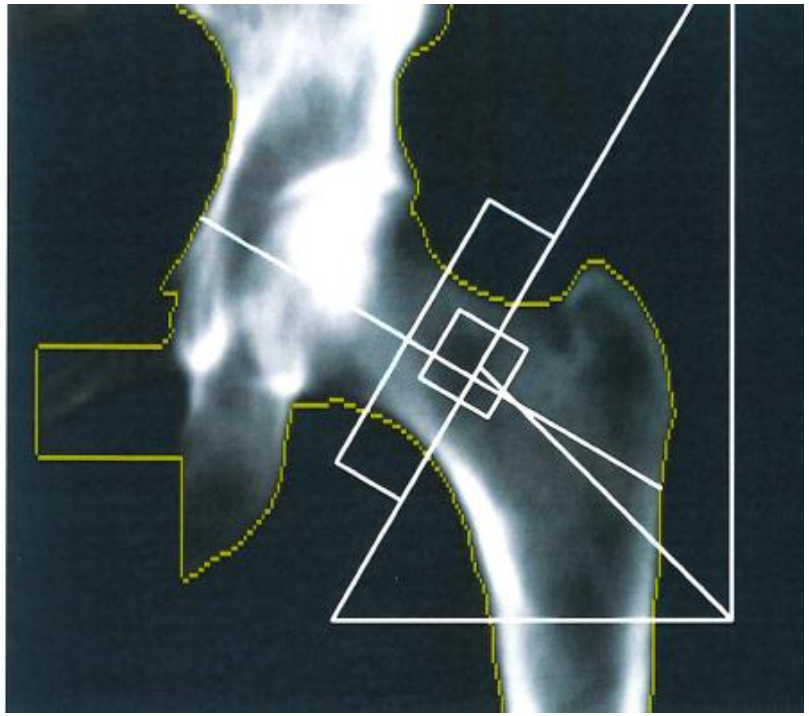
Re-cap Best Practice in DXA technique

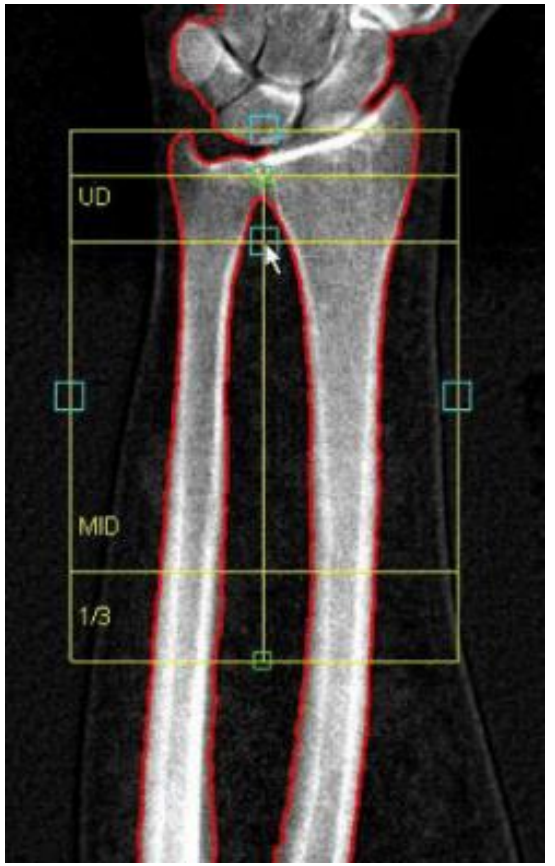
- Acquisition
- Analysis

Best Practice- positioning

- WHO 1994
  - Lumbar spine, proximal femur & distal forearm validated sites for diagnosis







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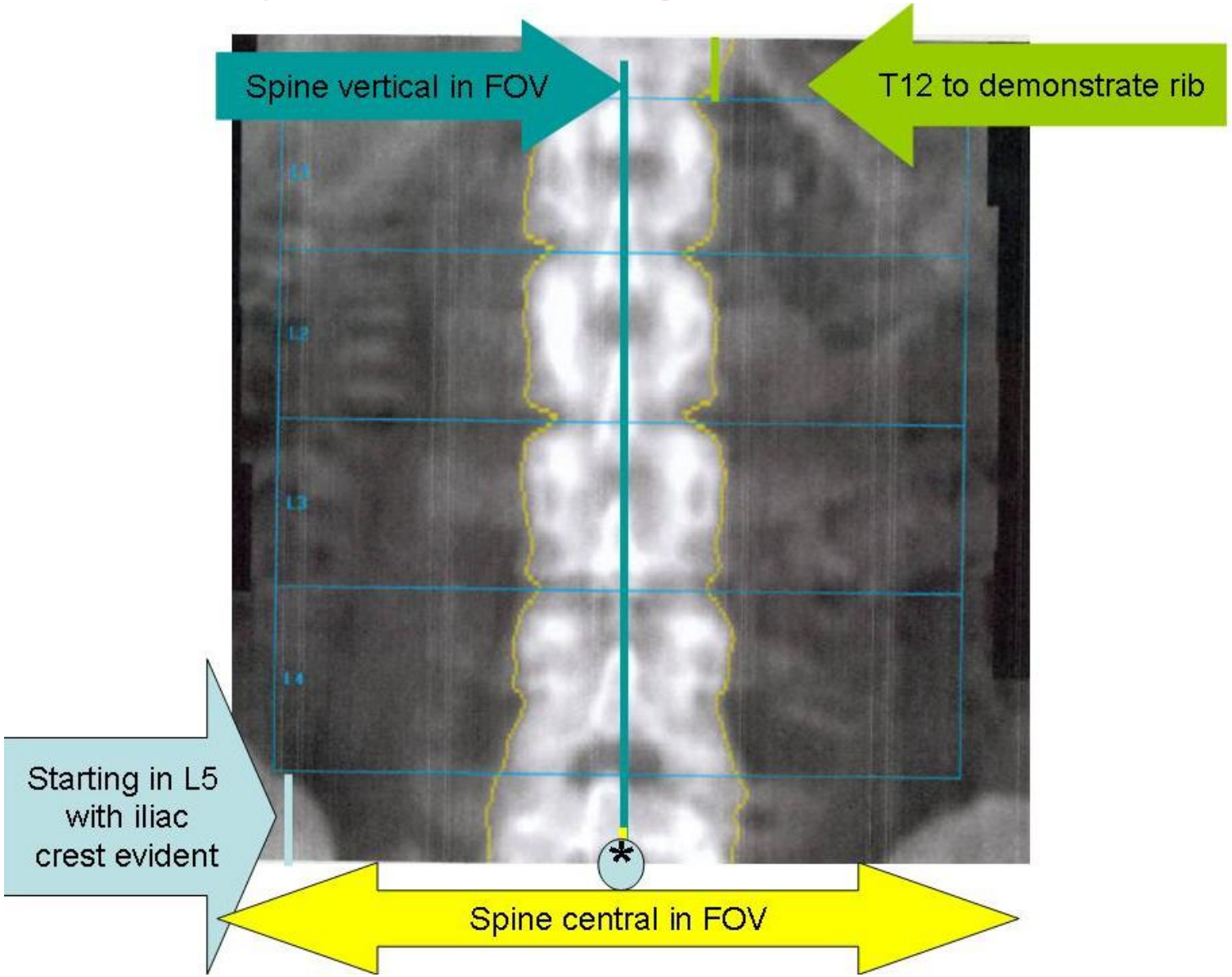
Best Practice- positioning



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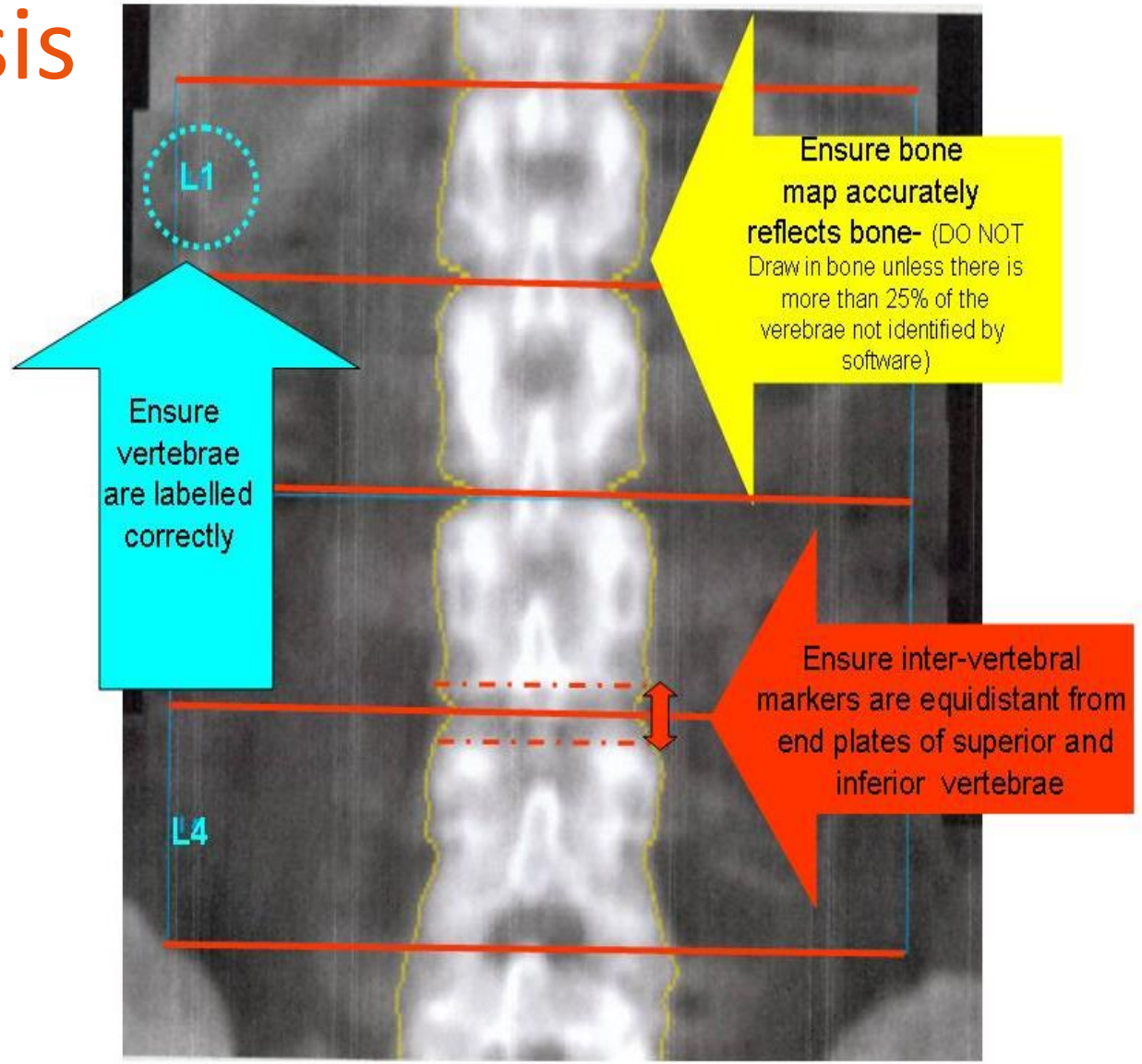
Best Practice- analysis

- **Bone map**
- **Nomenclature**
- **IVM**



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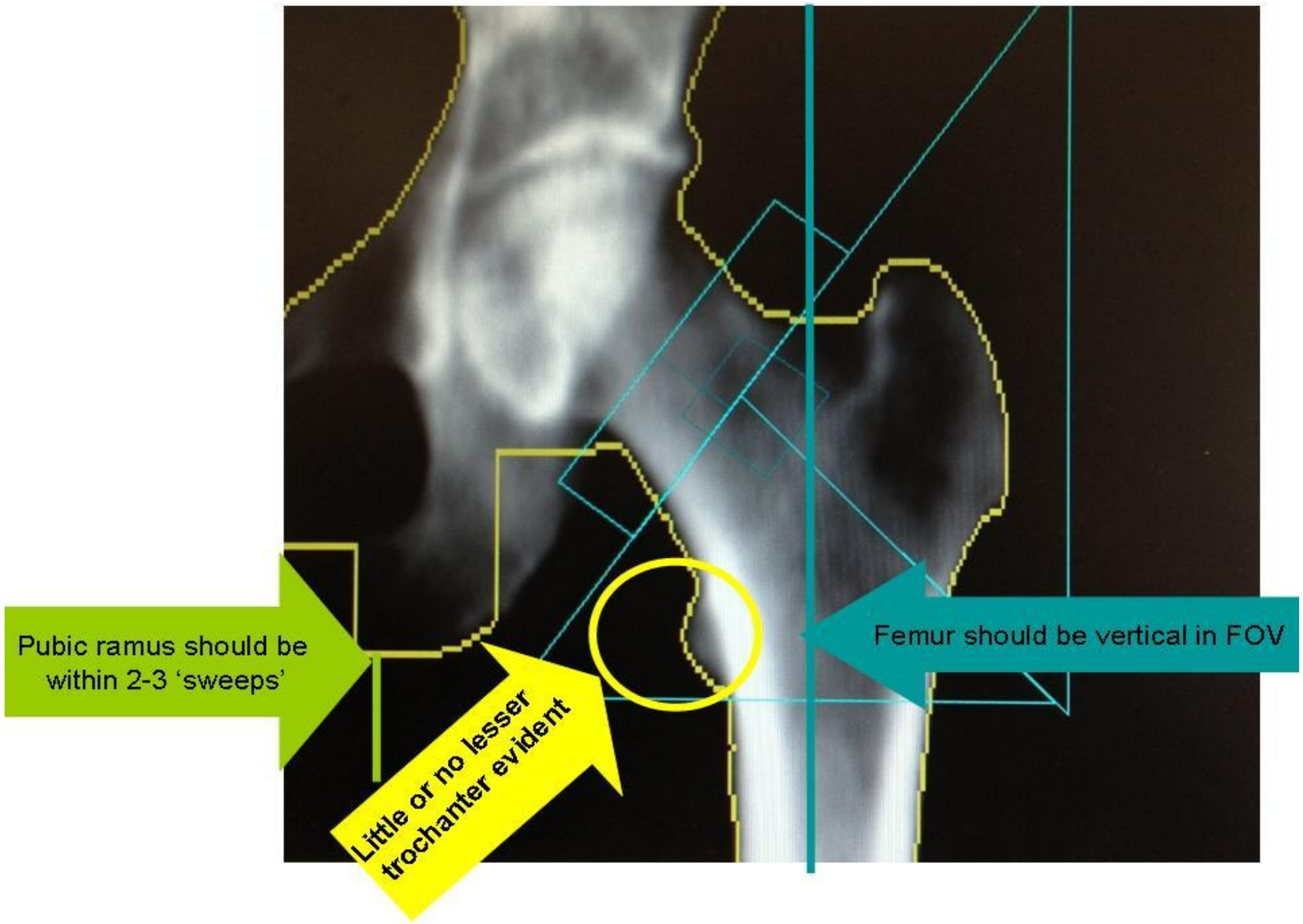
Best Practice- positioning



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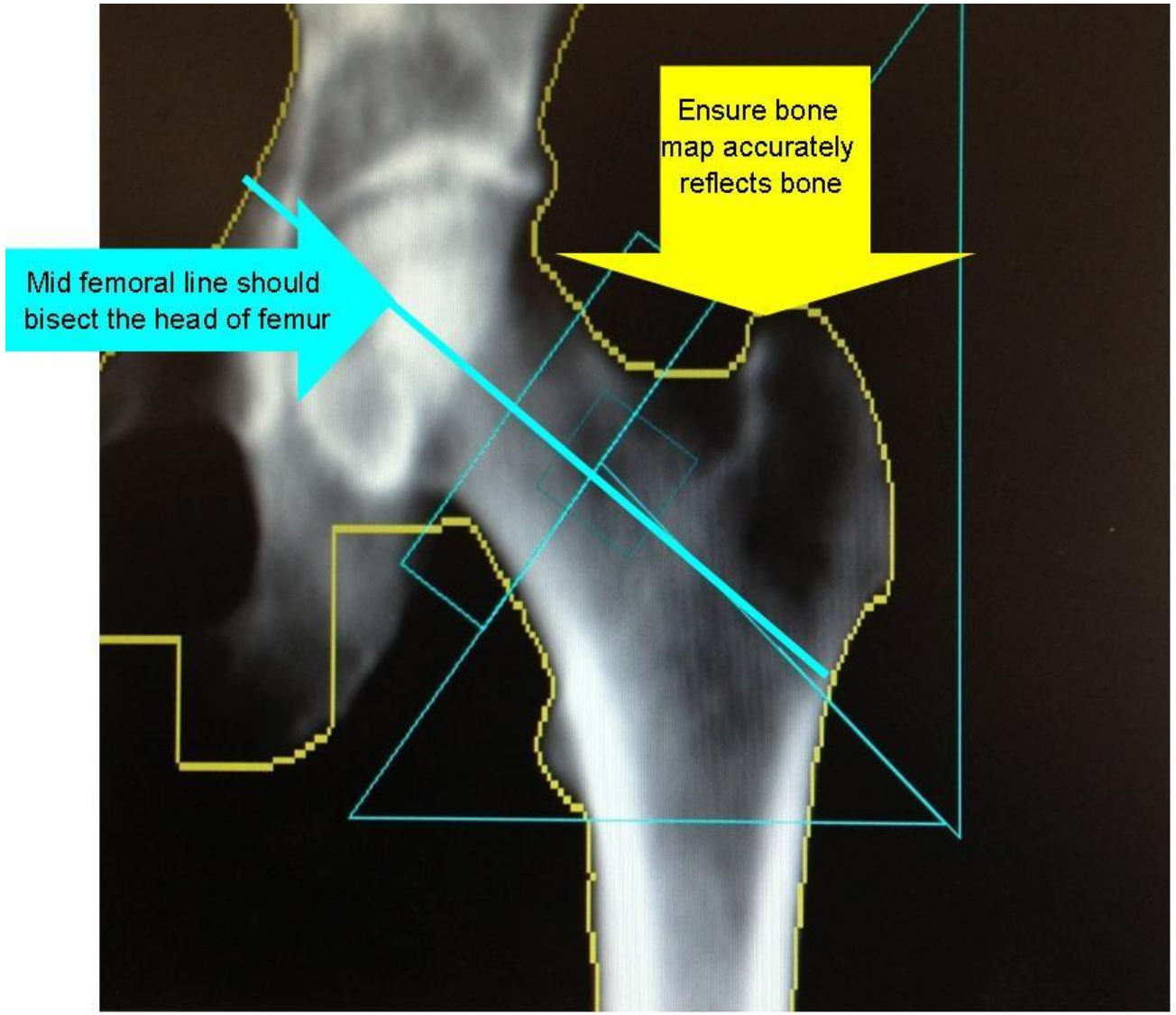
Best Practice- analysis



GE Lunar
& Hologic scanner differences

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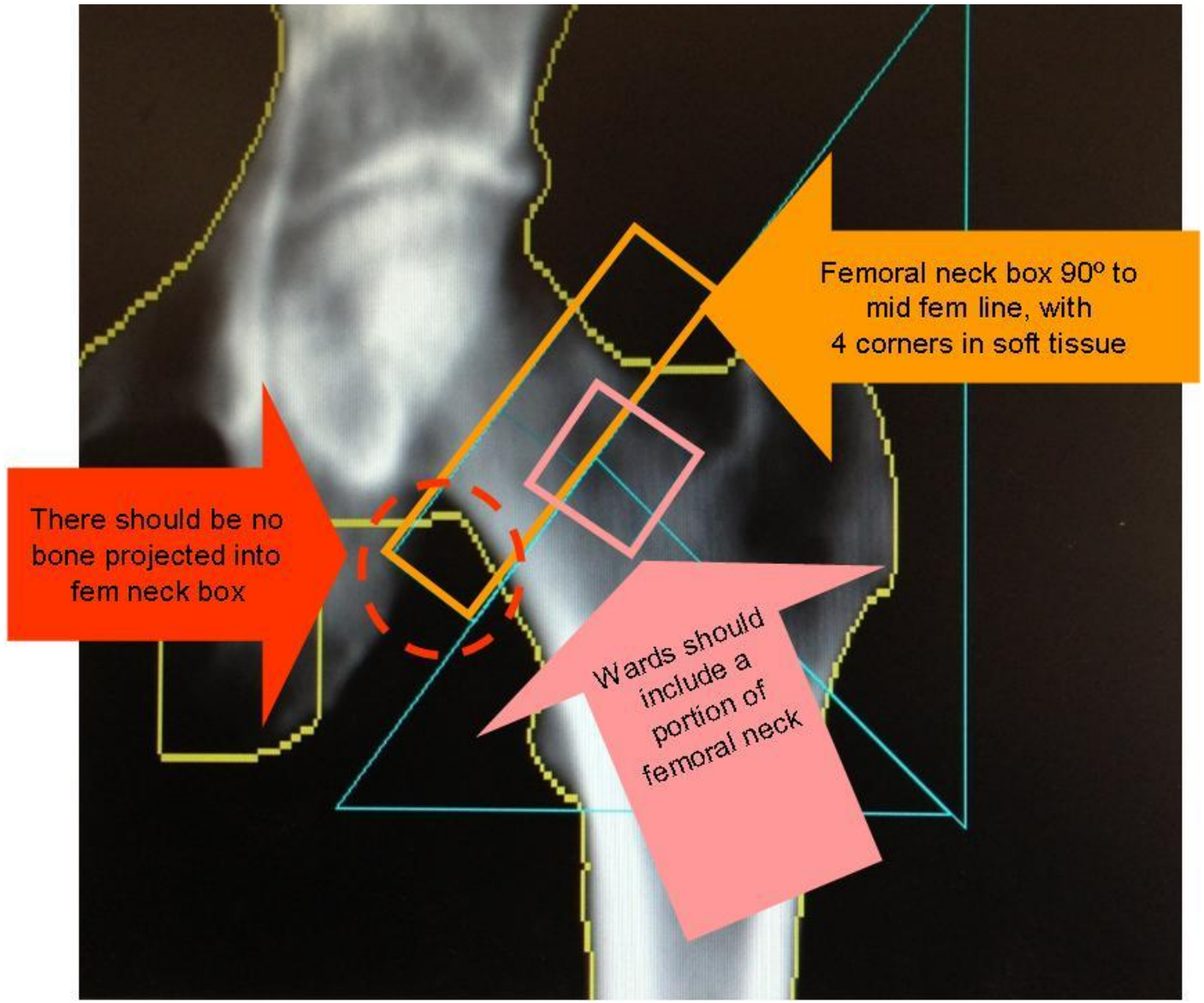
Best Practice- analysis



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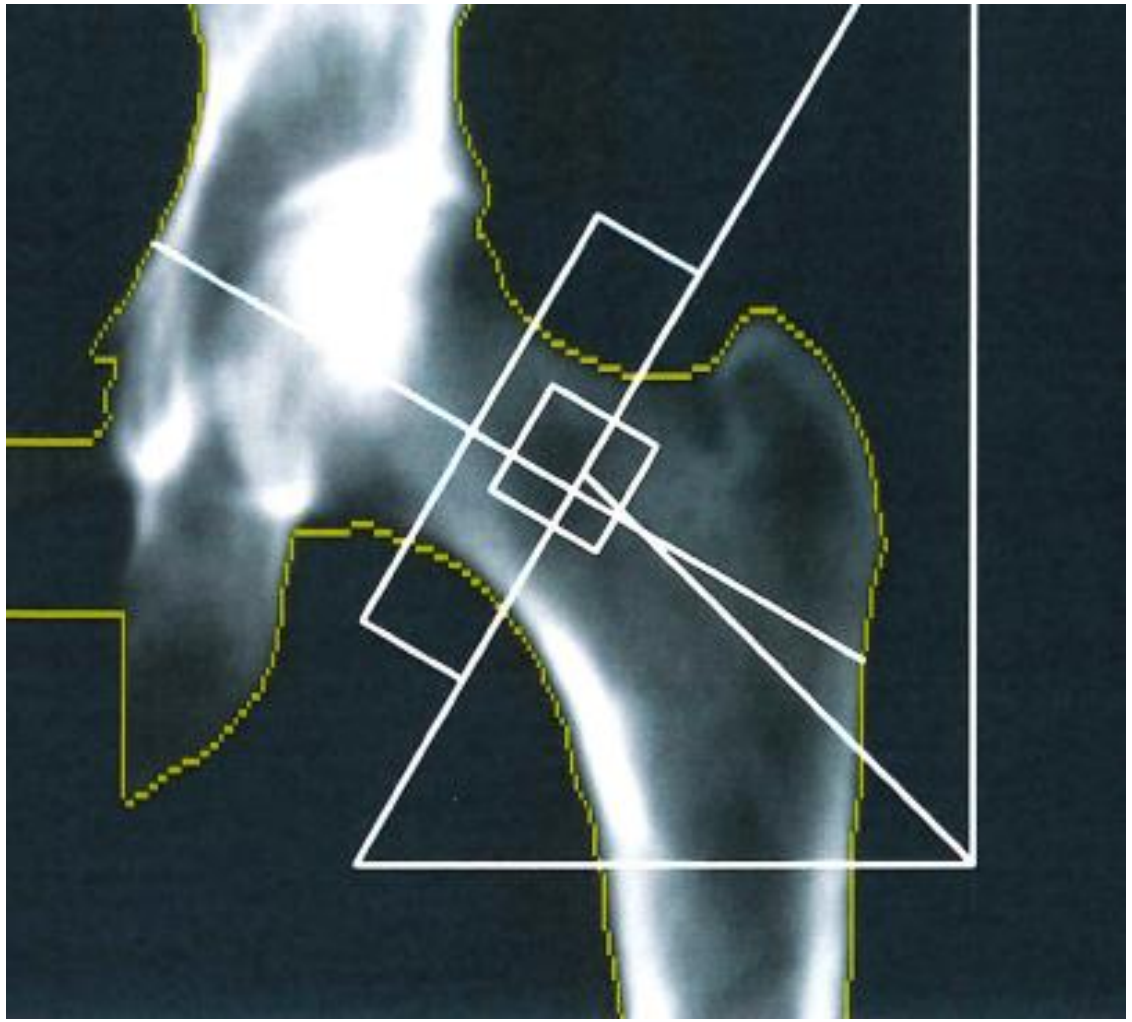

