DXA Dilemmas and Therapeutic Challenges in Osteoporosis

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DXA Dilemmas Overview

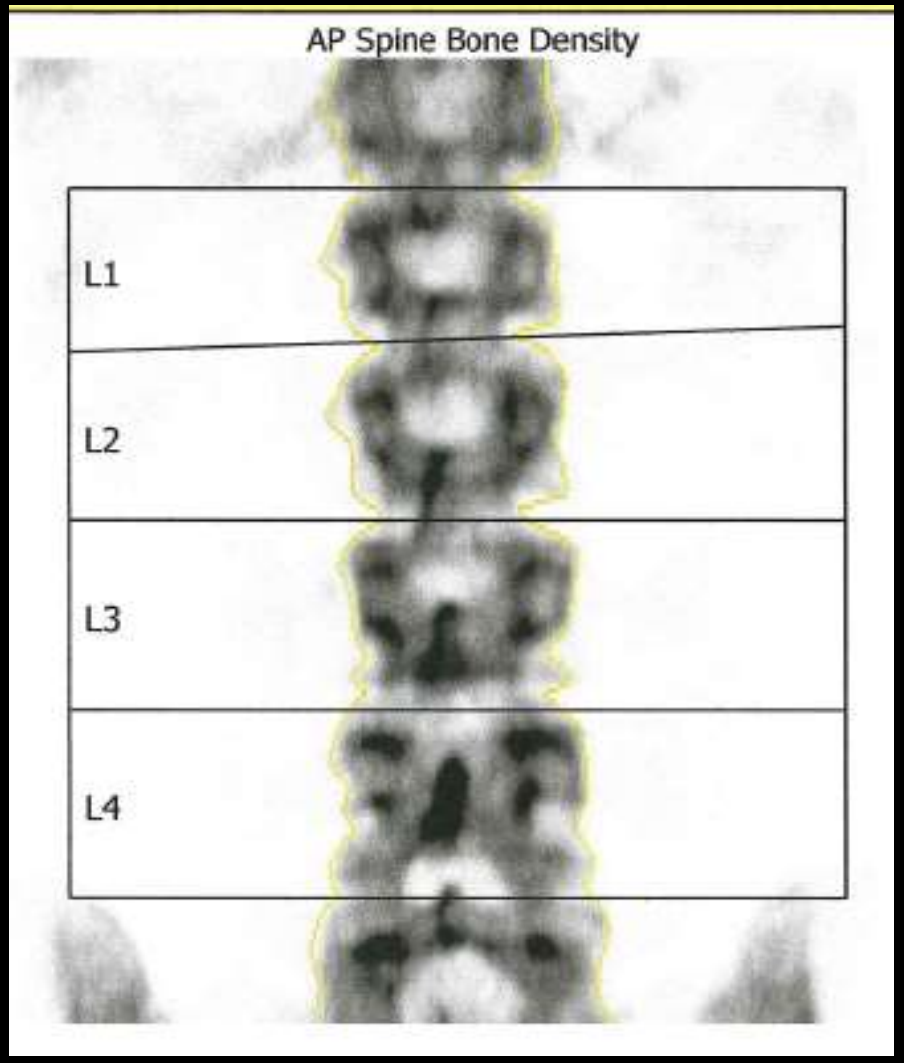
Seven illustrative cases of DXA problems leading to faulty diagnostic considerations