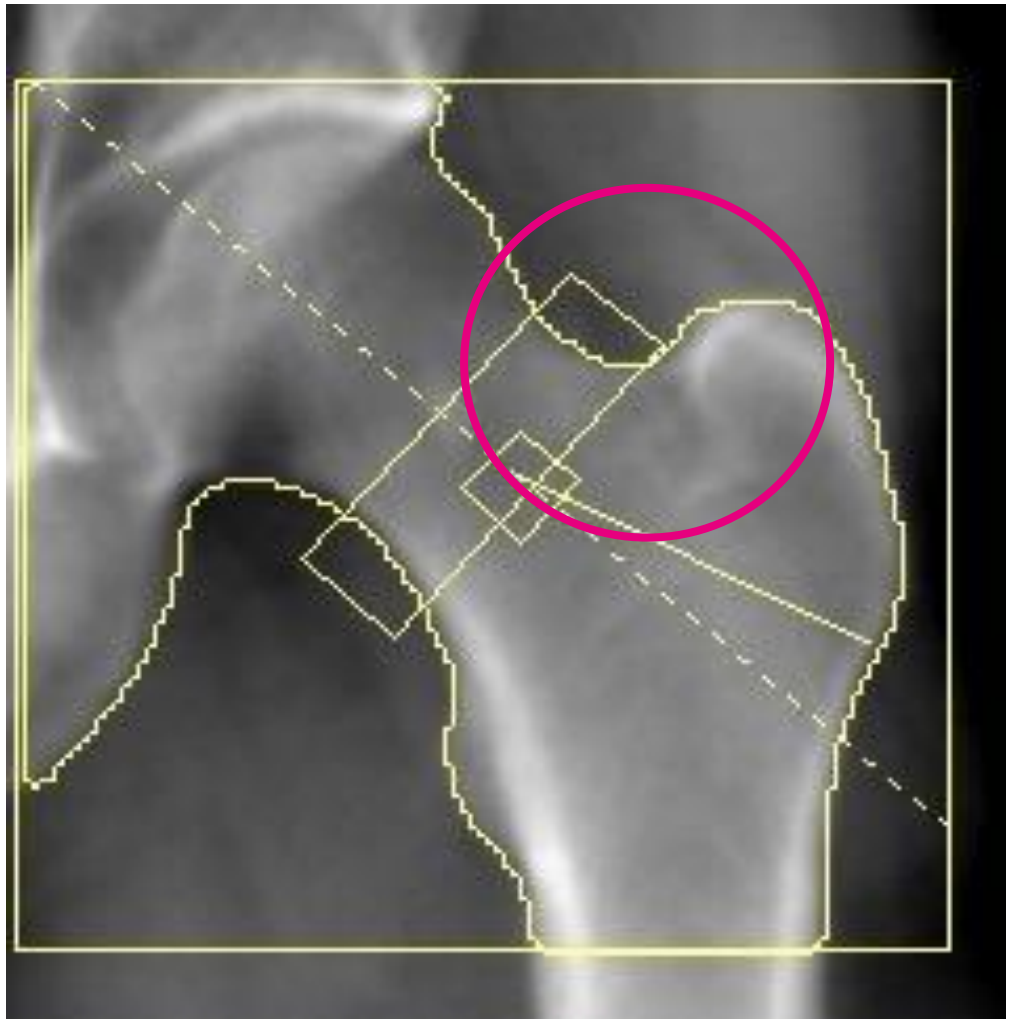

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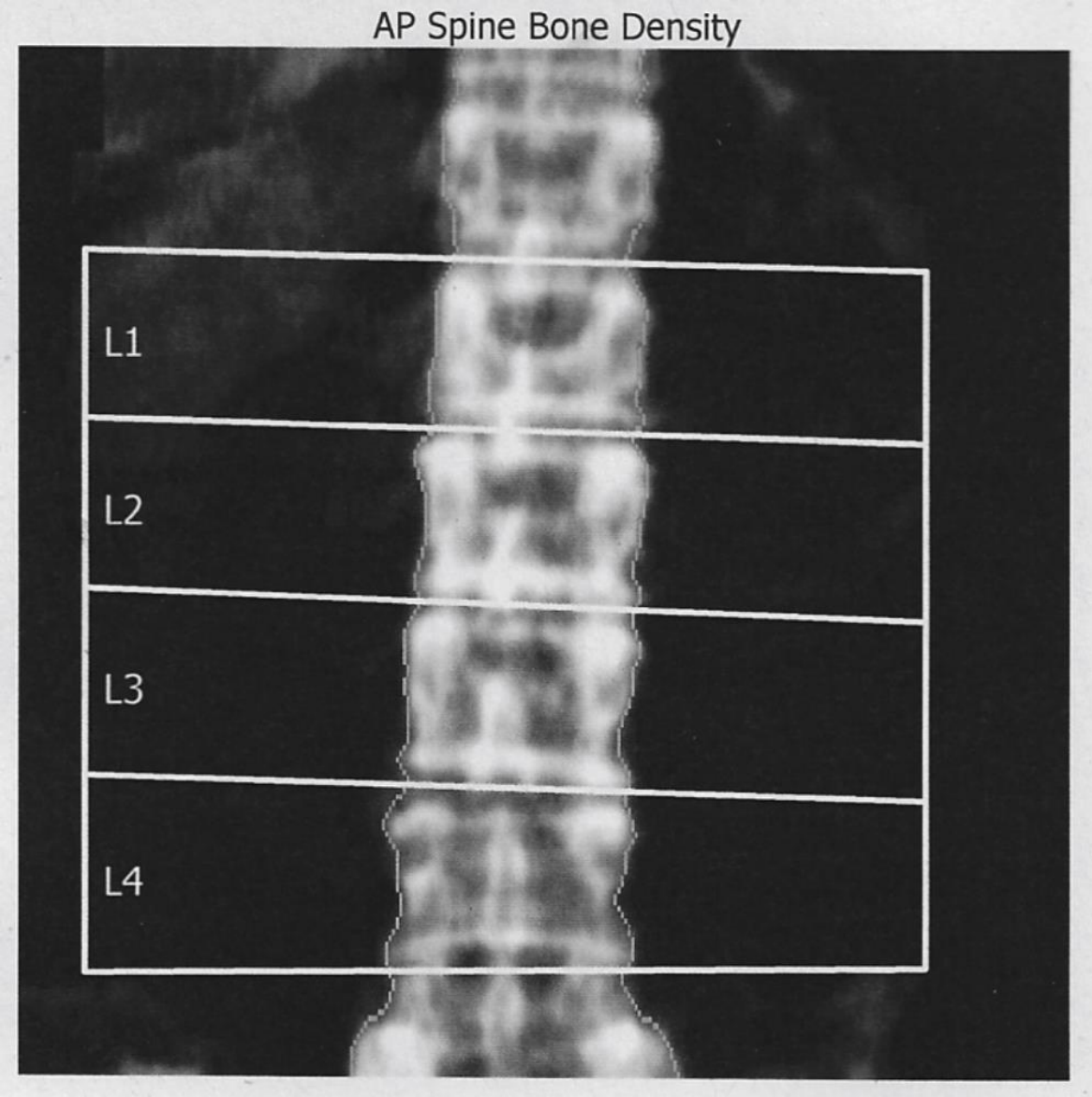
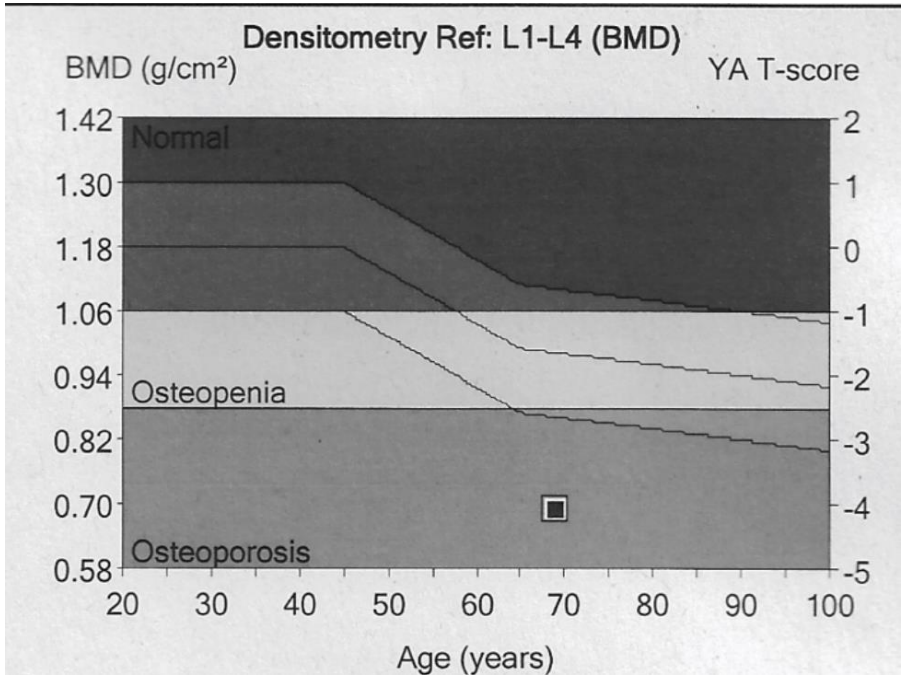
Case Studies

Spine 1



Region	BMD g/cm2	T-score	Z-score
L1-4	0.689	-4.1	-2.4



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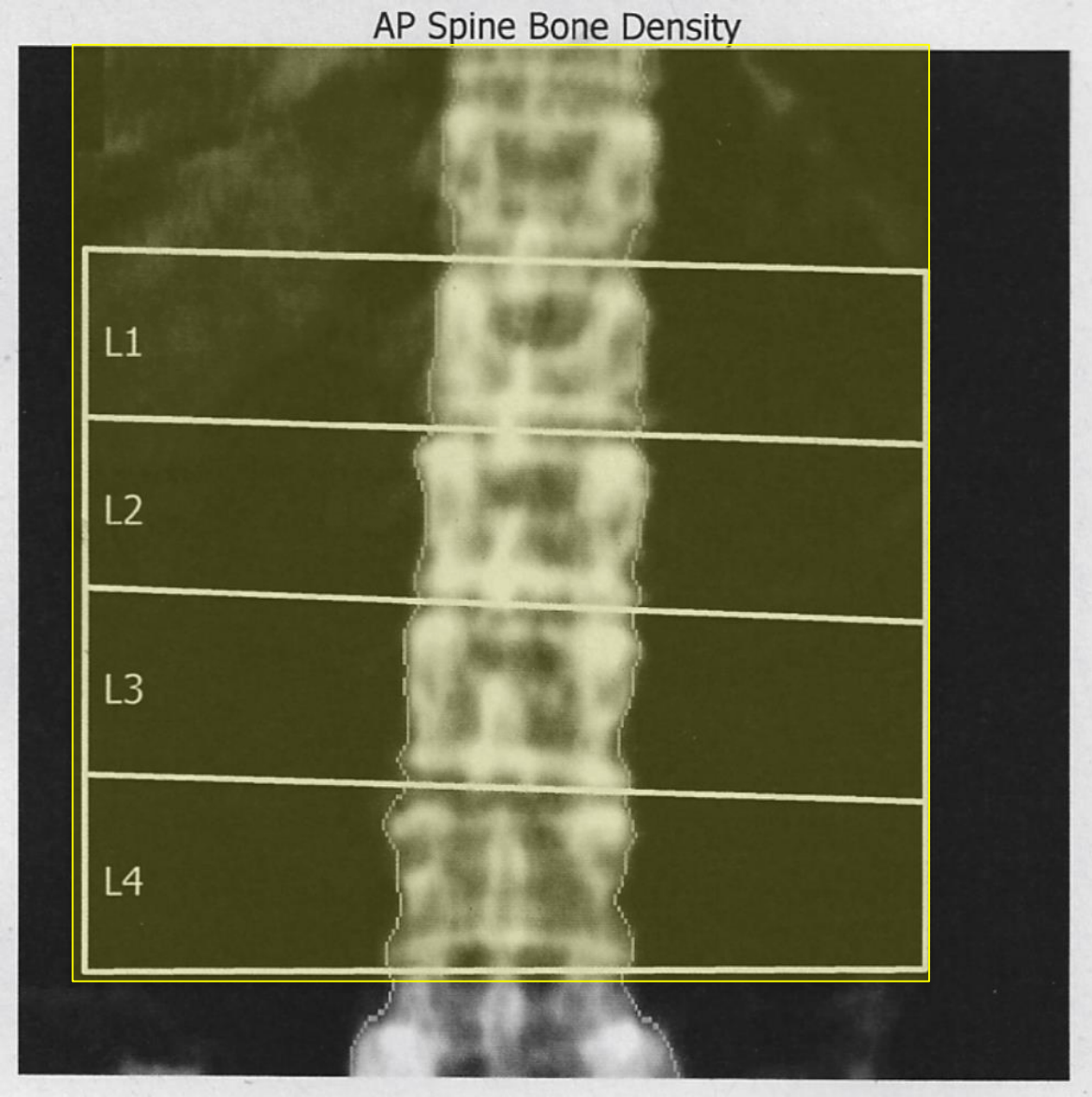
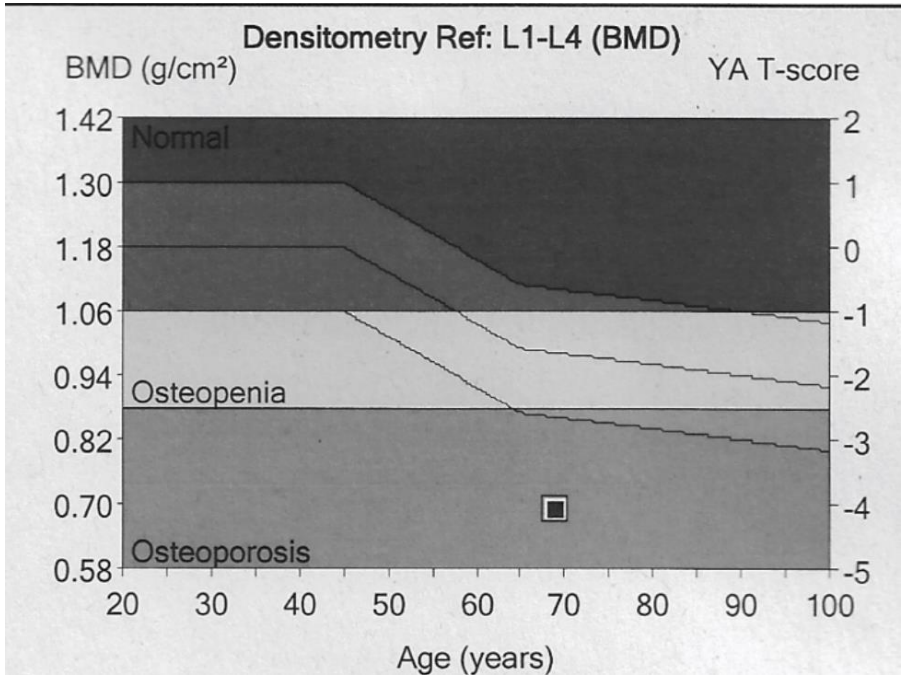
Spine 1



Region	BMD g/cm2	T-score	Z-score
L1-4 excess ST value	0.689	-4.1	-2.4



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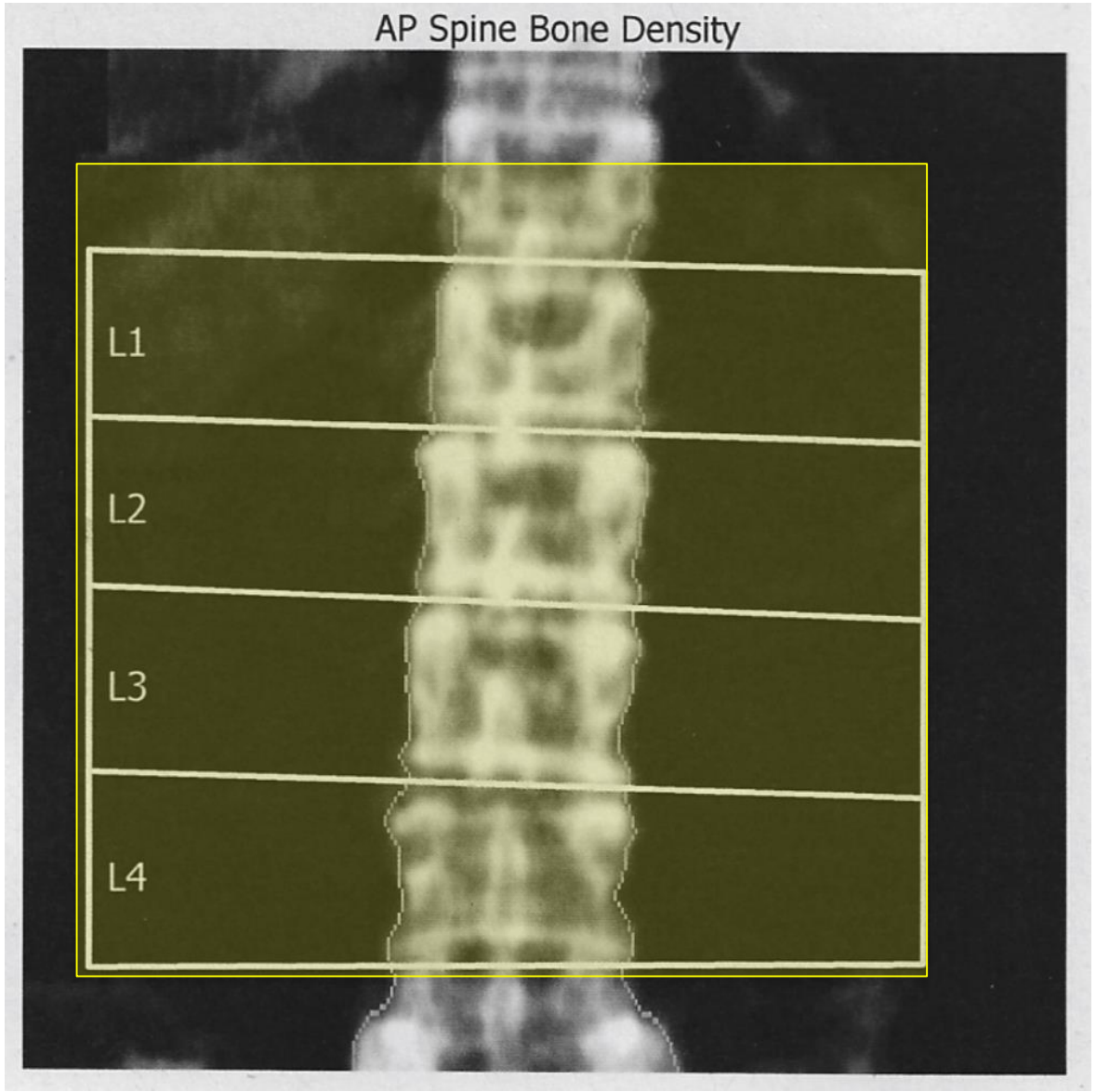
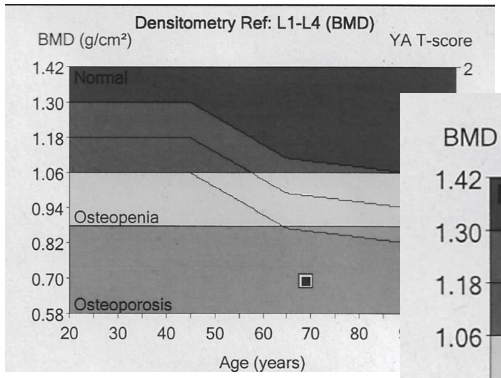
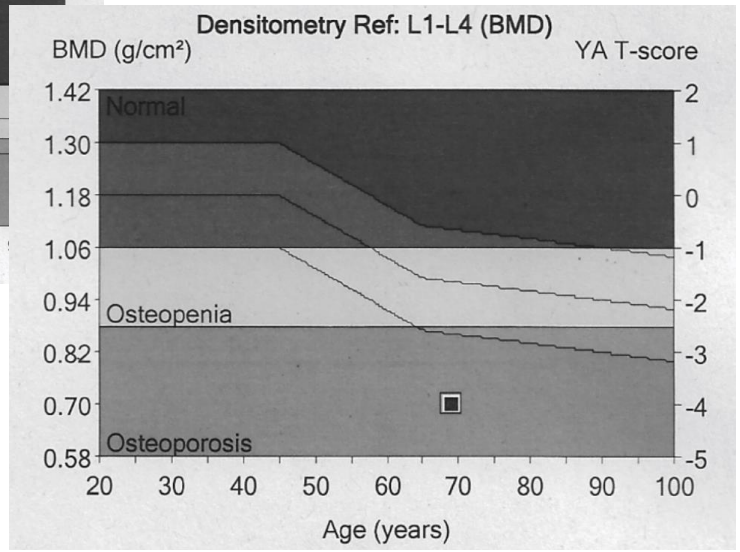
Spine 1



Region	BMD g/cm2	T-score	Z-score
L1-4 excess ST value	0.689	-4.1	-2.4
L1-4 corrected	0.699	-4.0	-2.4





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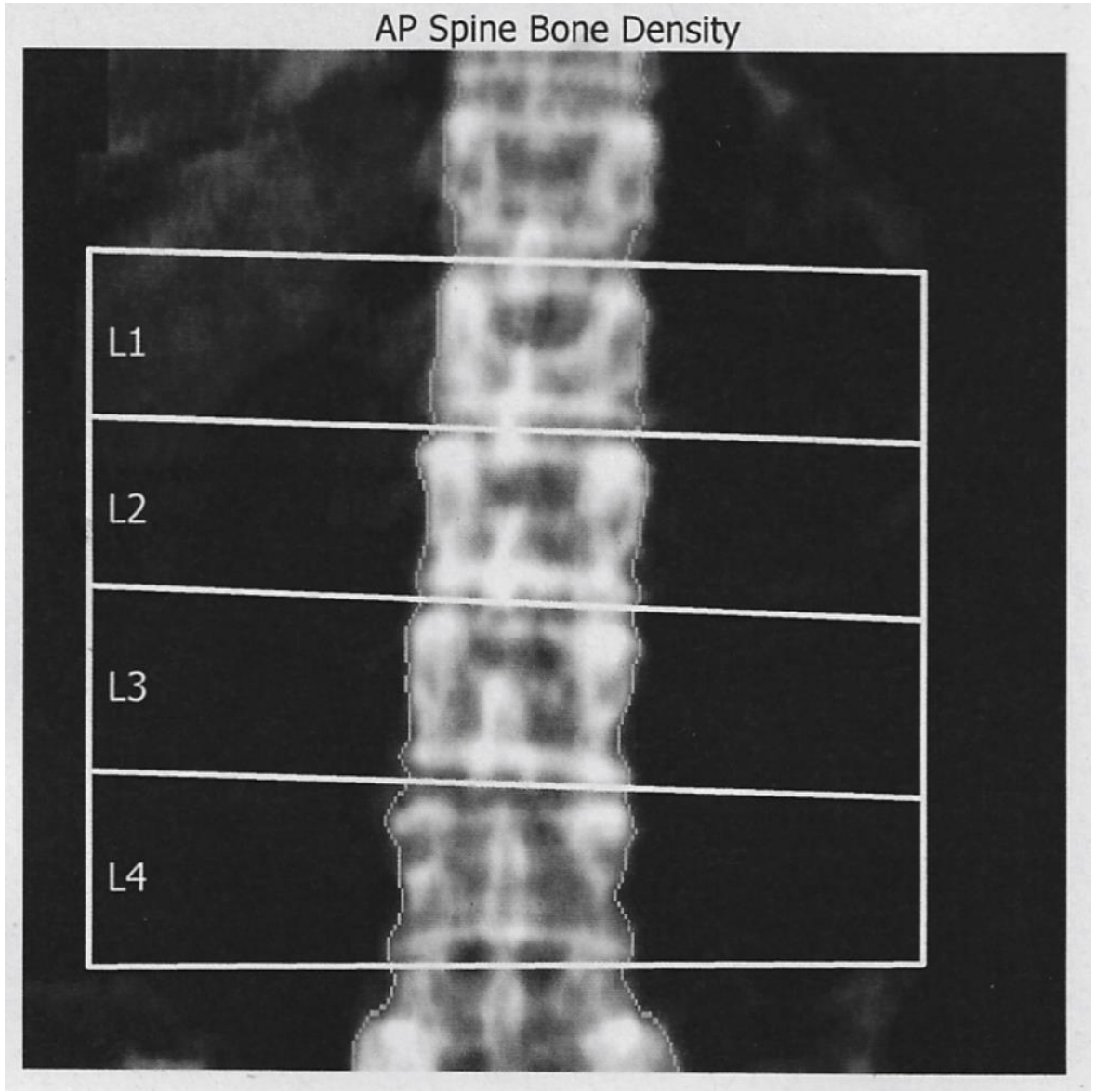
Spine 1



Region	BMD g/cm2	T-score	Z-score
L1-4 excess ST value	0.689	-4.1	-2.4
L1-4 corrected	0.699	-4.0	-2.4

Error effect Increased soft tissue area

Increased precision error	Decreased BMD Decreased reliability

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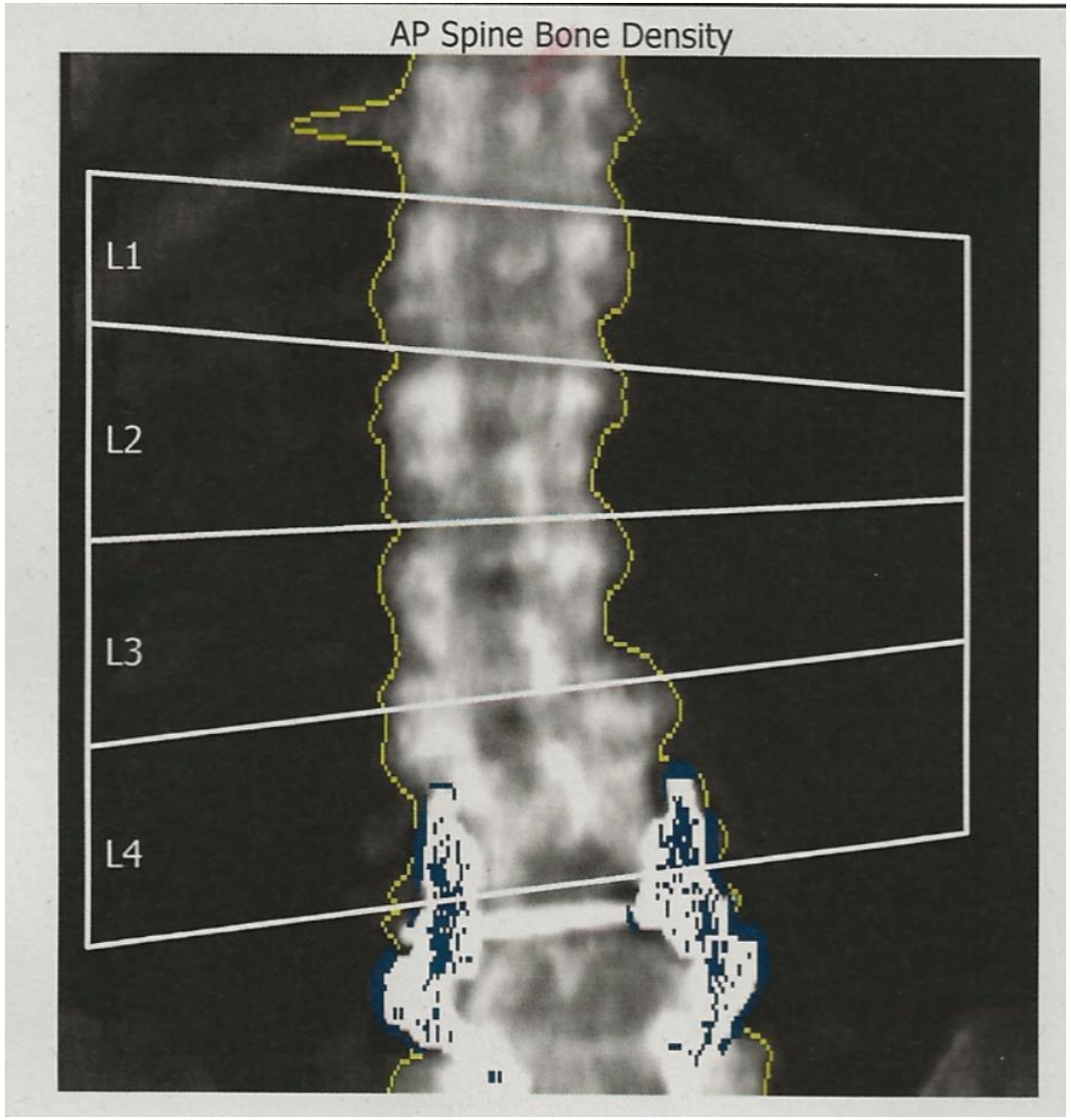
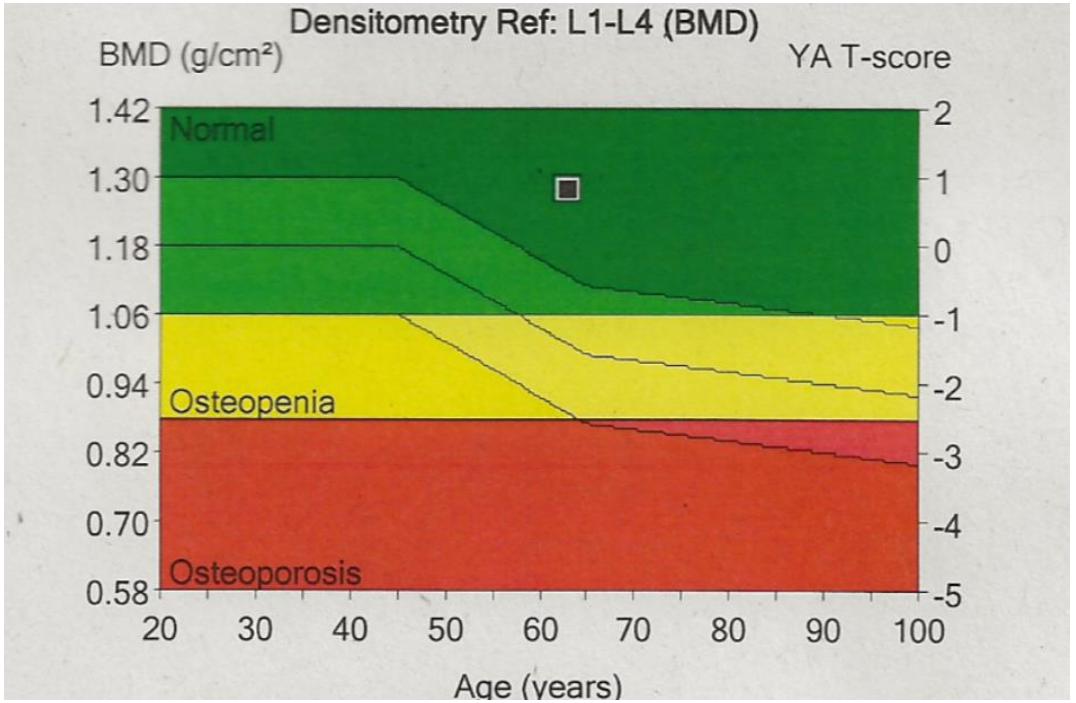
Spine 2



Region	BMD g/cm2	T-score	Z-score
L1-4	1.277	0.8	2.2



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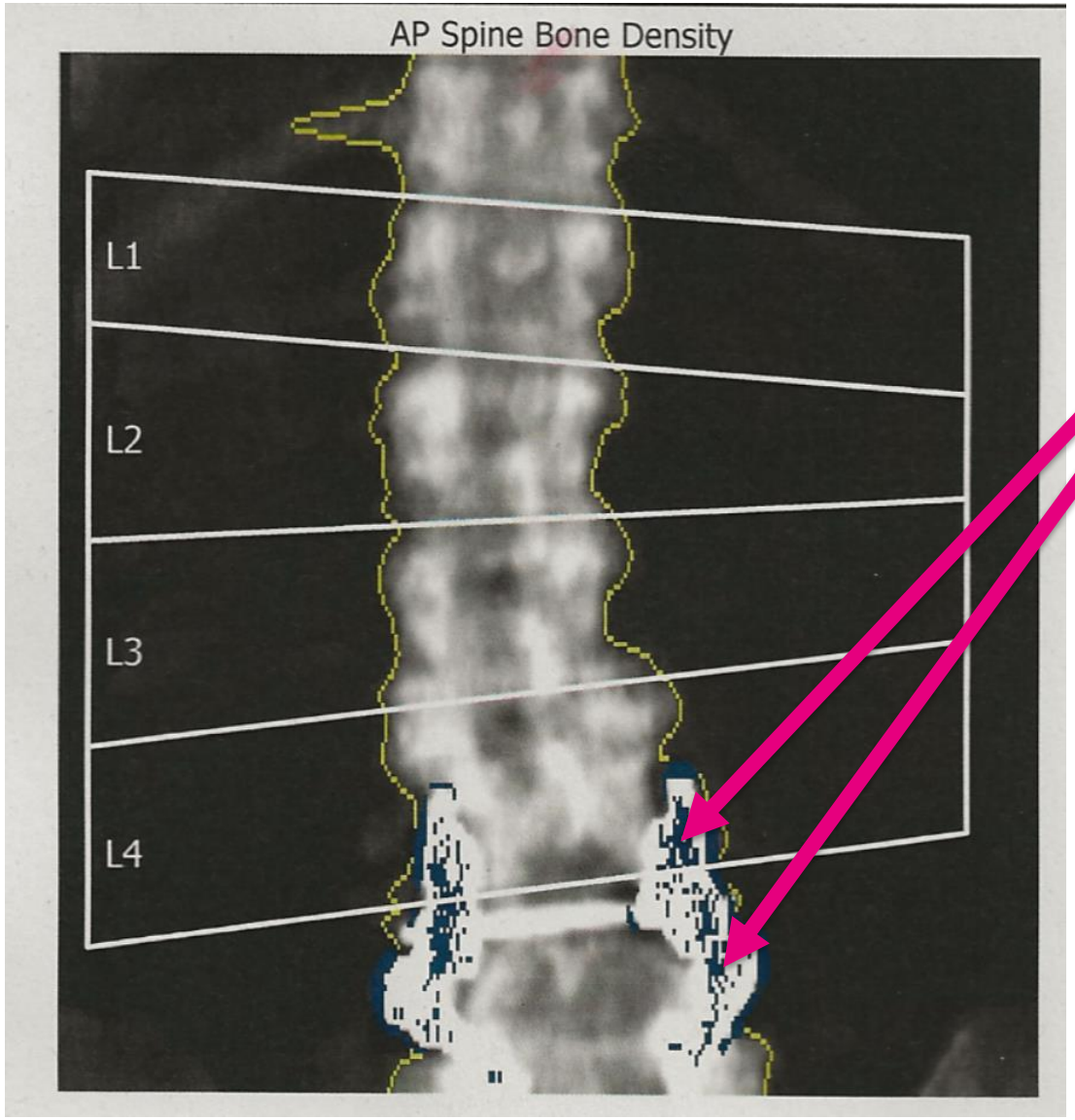
Spine 2



- Auto analysis and scanner software compensation of metallic artefact (mixed interpretation)

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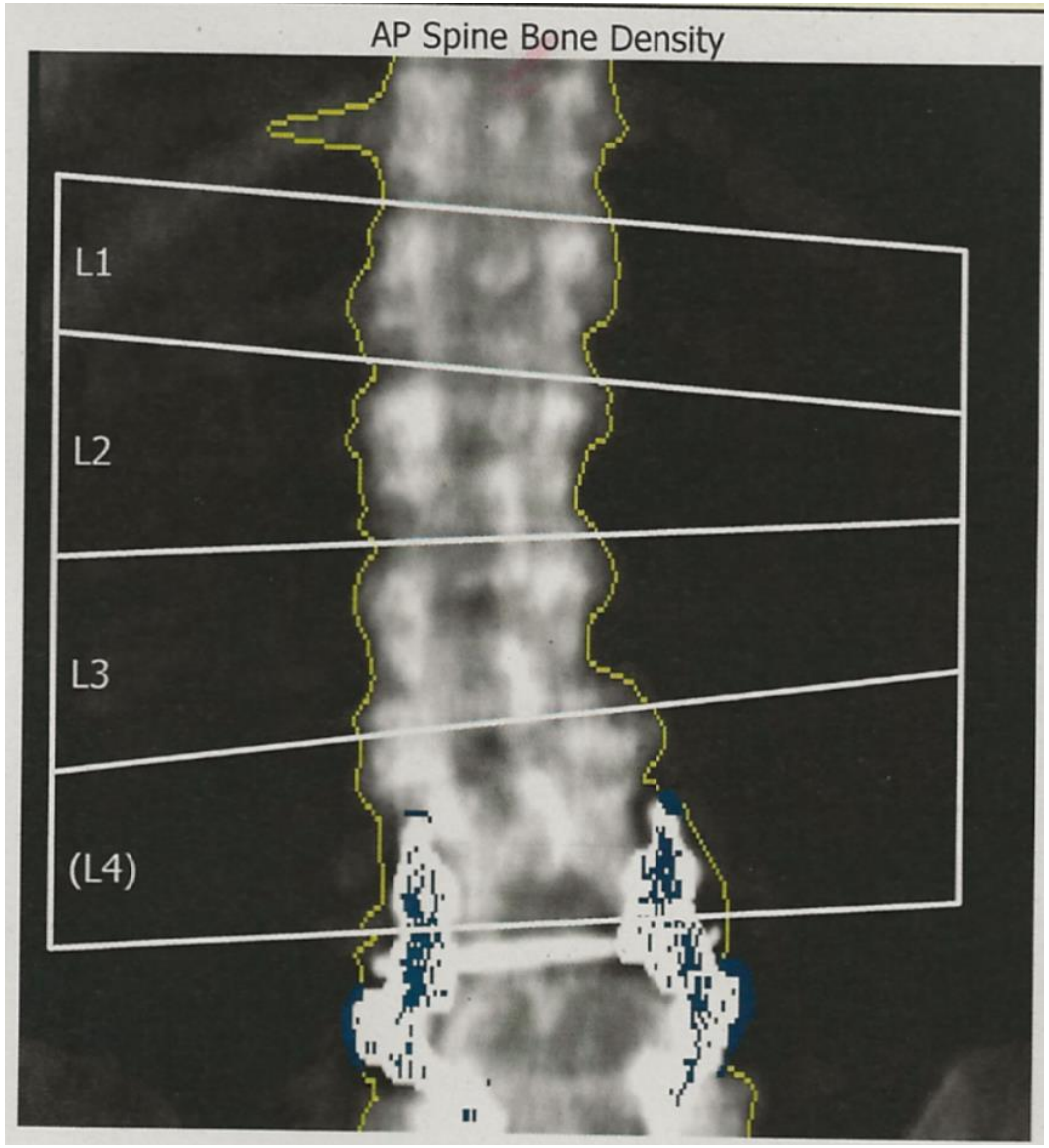
Spine 2



Region	BMD g/cm2	T-score	Z-score
L1-4	1.277	0.8	2.2
L1-3 corrected	1.394	1.9	3.3

Error effect inclusion of mixed value artefact

Increased precision error	Decreased BMD
	Decreased reliability

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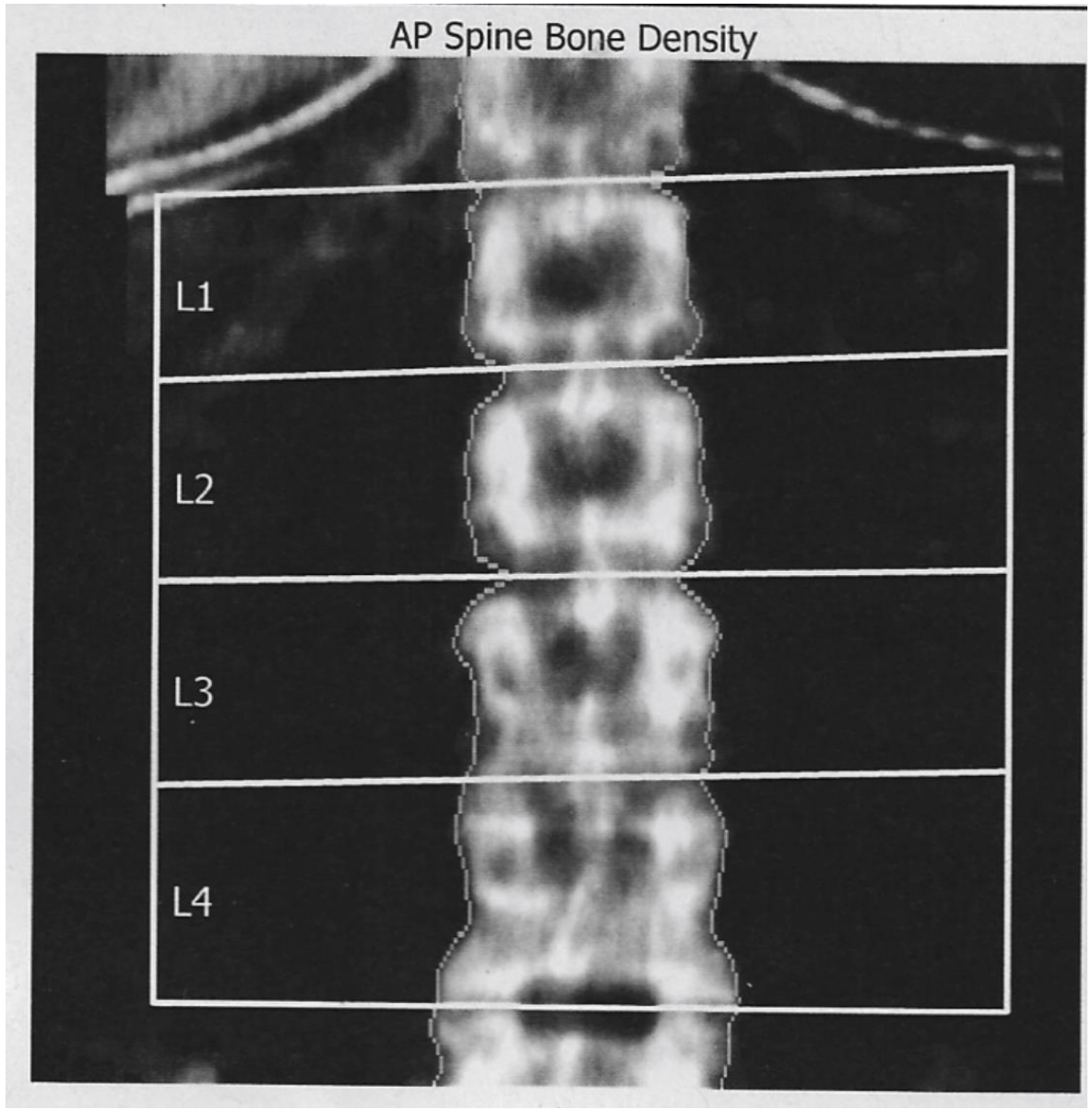
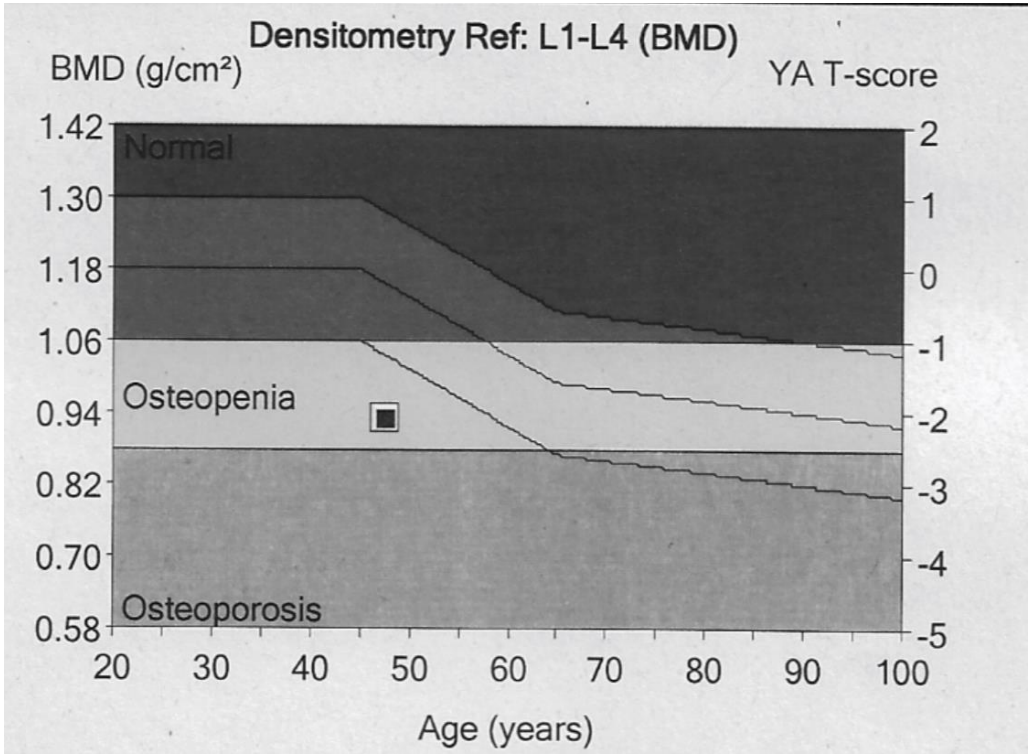
Spine 3



Region	BMD g/cm2	T-score	Z-score
L1-4	0.932	-2.1	-1.9



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Best Practice- analysis

ST artefacts

HOLOGIC Management of artefacts:

Artefact	Management	Effect on measurements
Soft tissue only	Use 'UNDO' at bone map	none
Over **bone/vertebral** body	**Delete** vertebra	None- caution with rates of change
Over soft tissue & **bone**	**Delete** vertebra	none
Small artefact in soft tissue e.g. clips, catheter	none	Little or none
Small artefact over **bone** e.g. clips, belly bar/ring	If abnormal- **delete** bone	Small effect
Large artefact over soft tissue	none	Possible effect- interpret with caution
Large artefact over soft tissue and **bone**	**Delete** vertebrae or exclude from global ROI	Definite effect- interpret with caution.