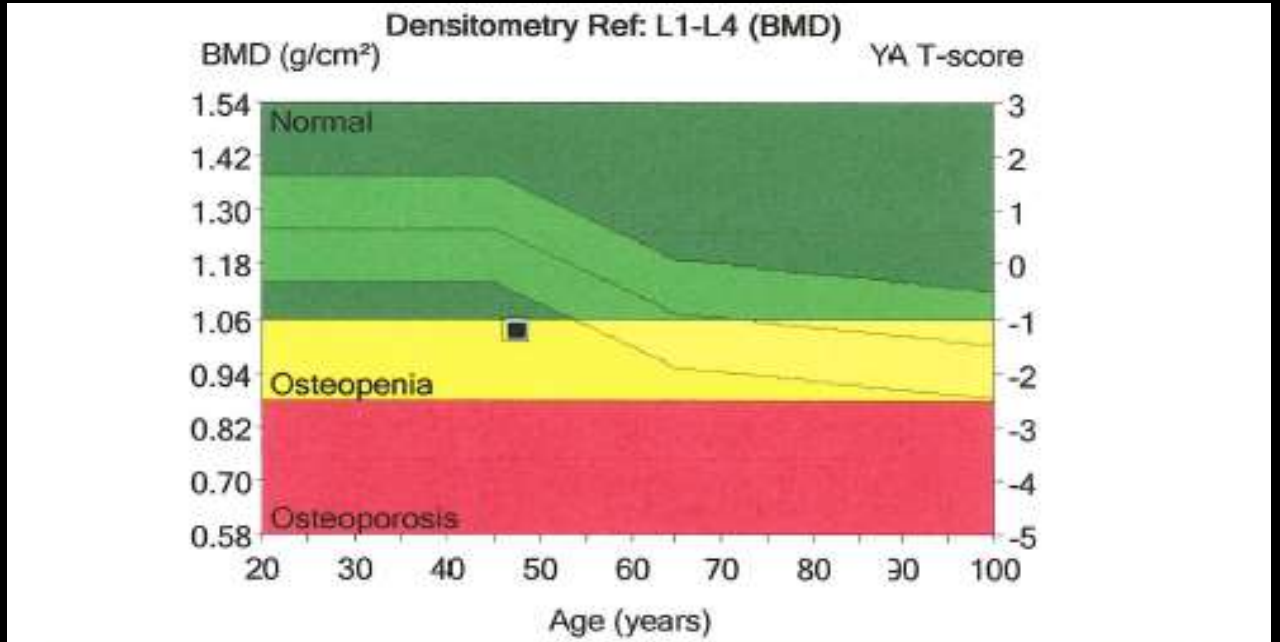
Interesting images with spine and hip artifacts

DXA Case 1

- 52-year old woman sent for evaluation of loss of bone mineral density (between baseline and follow-up scans)
- Followed in past with a prolactinoma, treated with bromocriptine
- Post-menopausal- faithfully takes hormone replacement therapy

Baseline DXA Scan





Region	BMD [1] (g/cm²)	Young-Adult [2] T-score	Age-Matched [3] Z-score
L1	0.983	-1.2	-1.7
L2	1.000	-1.7	-2.1
L3	1.065	-1.1	-1.6
L4	1.064	-1.1	-1.6
L1-L4	1.032	-1.2	-1.7