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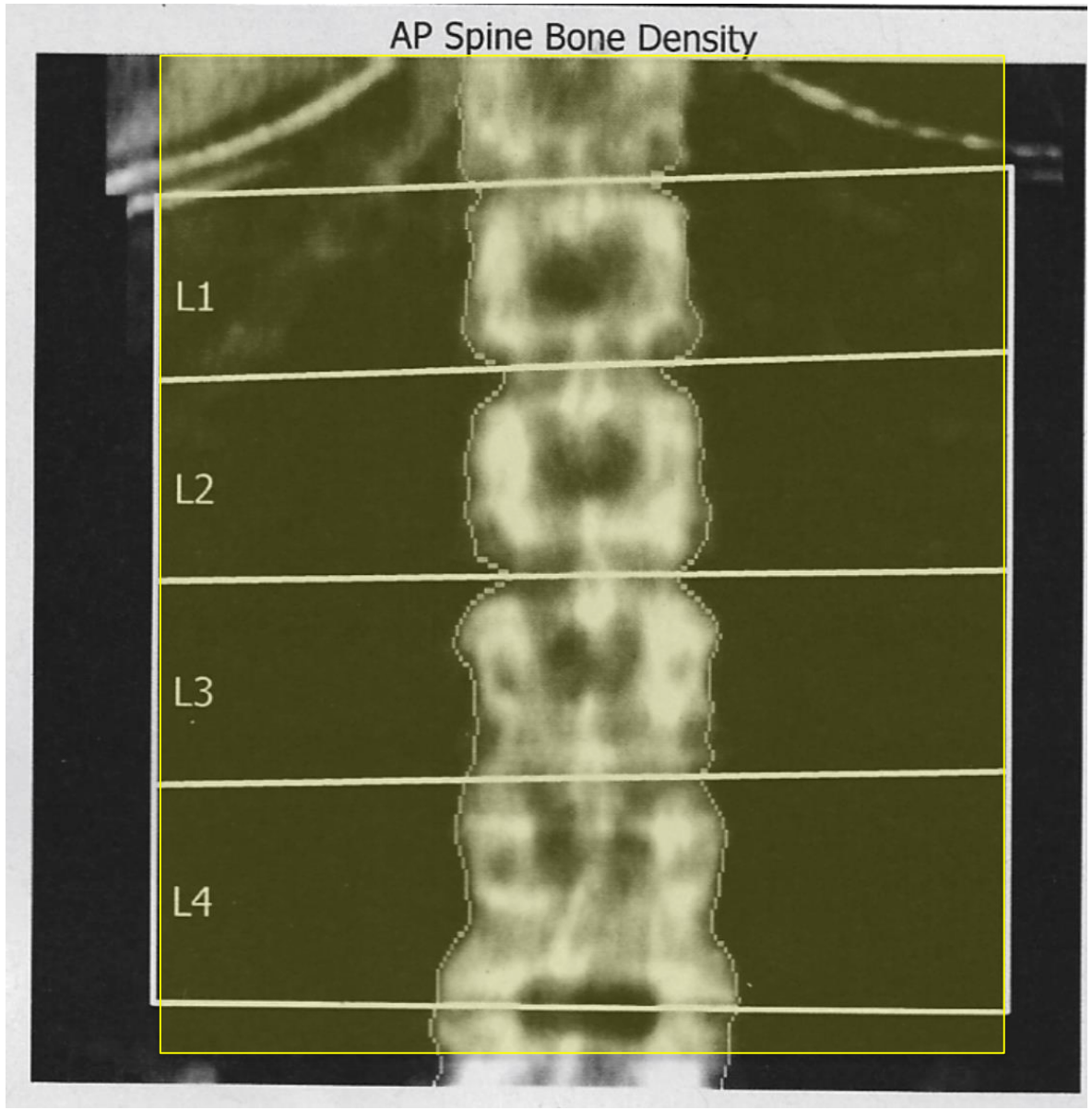
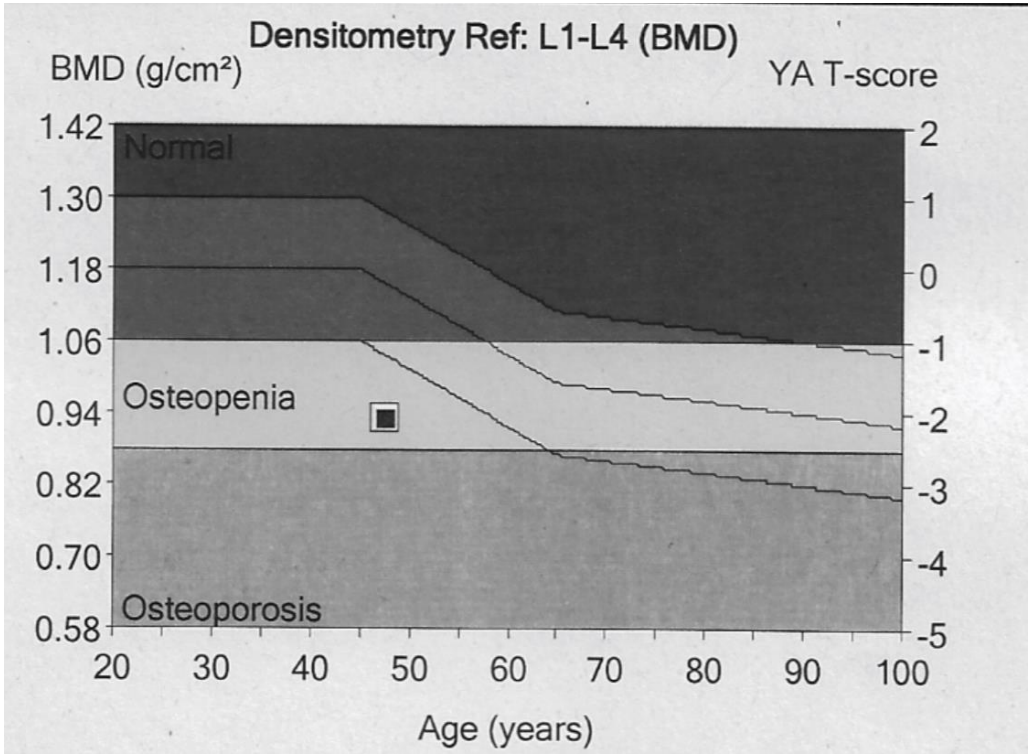
Spine 3



Region	BMD g/cm2	T-score	Z-score
L1-4	0.932	-2.1	-1.9



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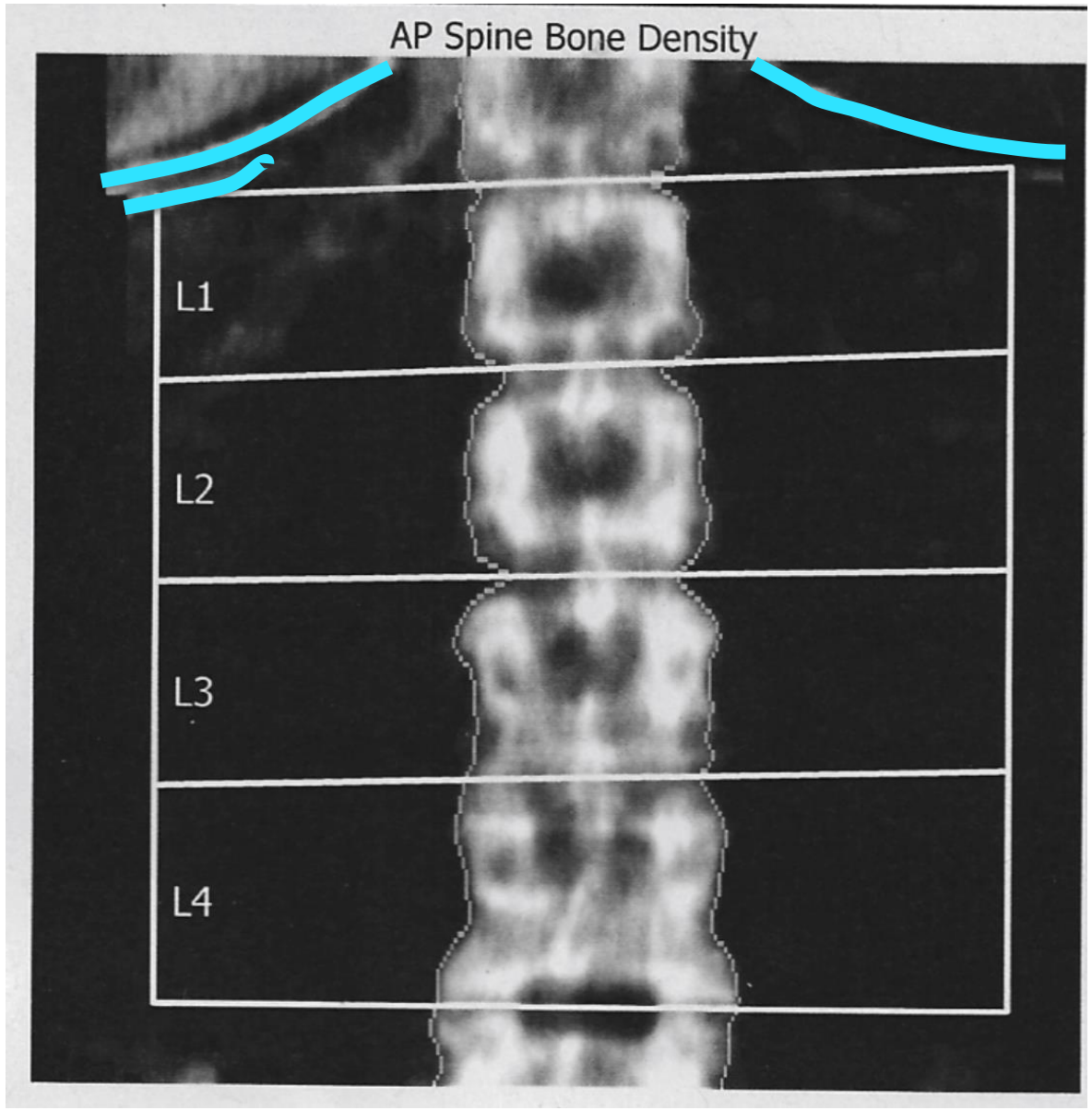
Spine 3



Region	BMD g/cm2	T-score	Z-score
L1-4 unmarked artefact	0.932	-2.1	-1.9
L1-4 artefact corrected	0.941	-2.0	-1.8

Error effect Including metal in soft tissue

Increased precision error	Decreased BMD
	Decreased reliability

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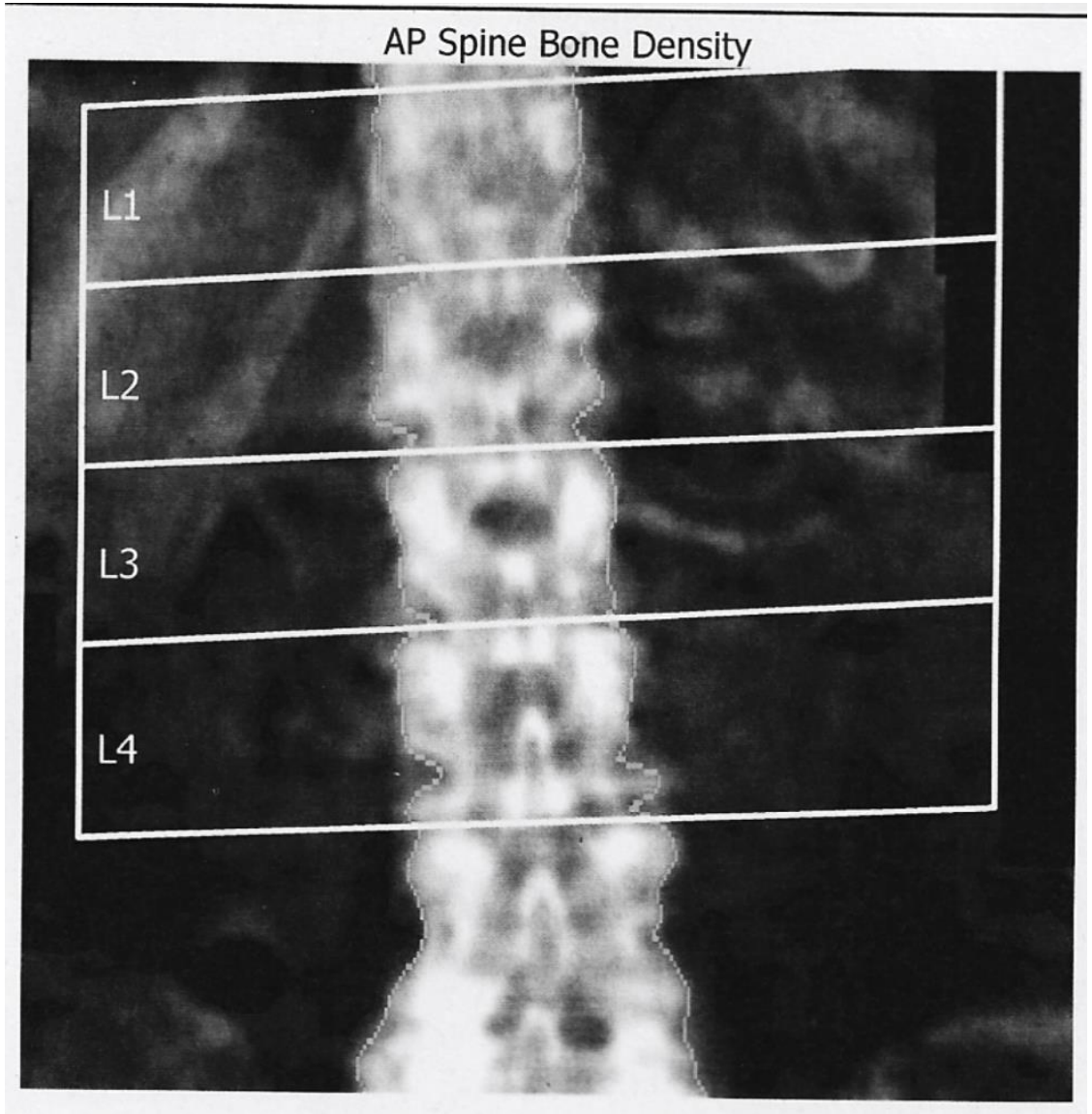
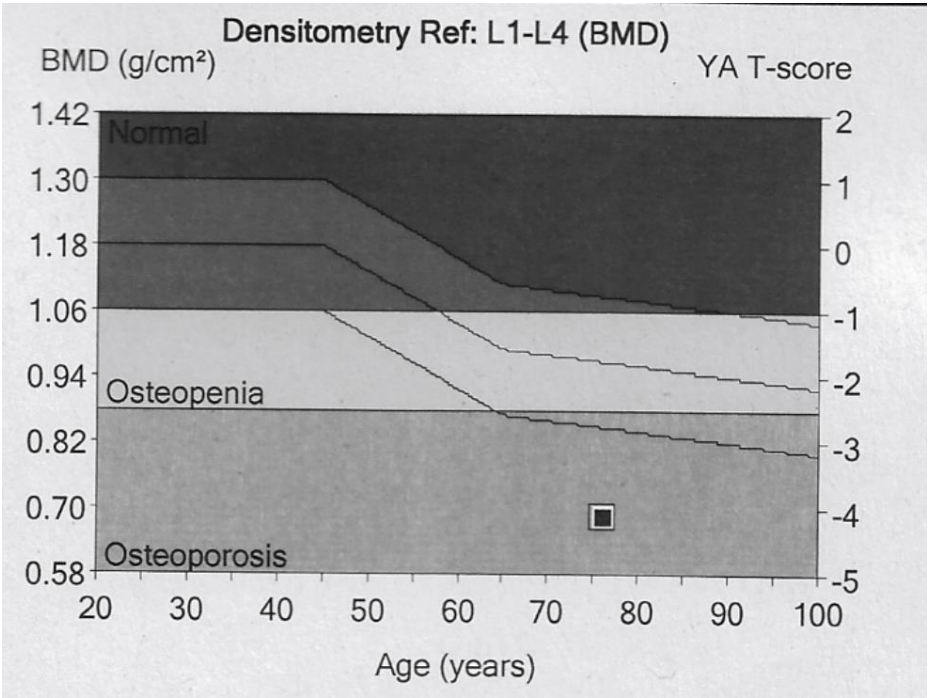
Spine 4



Region	BMD g/cm2	T-score	Z-score
L1-4	0.685	-4.1	-2.4



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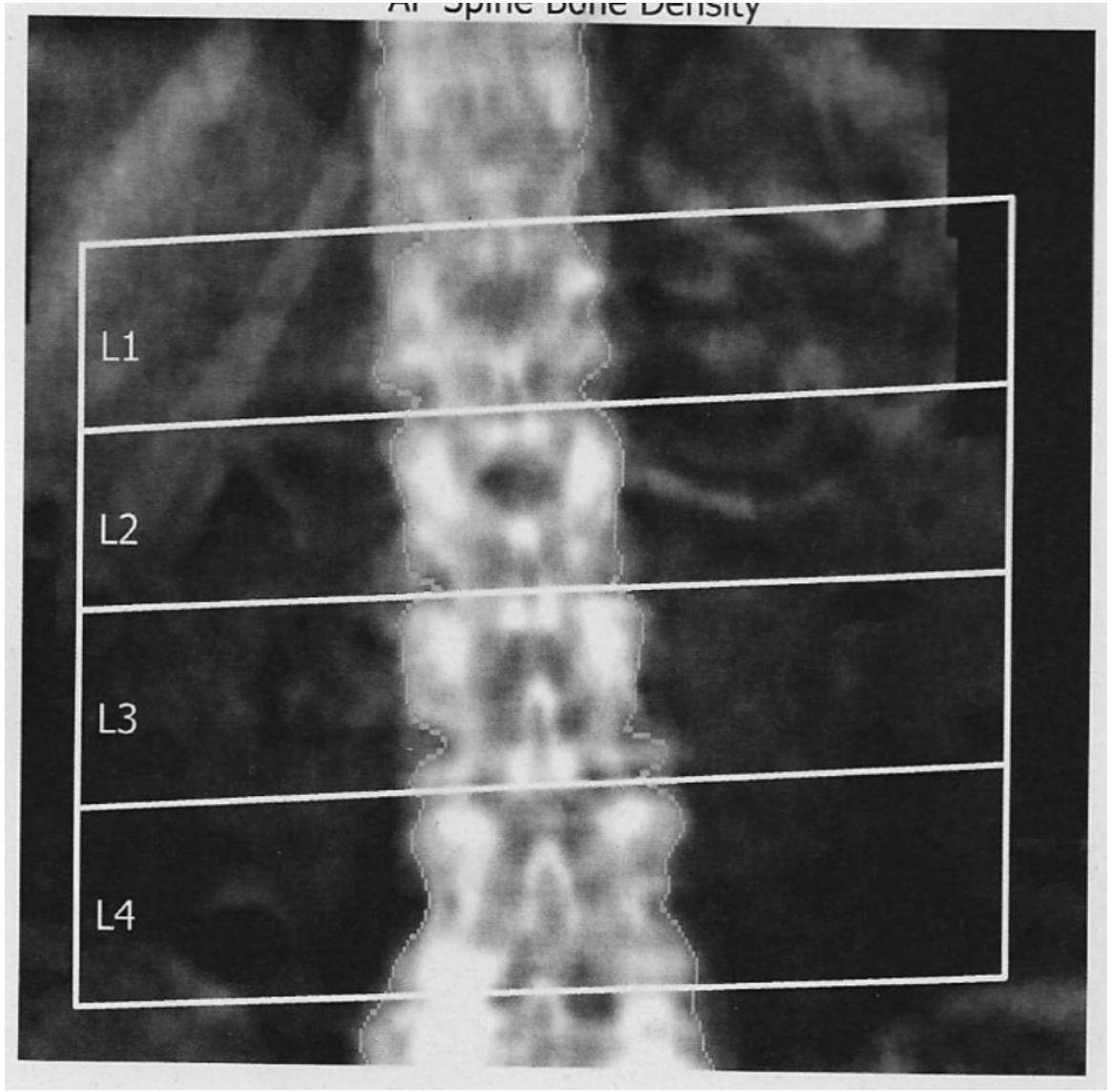
Spine 4



Region	BMD g/cm2	T-score	Z-score
L1-L4 incorrectly labelled	0.685	-4.1	-2.4
L1-4 corrected	0.746	-3.6	-1.8

Error effect labelling T12 as L1

Increased precision error	Decreased BMD Decreased reliability

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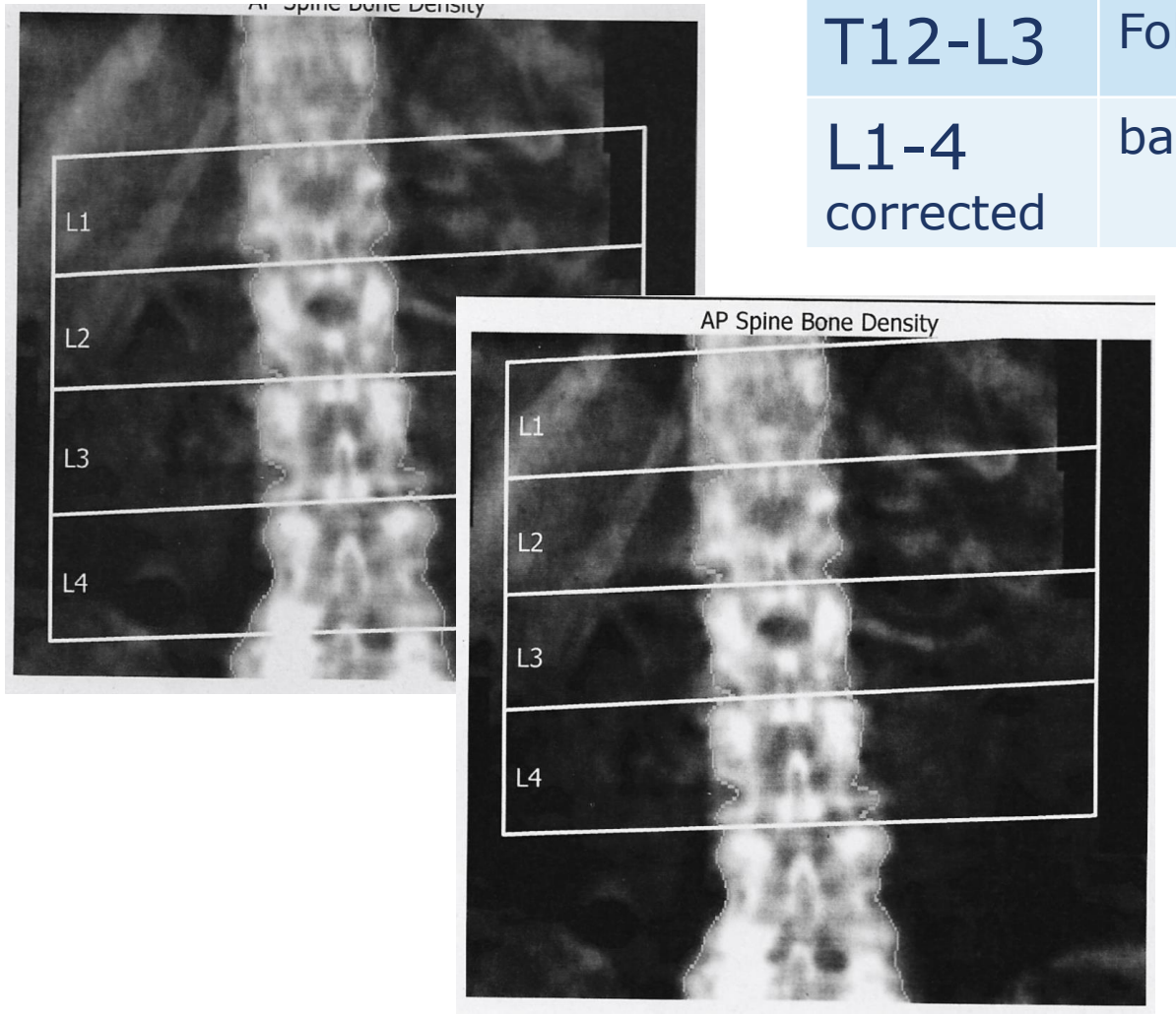
Spine 4

Region		BMD g/cm2	T-score	% change
T12-L3	Follow-up	0.685	-4.1	8%
L1-4 corrected	baseline	0.746	-3.6	



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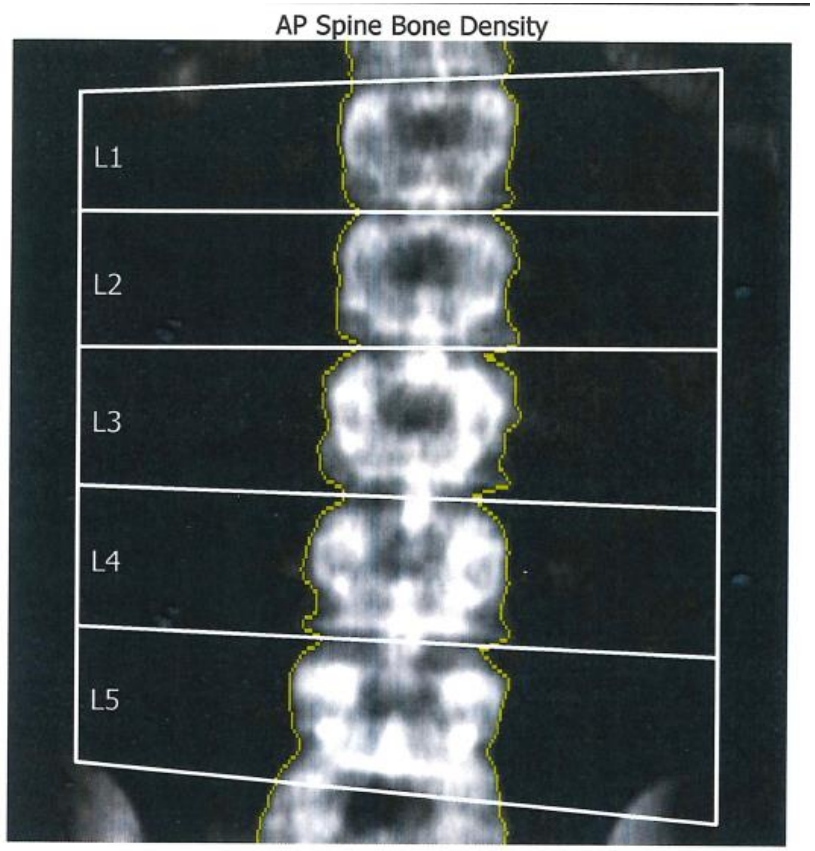
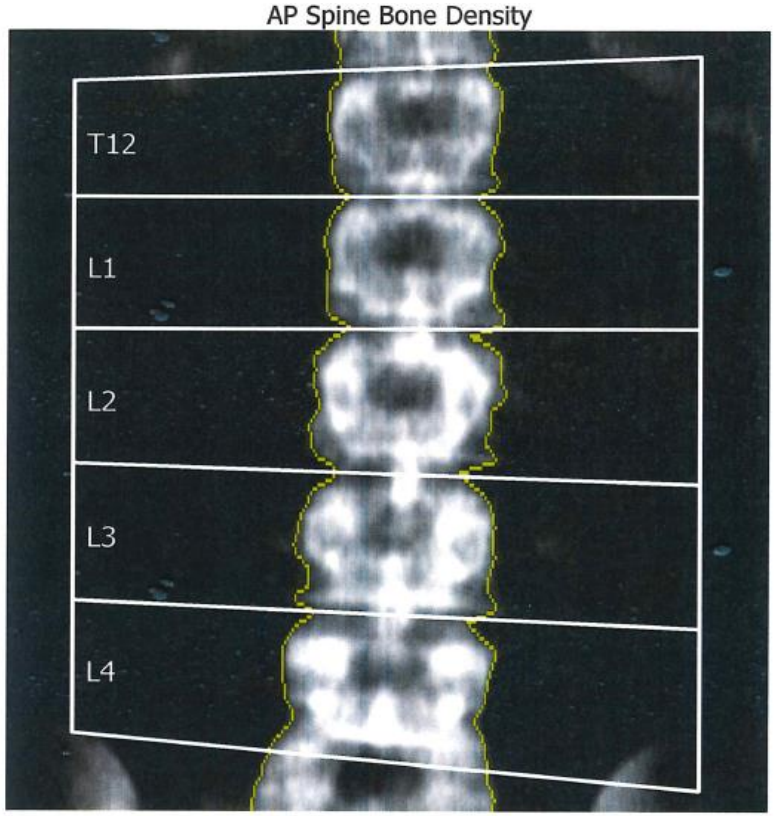
Spine 4



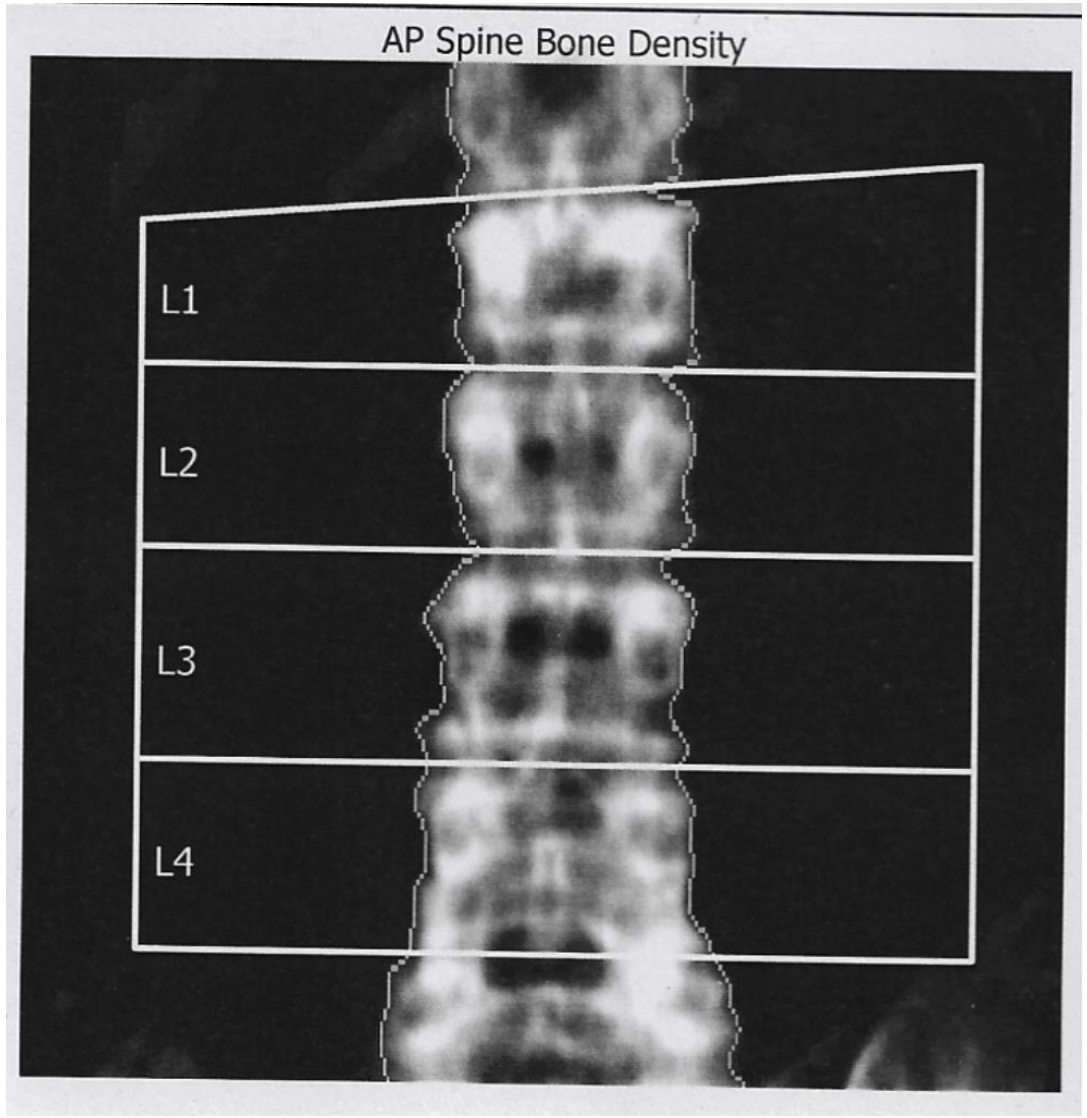


TREATMENT ALERT

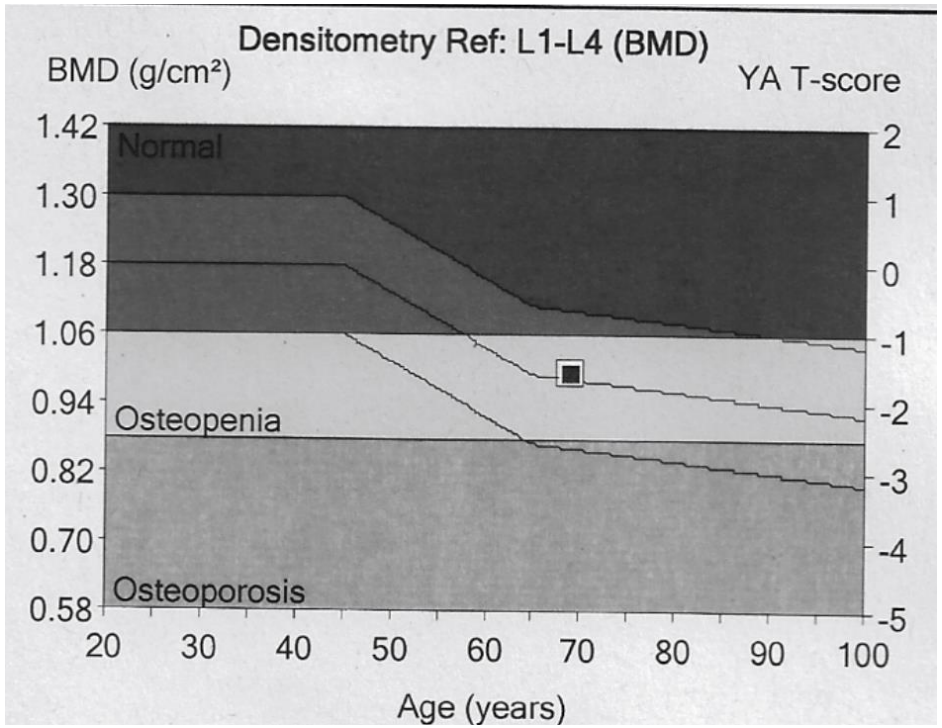
Region	BMD g/cm2	T-score
L1-L4	0.963	-2.5

Region	BMD g/cm2	T-score
L1-L4	1.029	-1.7

Spine 5



Region	BMD g/cm2	T-score	Z-score
L1-4	0.992	-1.6	0.1



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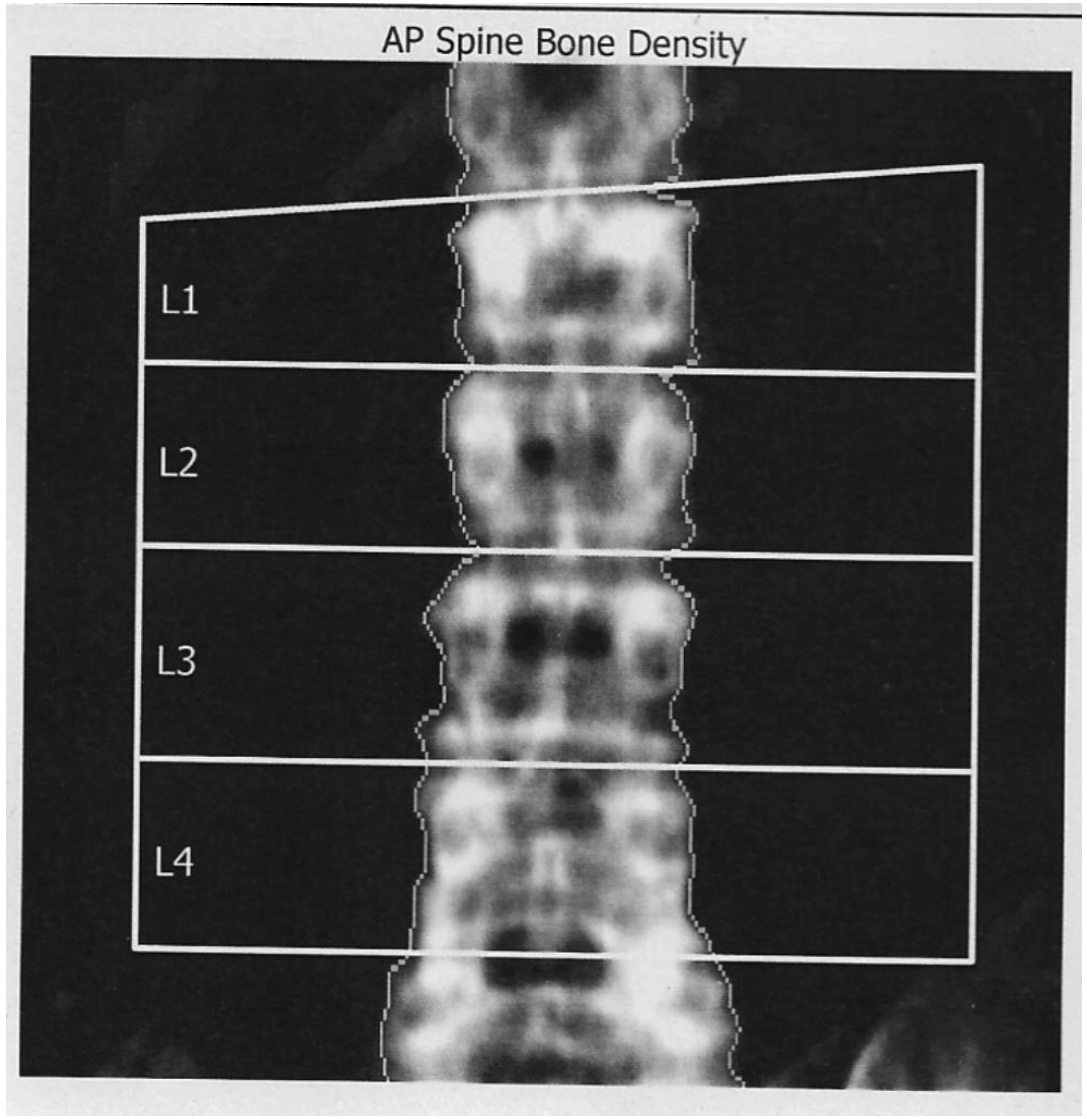
Spine 5



Region	BMD g/cm2	T-score
L1-4	0.992	-1.6
L1		-0.5
L2		-2.4
L3		-2.2
L4		-1.3

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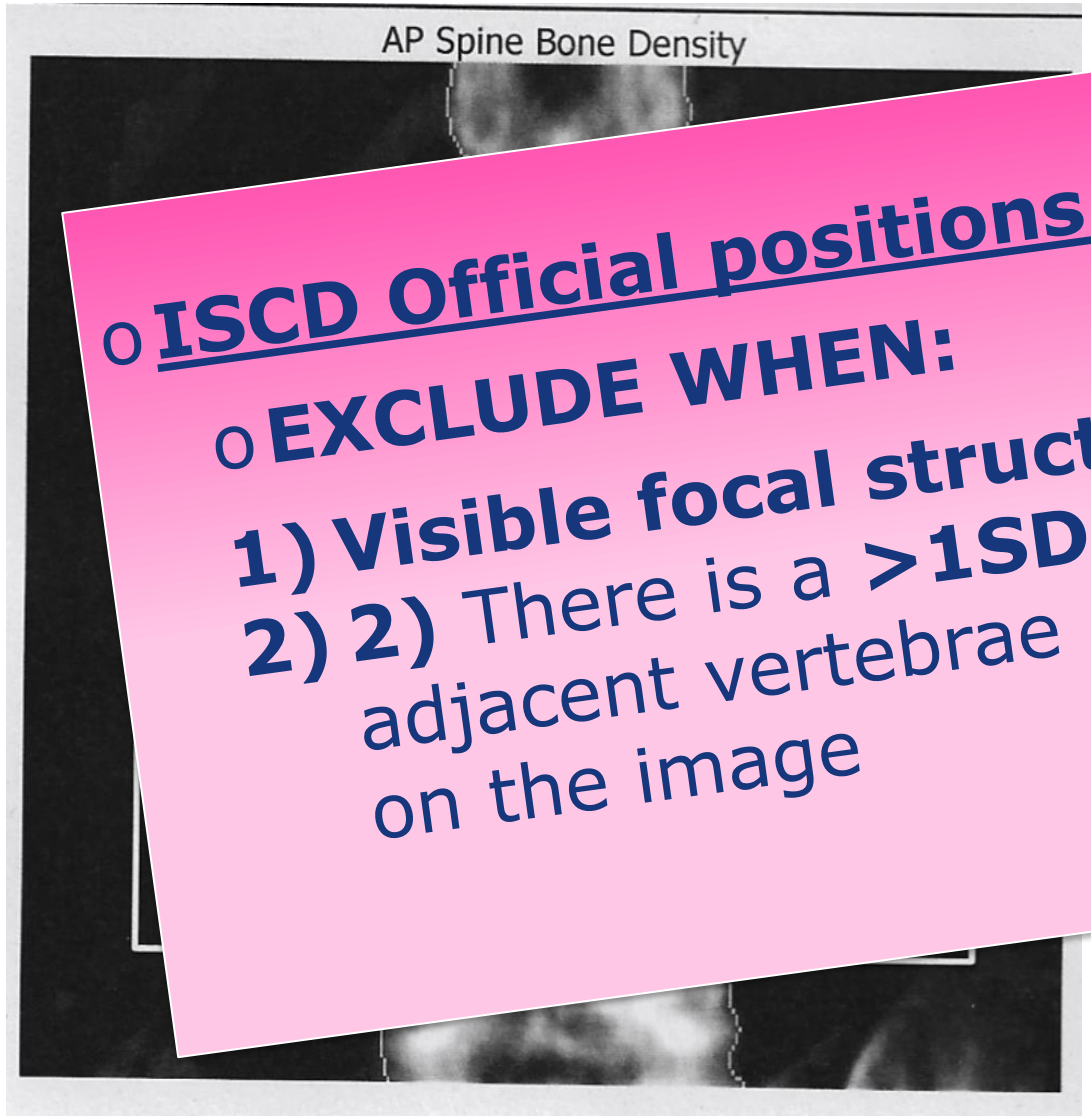
Spine 5



- **ISCD Official positions 2015- vertebral exclusions:**
  - **EXCLUDE WHEN:**
    1) **Visible focal structural defects**
    2) **2)** There is a **>1SD T-score** discrepancy between adjacent vertebrae **AND** evidence of sclerotic defect on the image

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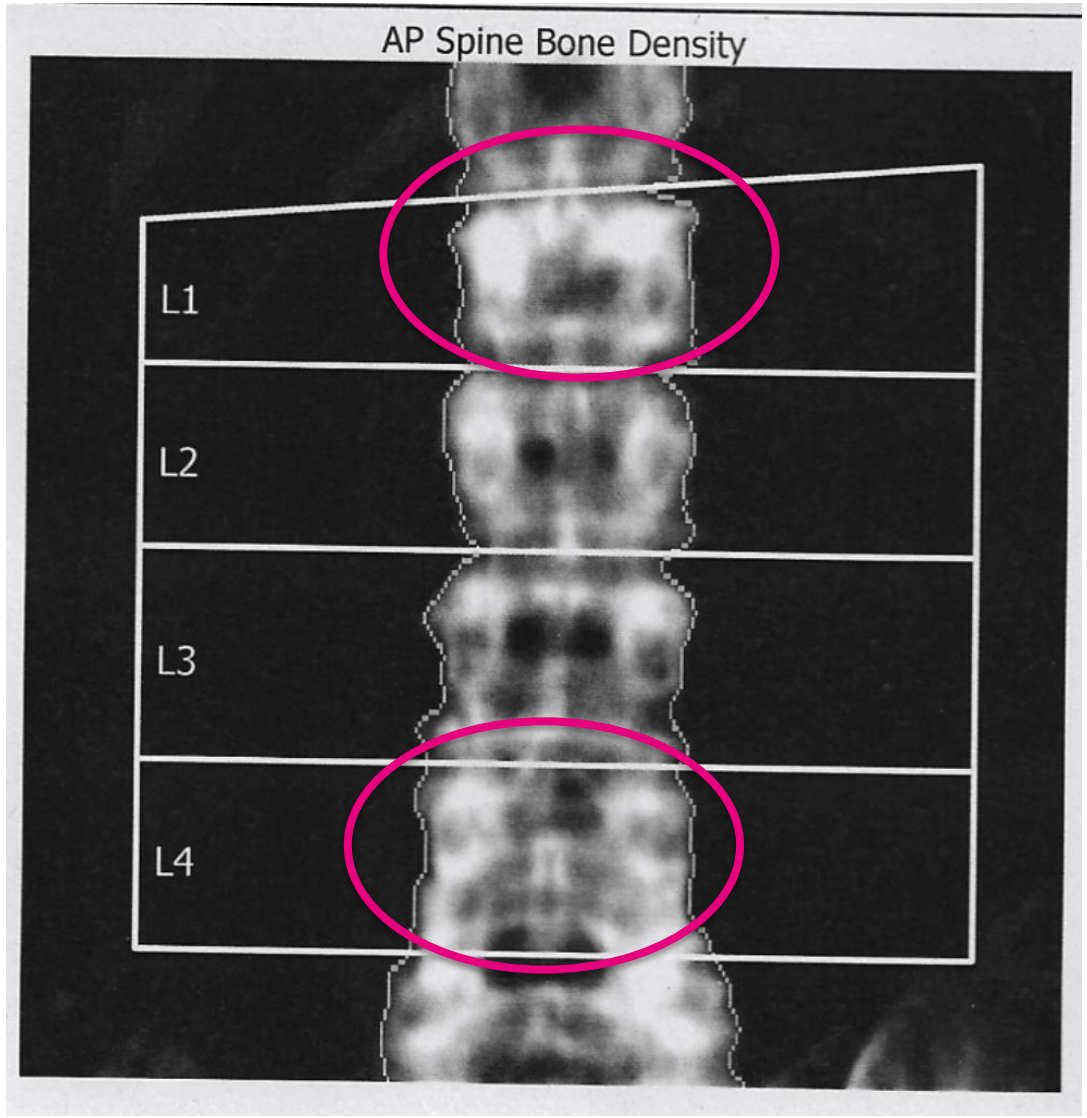
Spine 5



Region	BMD g/cm2	T-score
L1-4	0.992	-1.6
L1		-0.5
L2		-2.4
L3		-2.2
L4		-1.3

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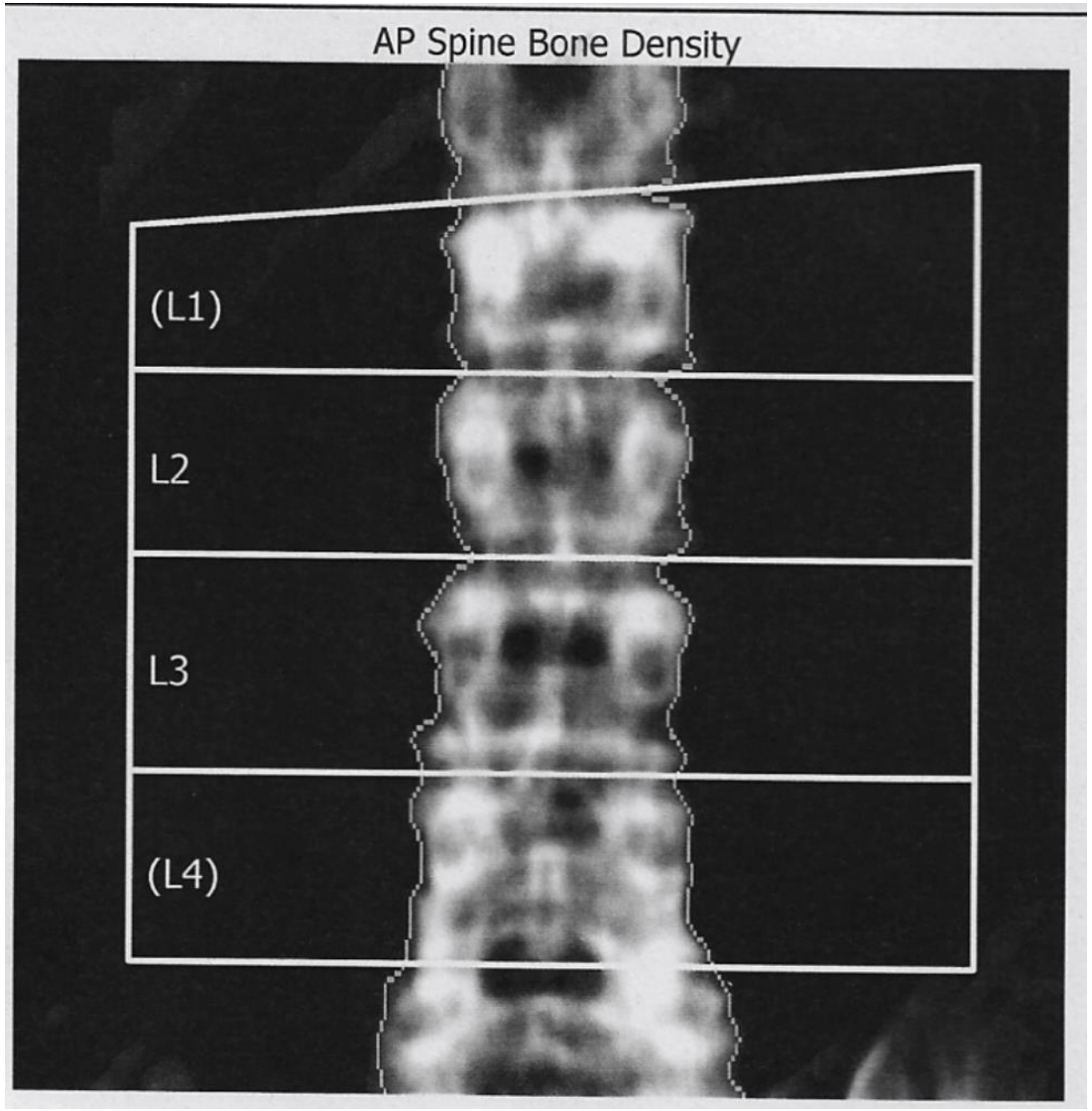
Spine 5



Region	BMD g/cm2	T-score	Z-score
L1-4	0.992	-1.6	0.1
L2–3	0.926	-2.3	-0.6

Error effect inclusion of degenerative change

Increased BMD **Increased precision error**	Decreased reliability

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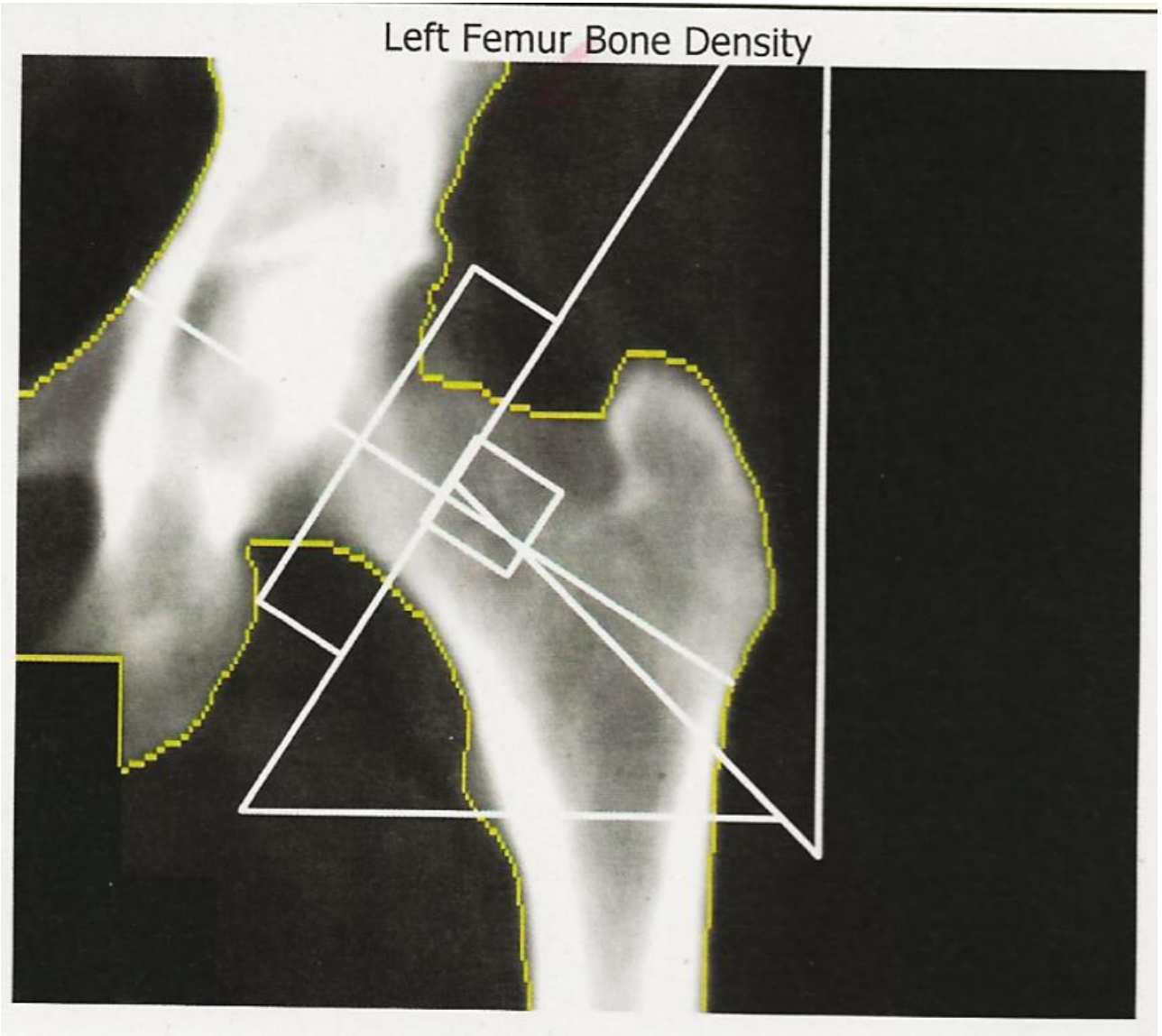
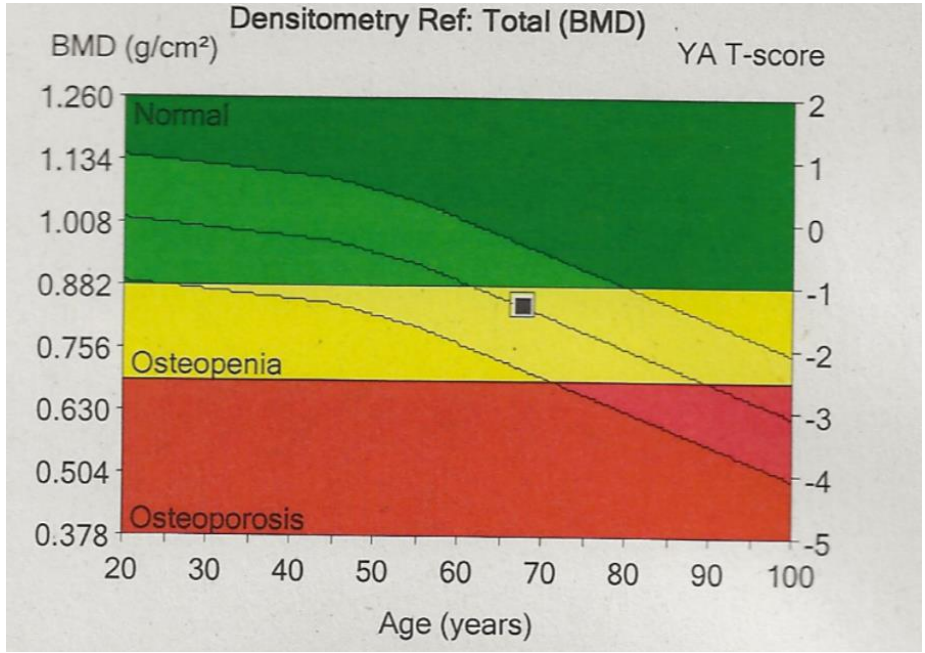
Femur 1



Region	BMD g/cm2	T-score
Total	0.992	-1.6
NOF	0.819	-1.6



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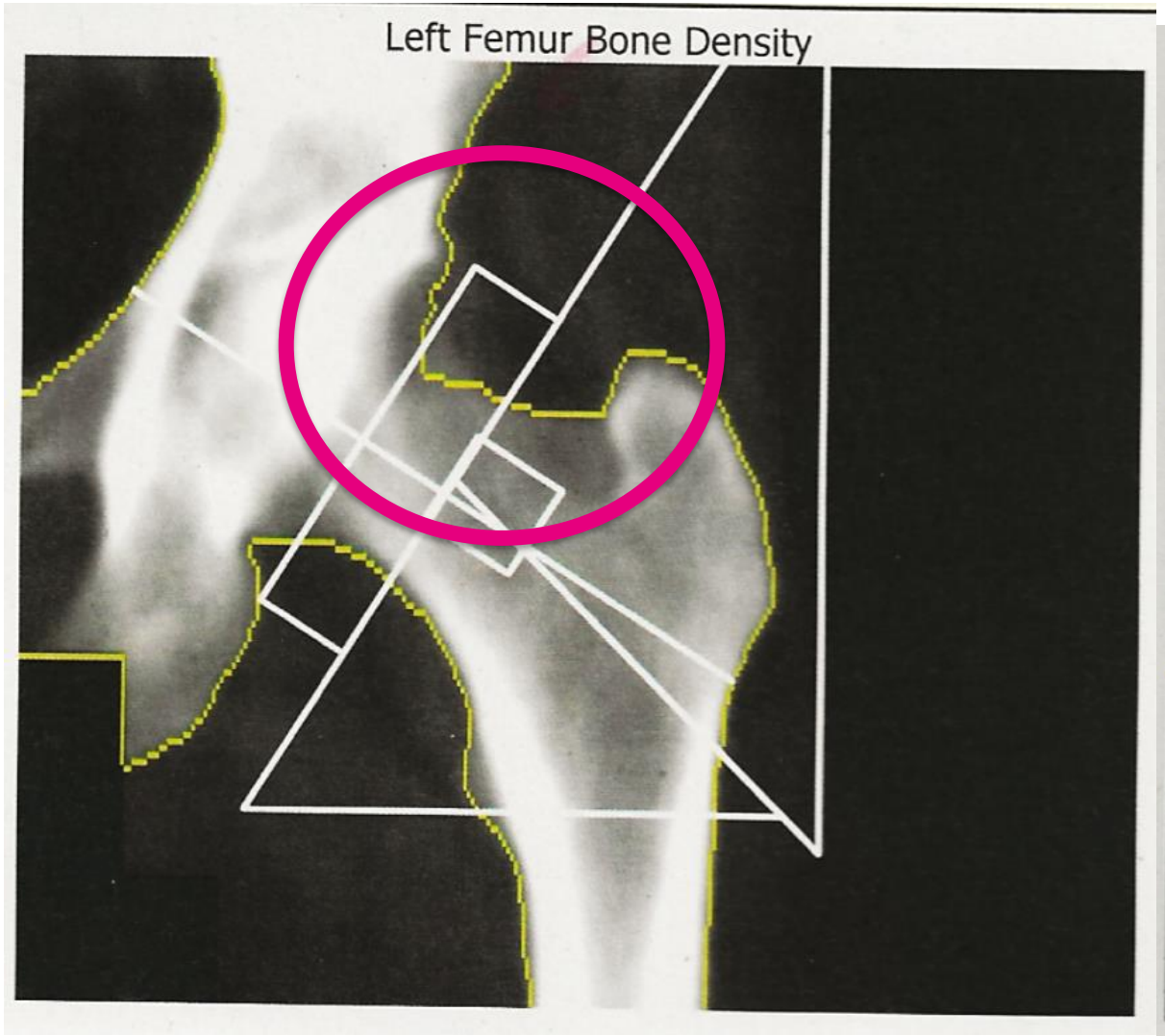
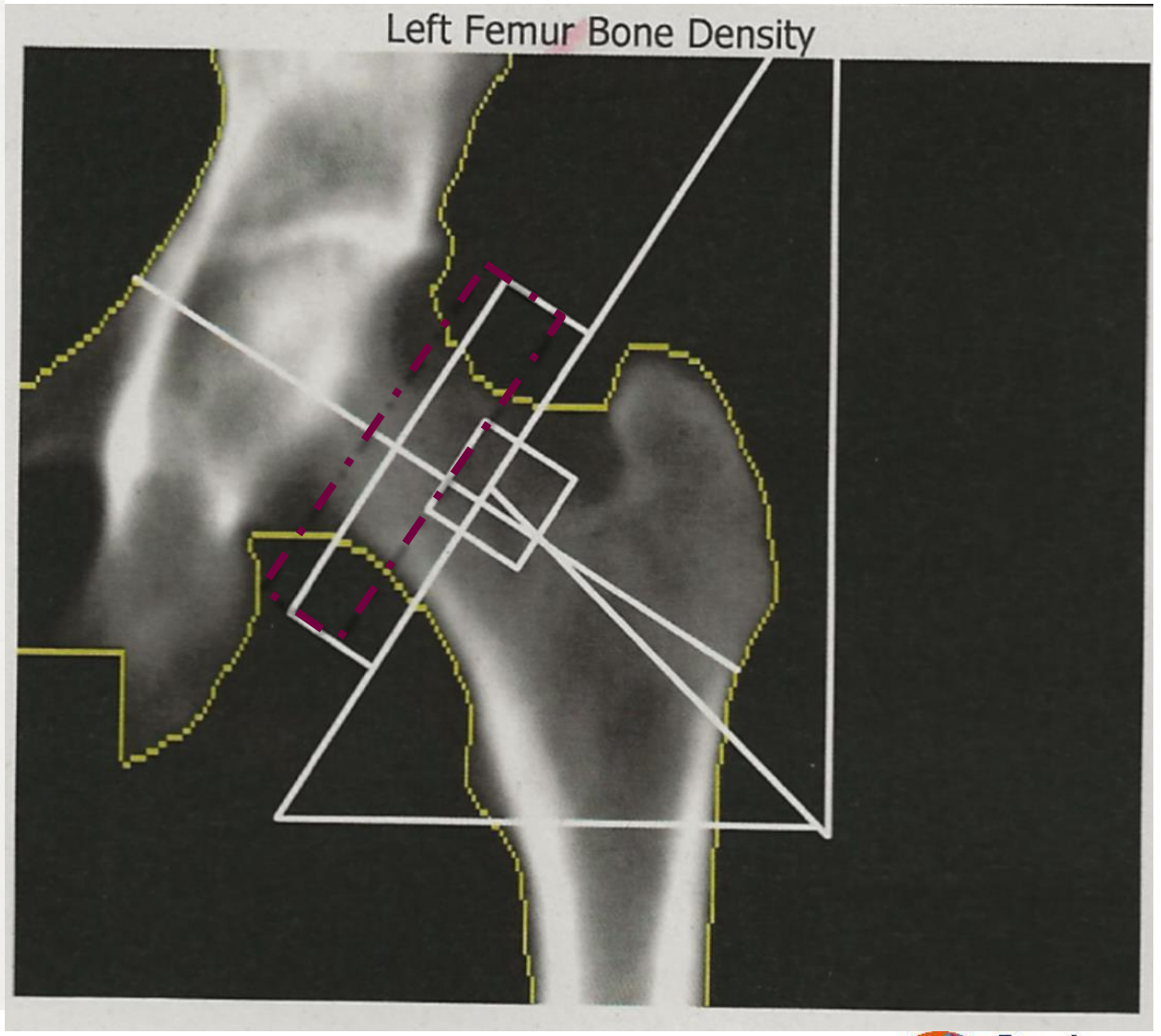
Femur 1





FN box measuring bone as ST and incorrect place

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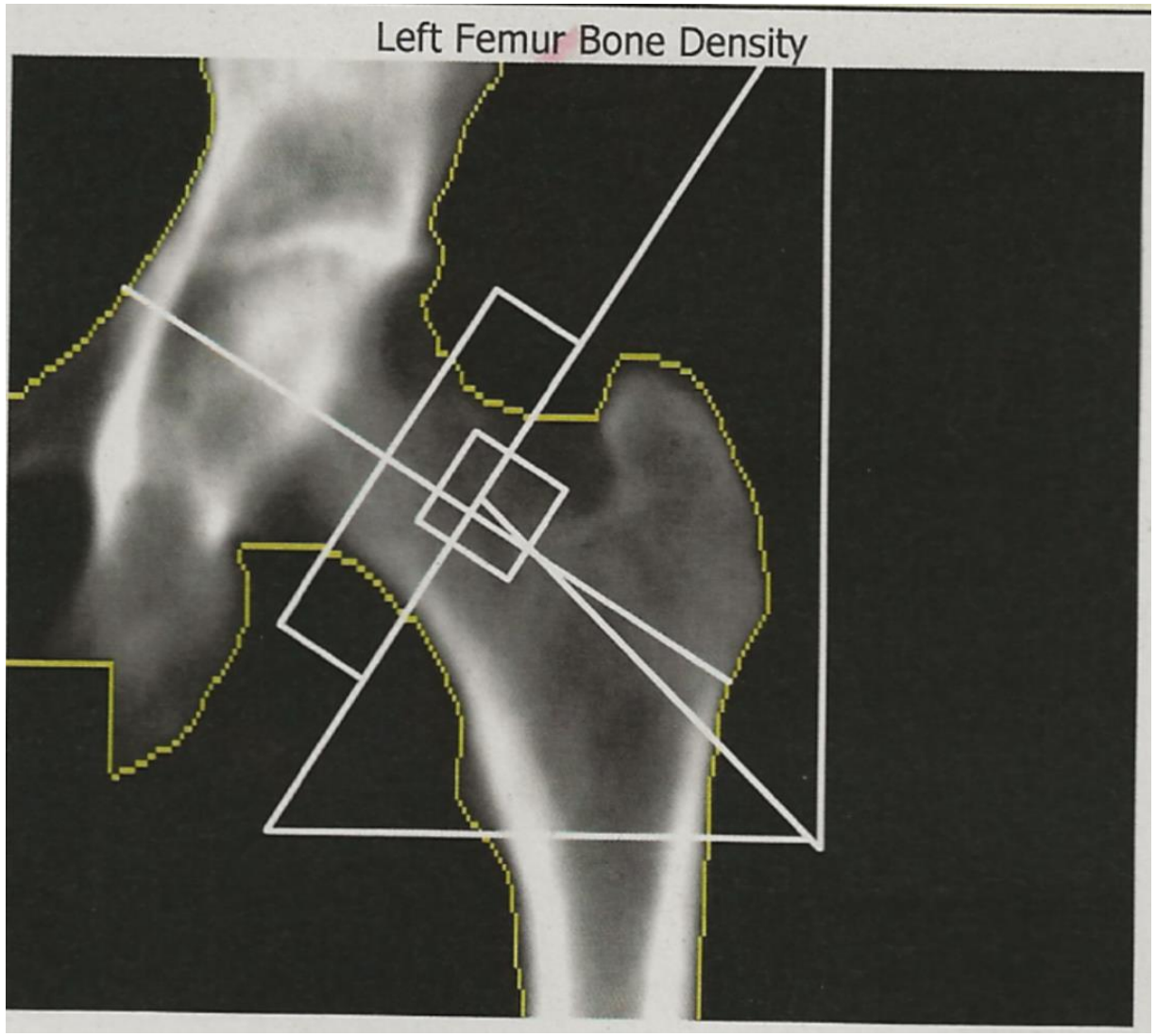
Femur 1



Region	BMD g/cm2	T-score
Total Incorrectly placed	0.846	-1.3
Total Corrected	0.851	-1.2
NOF Incorrectly placed	0.819	-1.6
NOF Corrected	0.783	-1.8

Error effect poor bone map &incorrect FN box placement

Increases NOF BMD	Decreases Total BMD

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Femur 1

Effect on fracture risk assessment using FRAX

Risk factors:
female, ages 67 years with fragility fracture

Region	BMD g/cm2	T-score	FRAX major osteoporotic fracture	FRAX hip fracture
NOF Incorrectly placed	0.819	-1.6	14.3%	2.1%
NOF Corrected	0.783	-1.8	15.8%	2.7%

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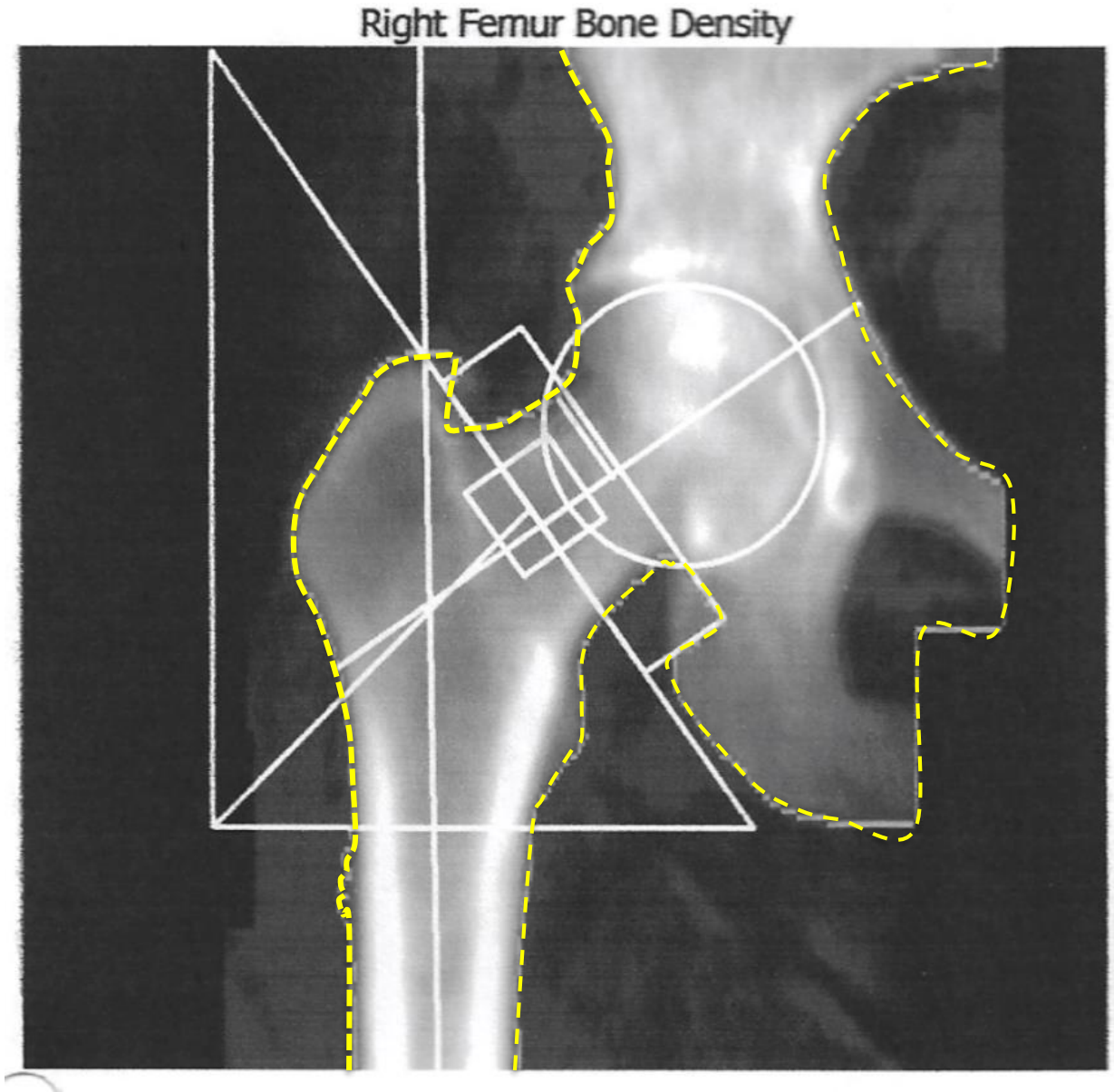
Femur 2



Region	BMD g/cm2	T-score
Total	1.174	1.3
NOF	1.108	0.5

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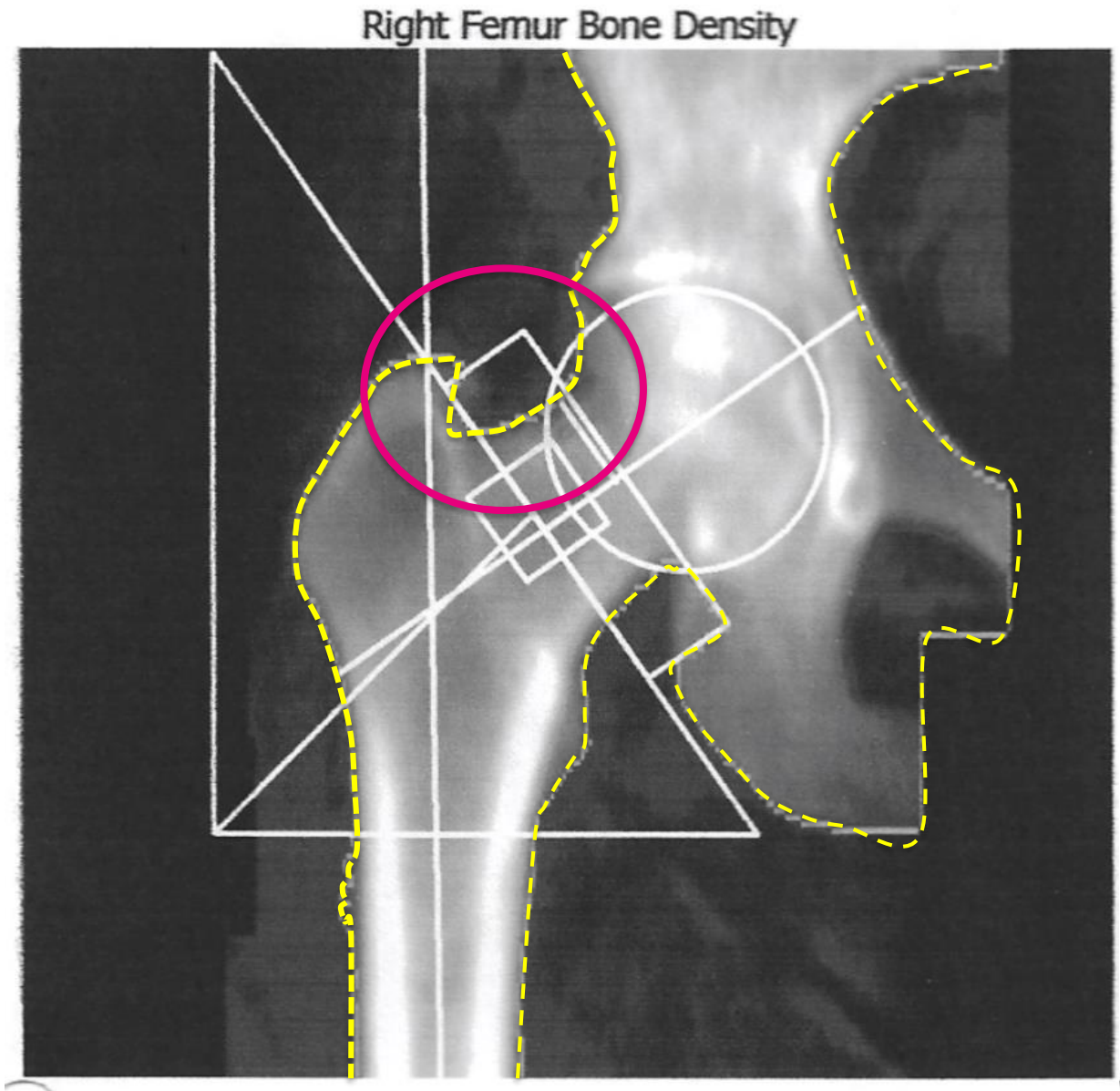
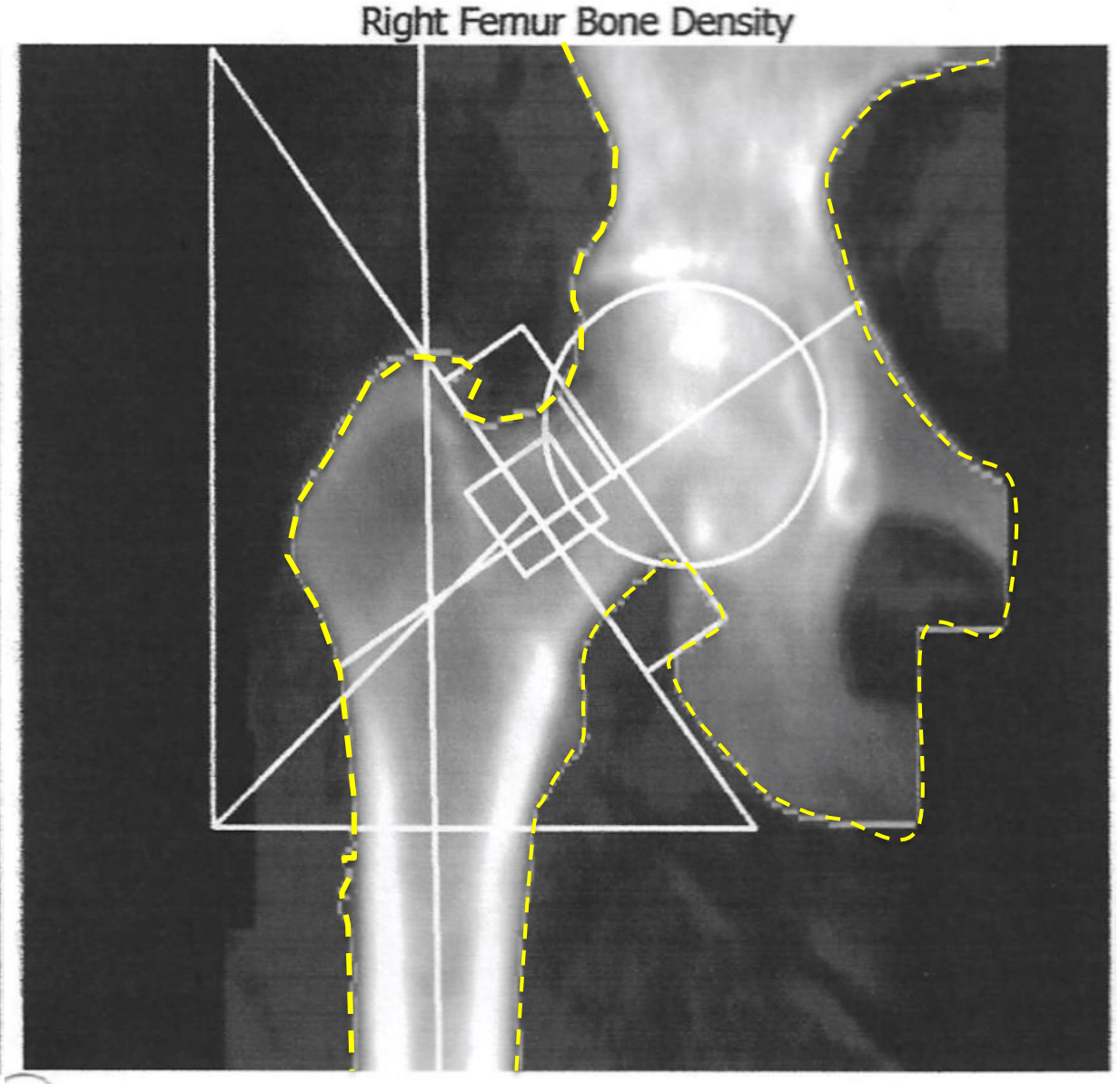
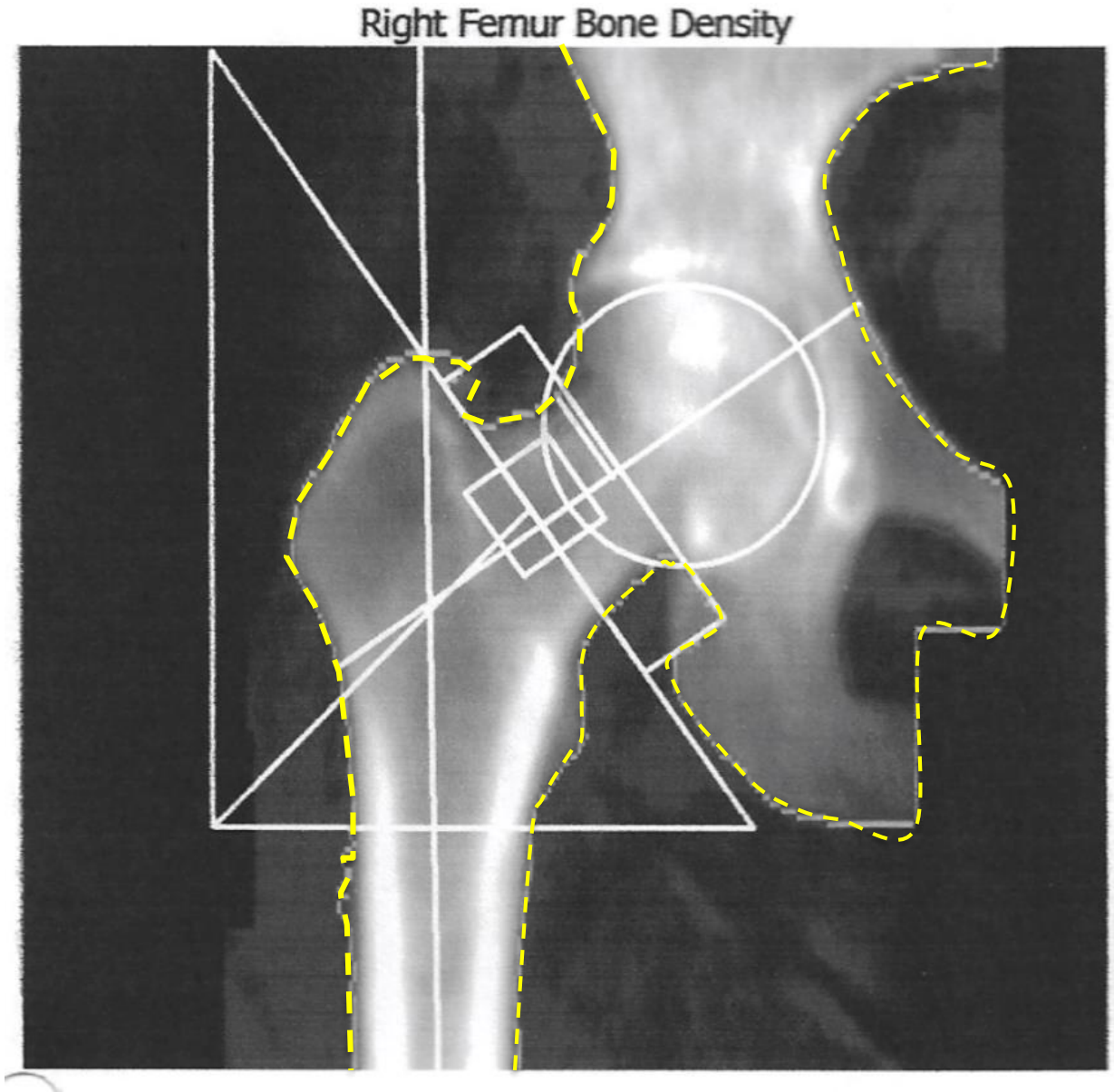
Femur 2





Femur 2



Error effect: poor bone map deleting greater trochanter

Incorrect total hip measurement

?? Effect on BMD

Decreased reliability of NOF measurement

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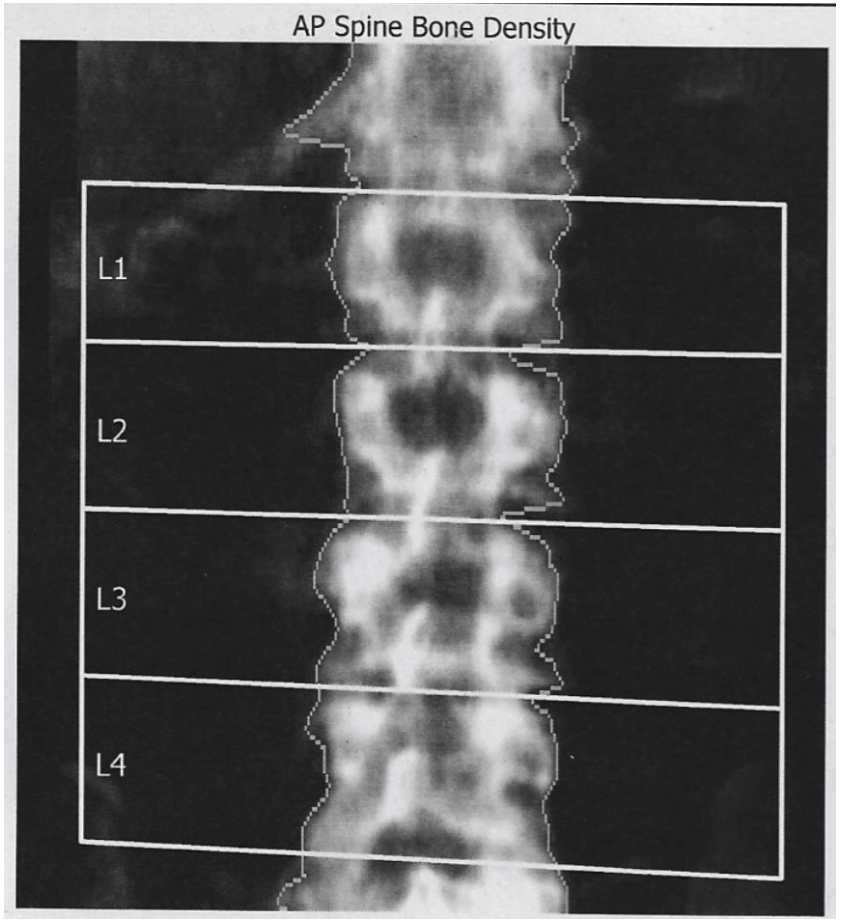
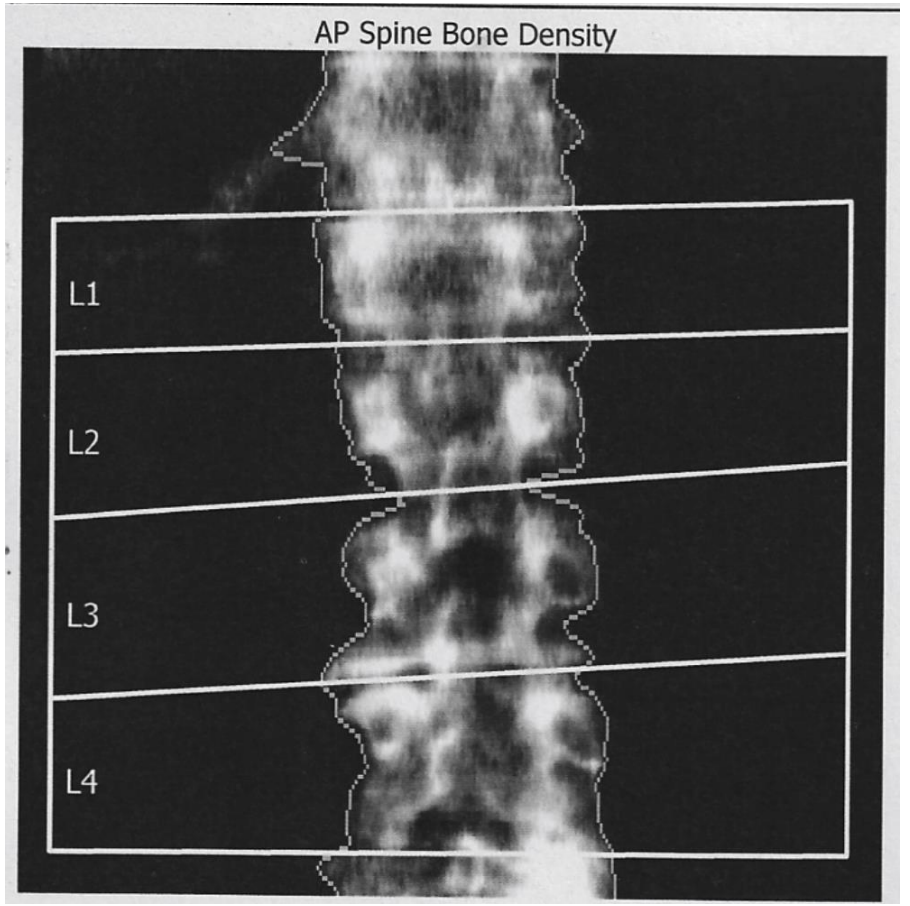
Follow up case 1





Region	BMD g/cm2	T-score	Z-score
L1-4	1.026	-1.6	-1.5

Region	BMD g/cm2	T-score	Z-score	% change
L1-4	0.959	-2.2	-2	-6.5 %

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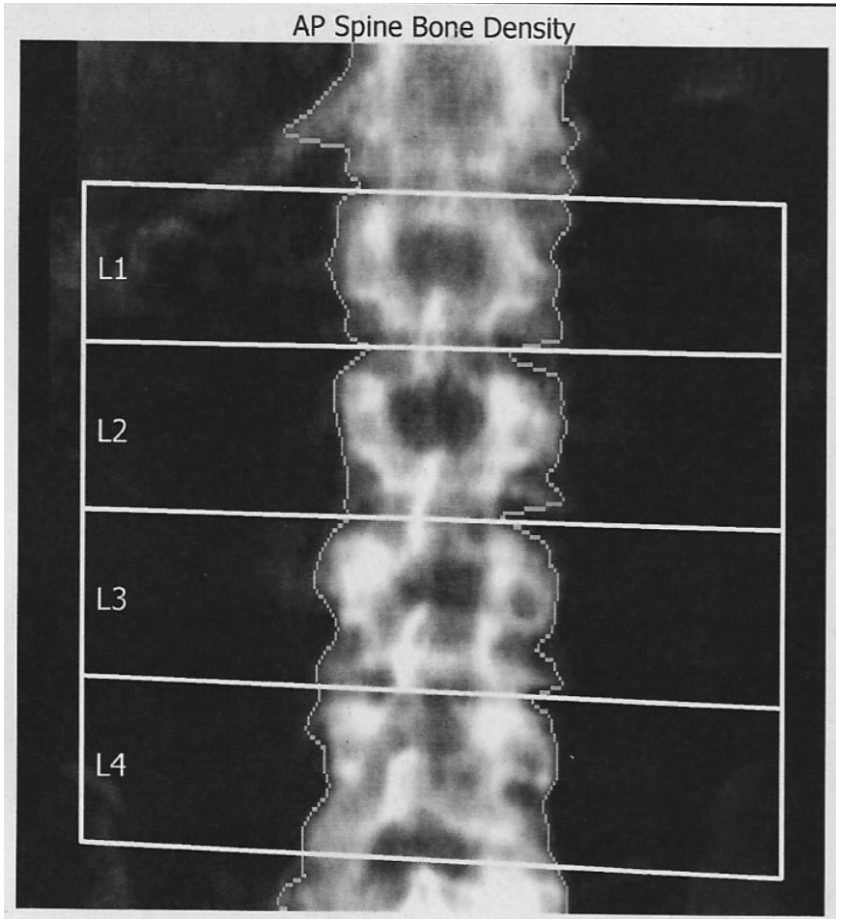
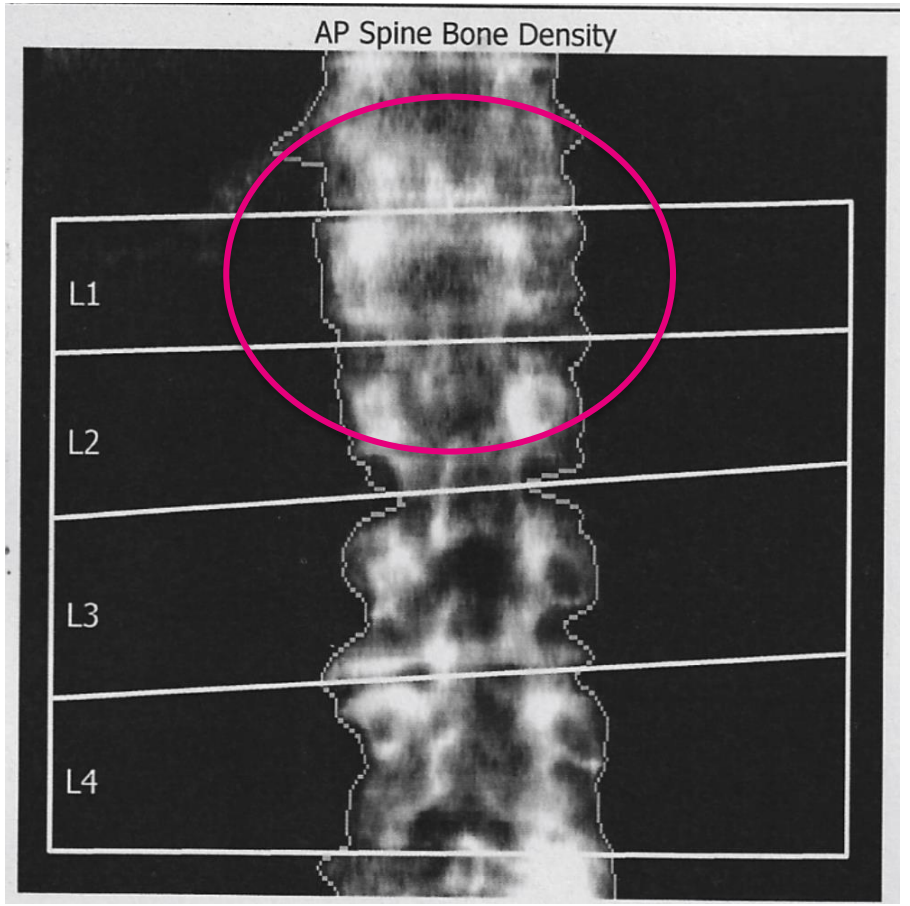
Follow up case 1





Region	BMD g/cm2	T-score	Z-score
L1-4	1.026	-1.6	-1.5

Region	BMD g/cm2	T-score	Z-score	% change
L1-4	0.959	-2.2	-2	-6.5 %

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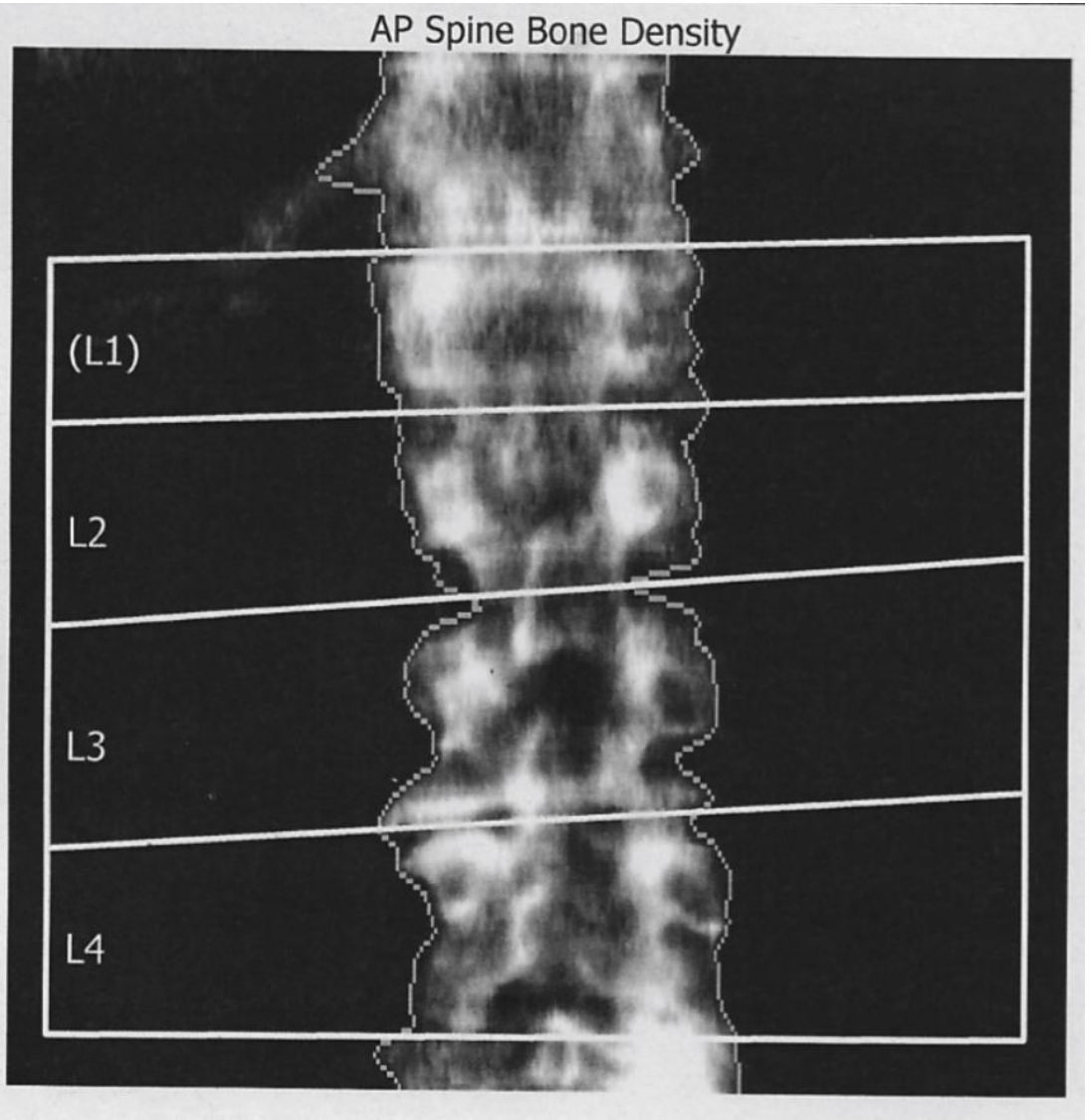
Follow up case 1



Region	BMD g/cm2	T-score	Z-score	% change
L1-4	0.959	-2.2	-2	-6.5 %
L2-4	0.963	-2.3	-2.1	-9.2 %

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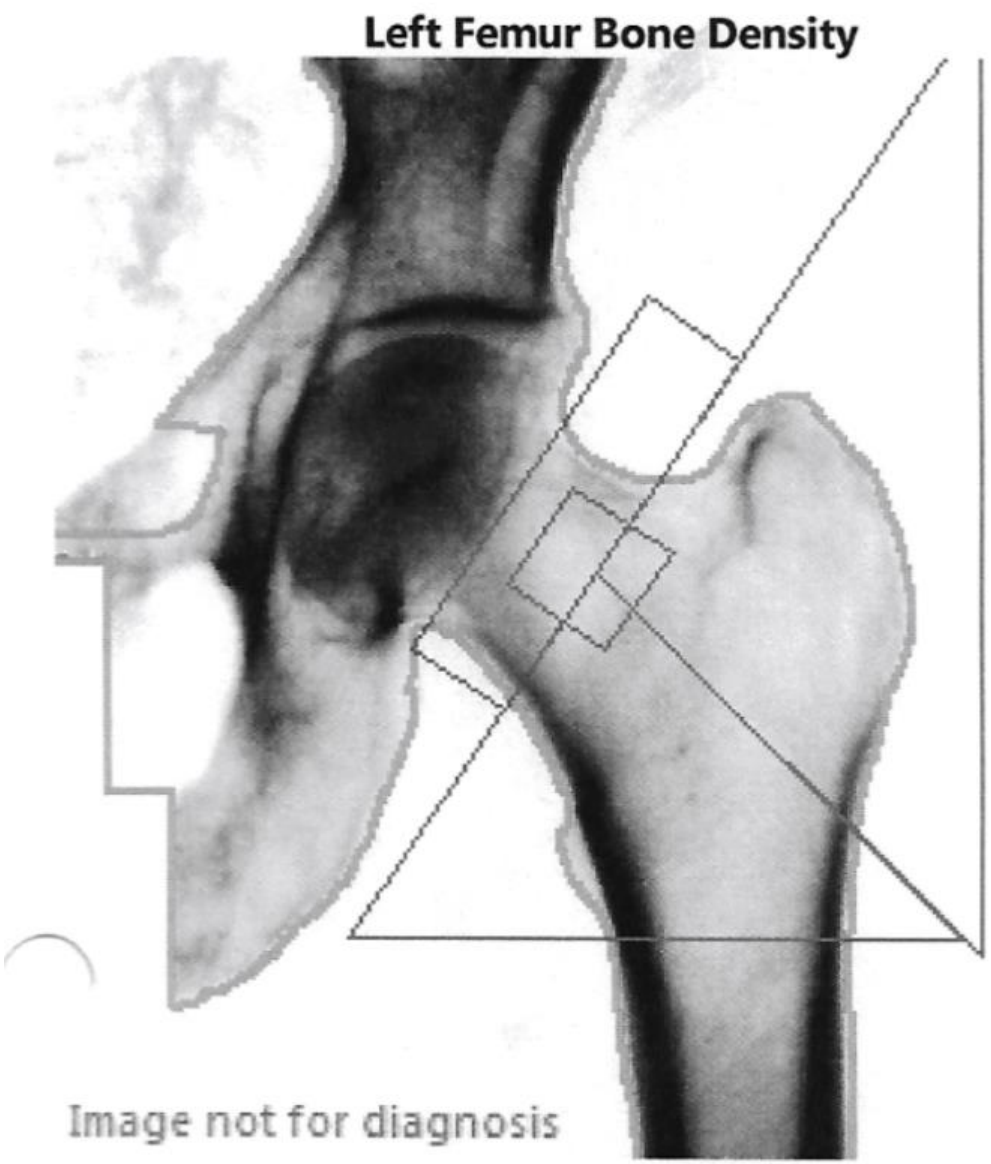
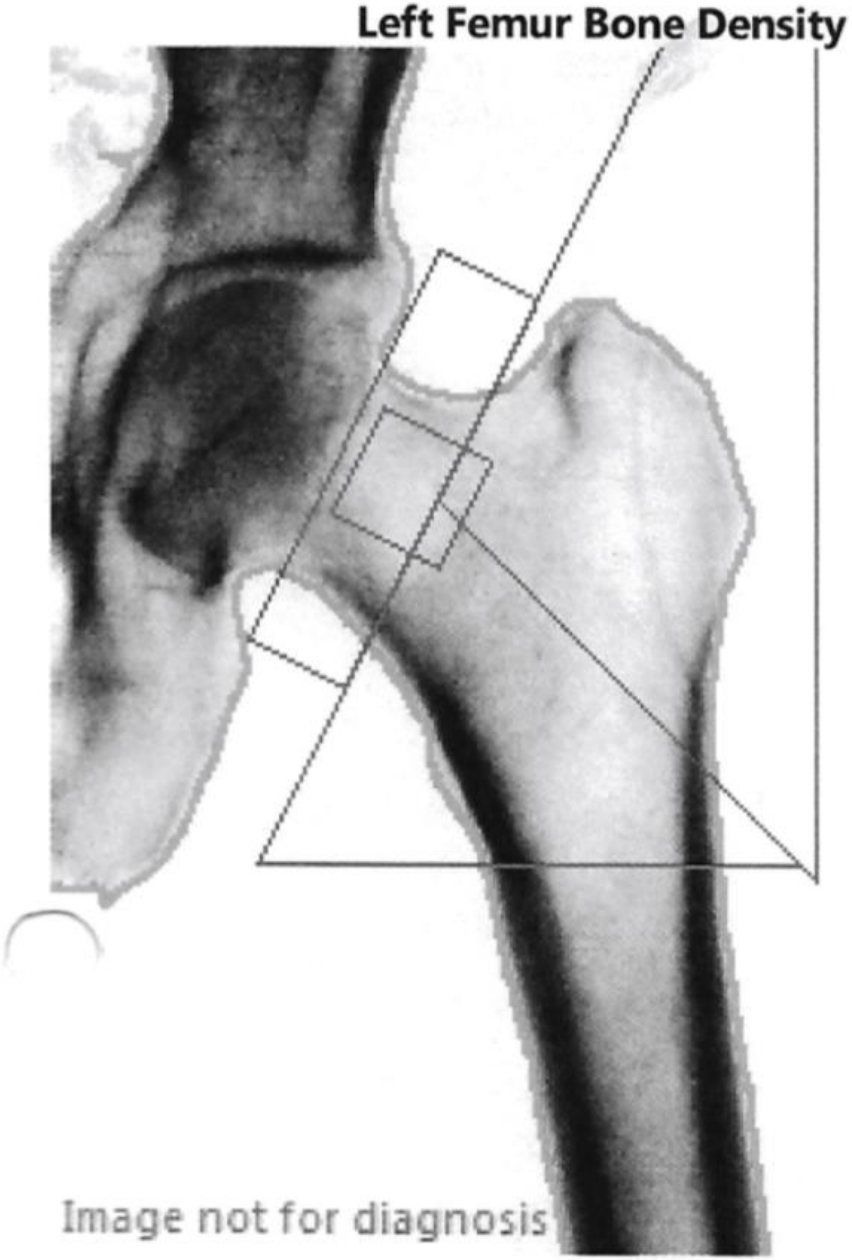
Reliable or not reliable???





- Rate of change 1.1% in 3 years

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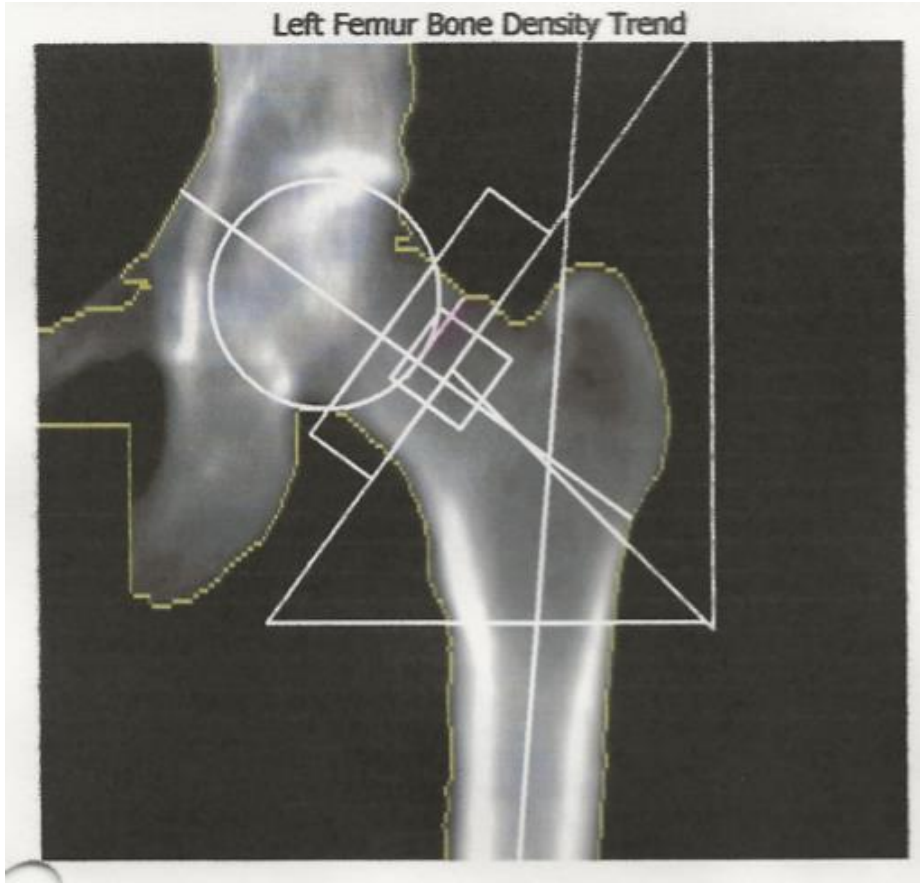

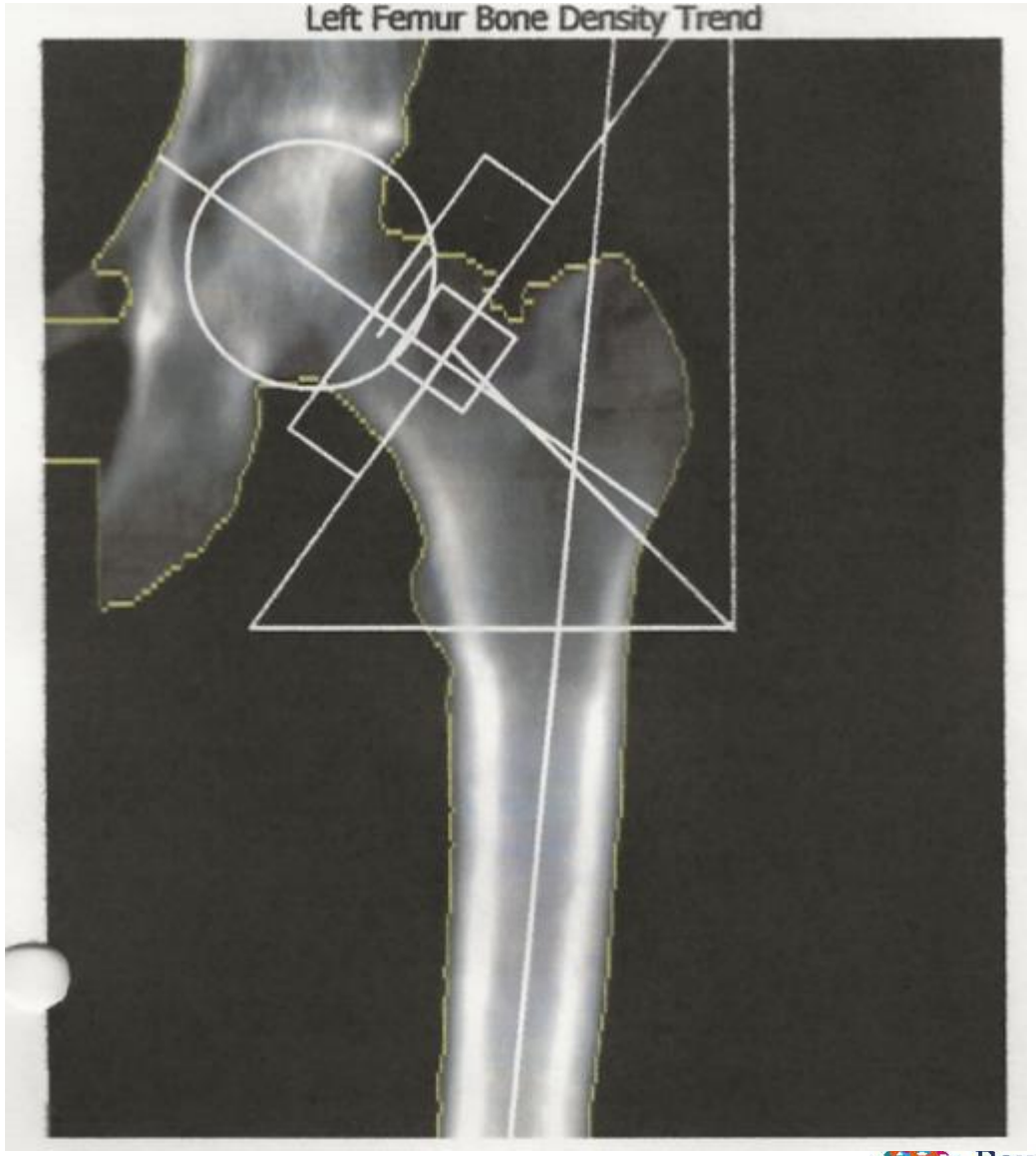

- Rate of change 13.9% in 2 years

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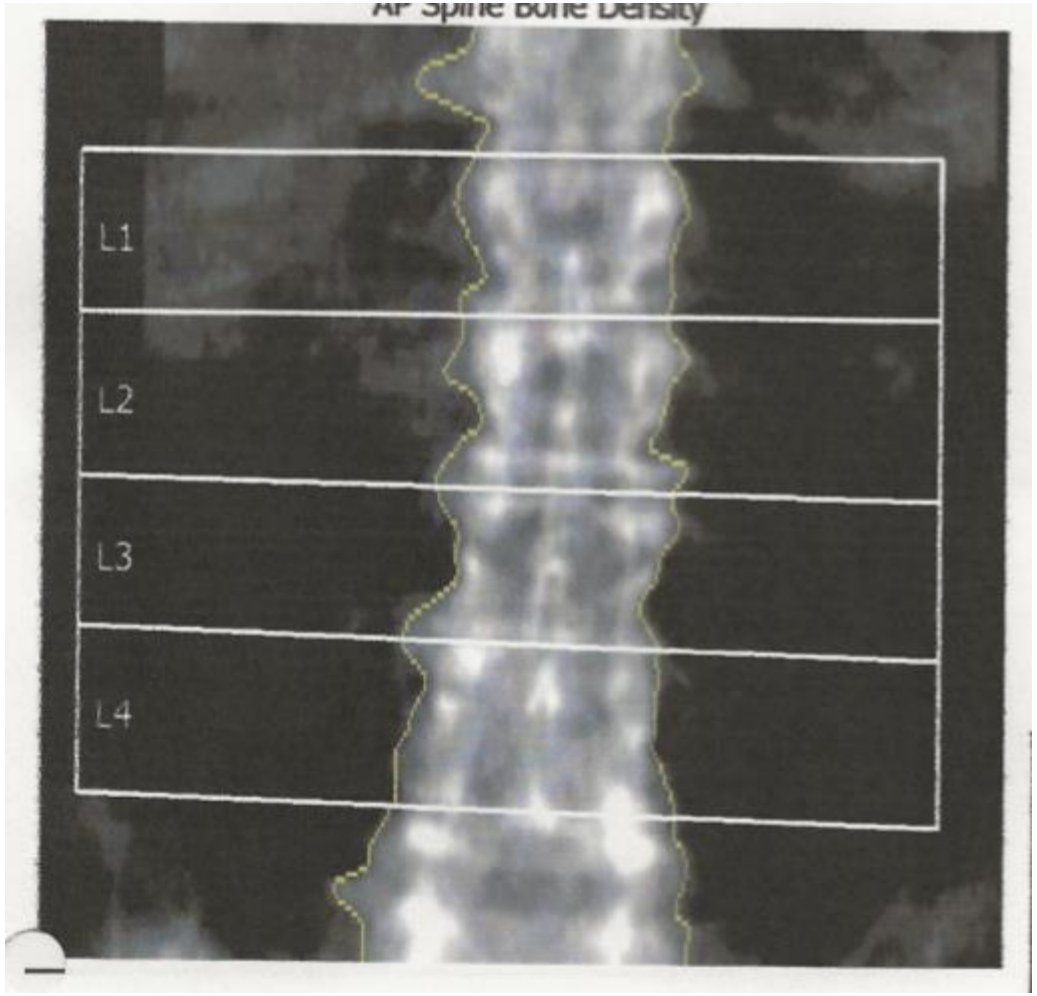
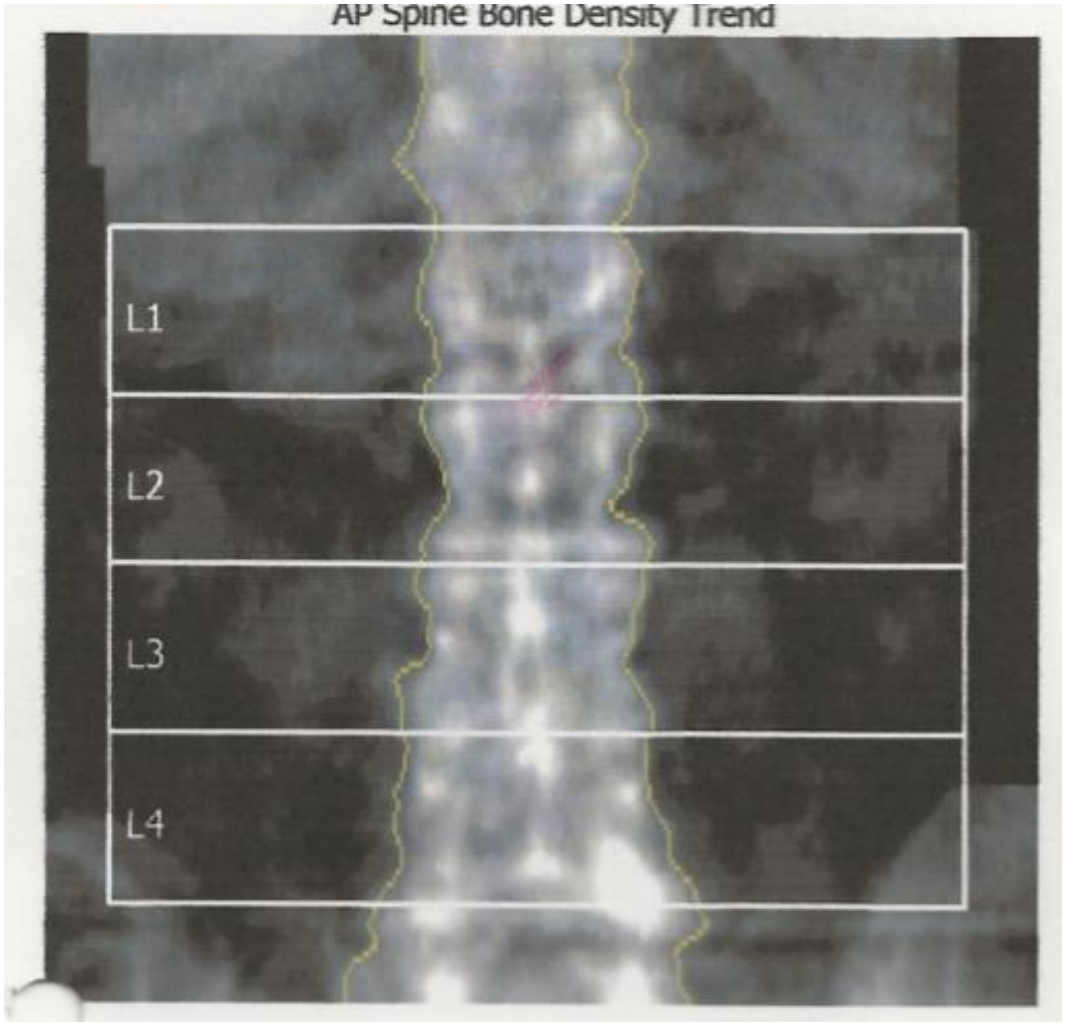
Measured:	19/02/2007	14:33:32	(10.50)
Analyzed:	19/02/2007	14:43:50	(10.50)



	14/09/2018	12:37:53	(13.60)
	14/09/2018	12:39:30	(13.60)



- Rate of change 12.5% in 11 years

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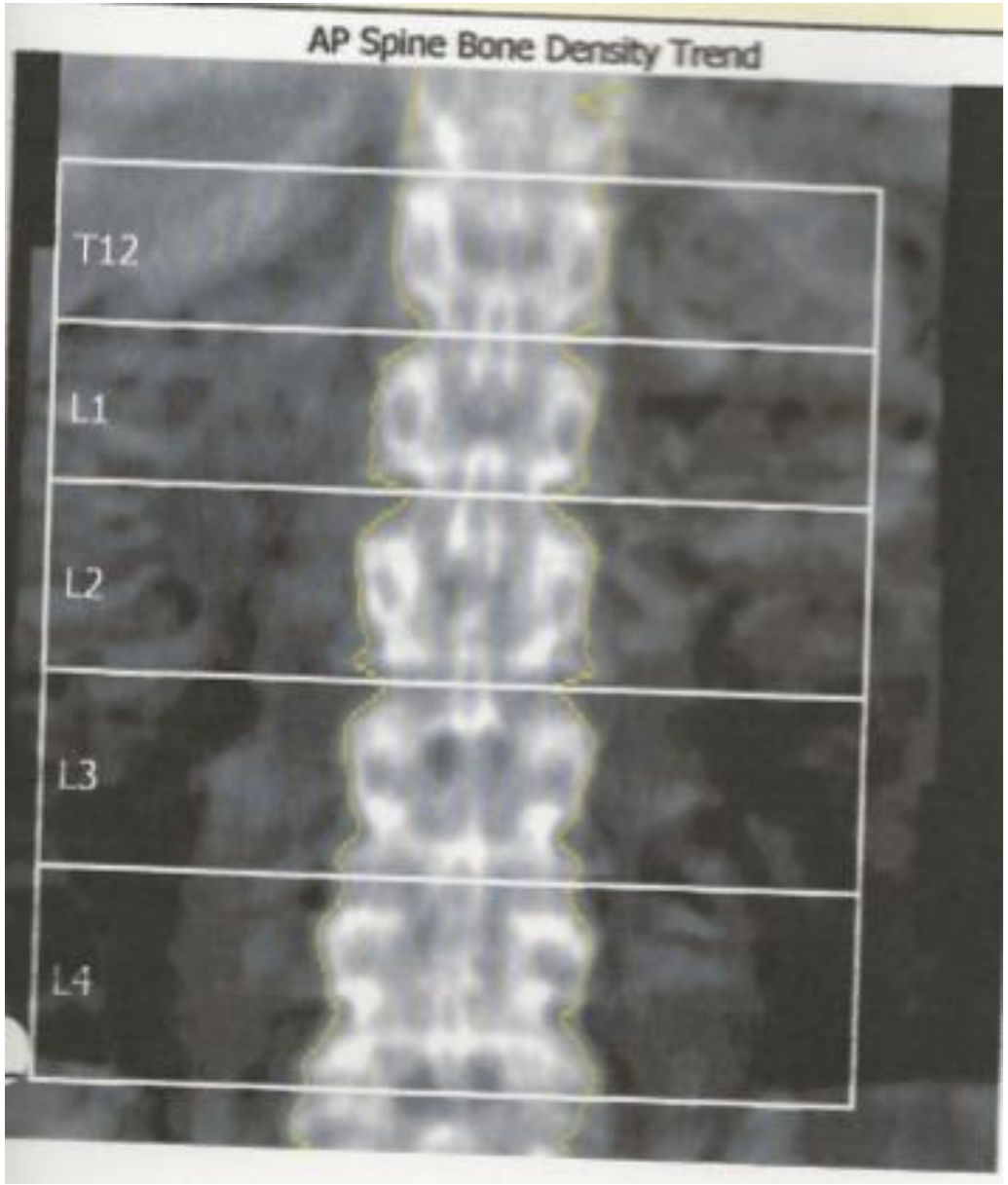

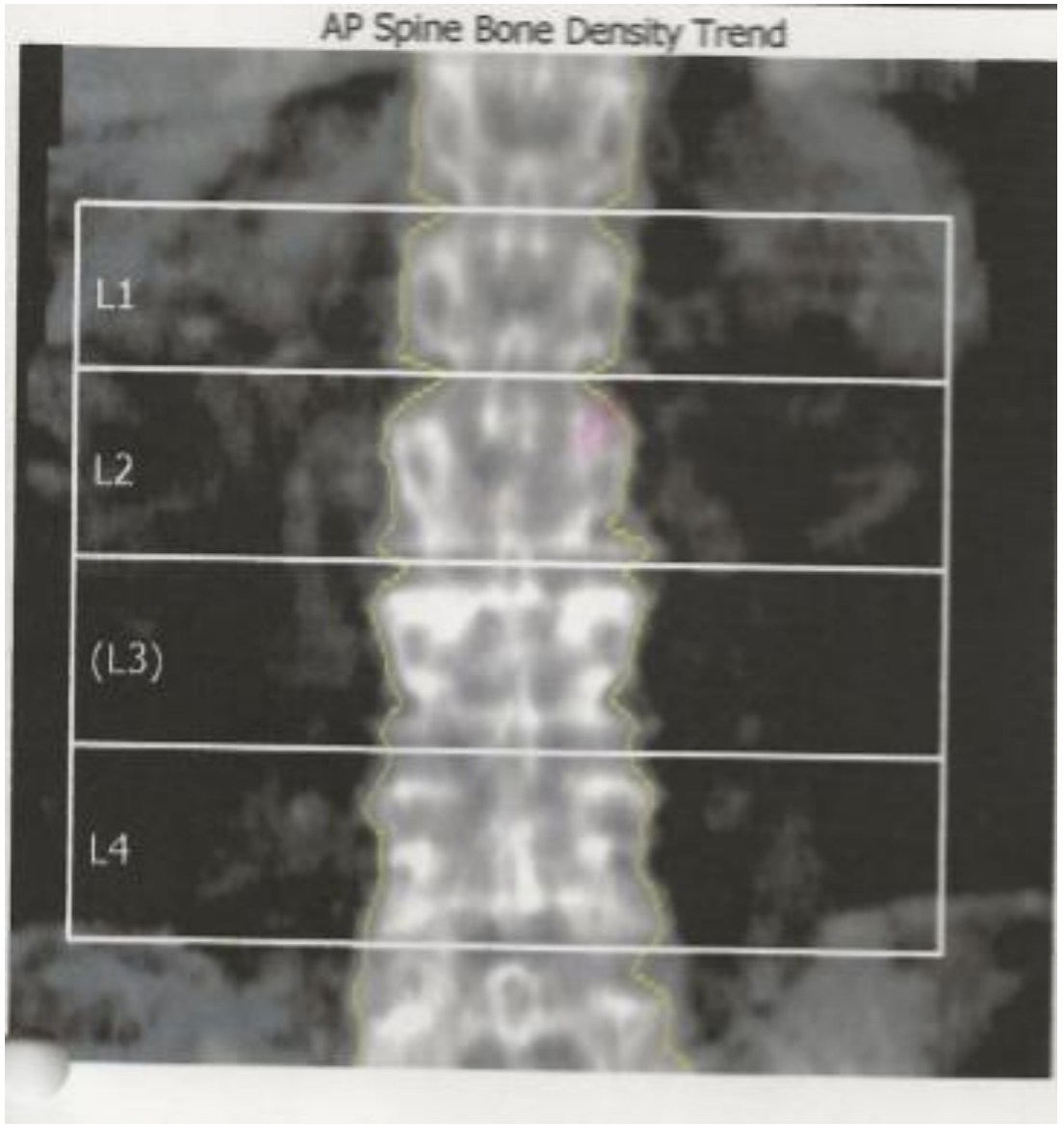

- Rate of change 2% in 2 years

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Questions & discussion

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