DualFemur Bone Density

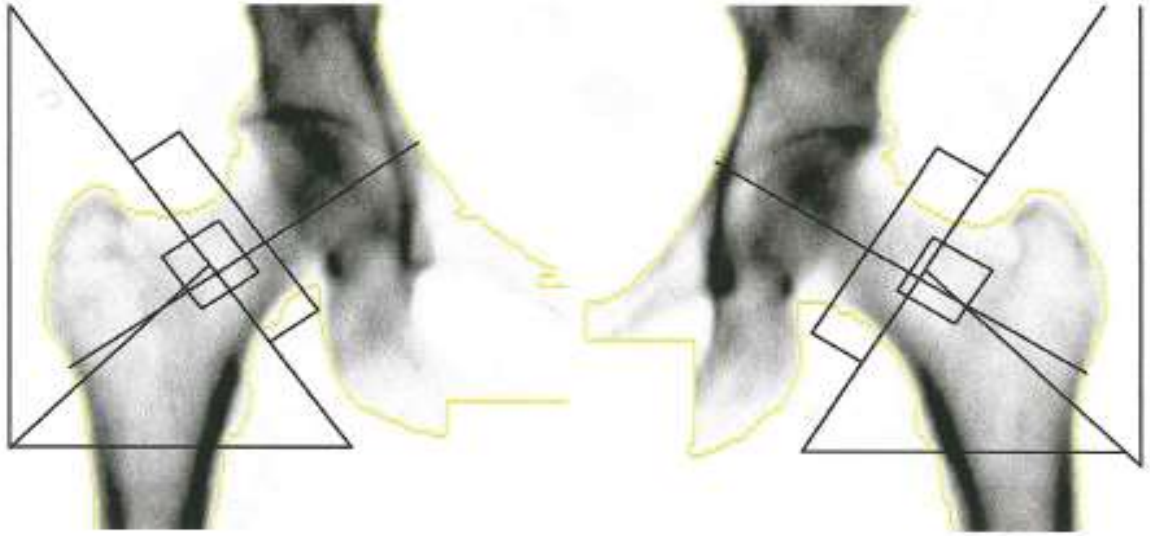
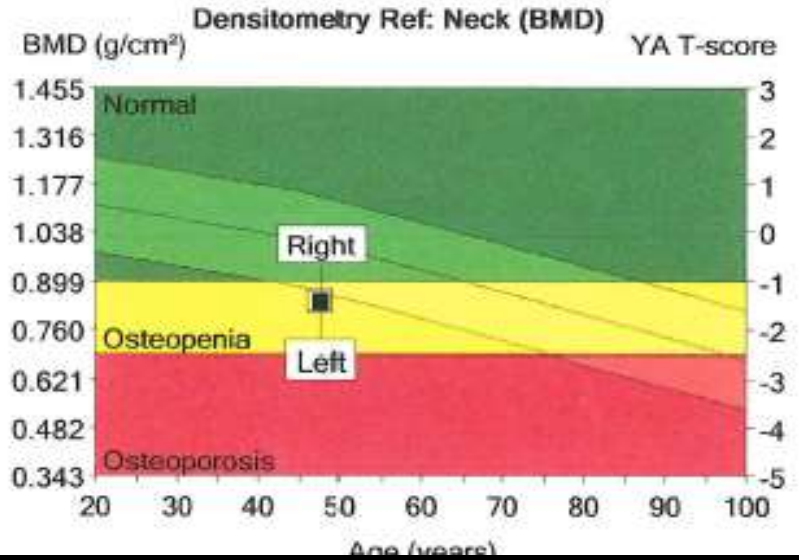
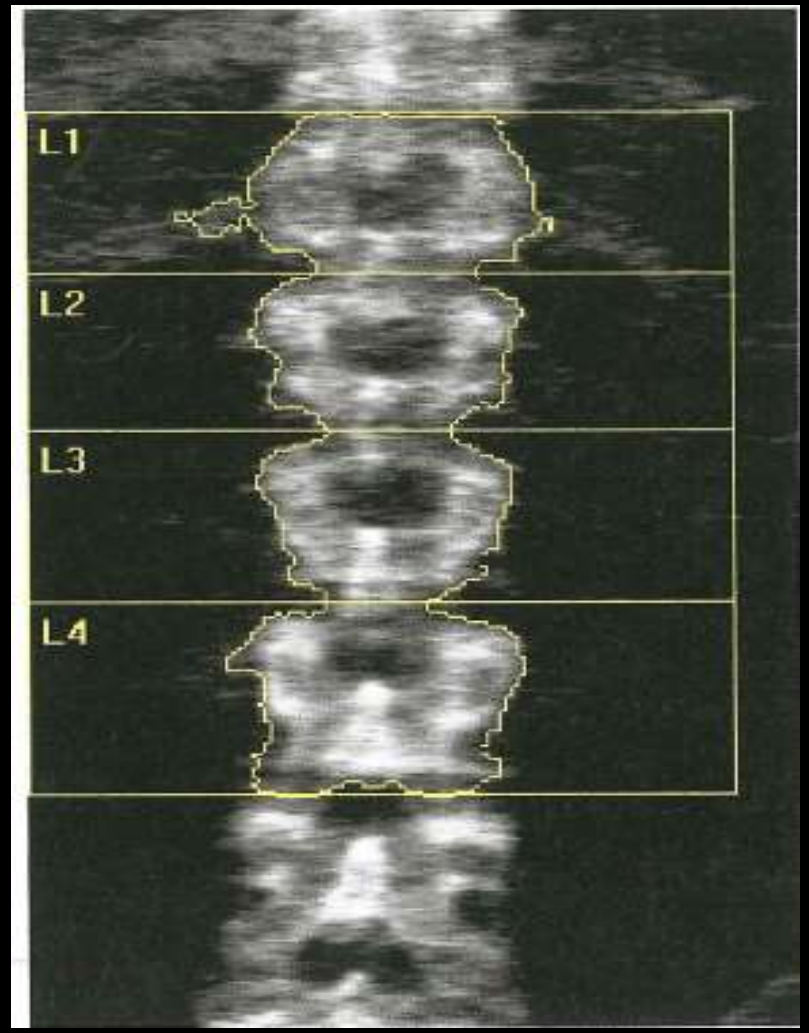


Image not for diagnosis



Region	BMD [1] (g/cm²)	Young-Adult [2,7] T-score	Age-Matched [3] Z-score
Neck			
Left	0.835	-1.5	-1.2
Right	0.841	-1.4	-1.2
Mean	0.838	-1.4	-1.2
Difference	0.007	0.0	0.0
Total			
Left	0.869	-1.1	-1.2
Right	0.894	-0.9	-1.0
Mean	0.881	-1.0	-1.1
Difference	0.025	0.2	0.2

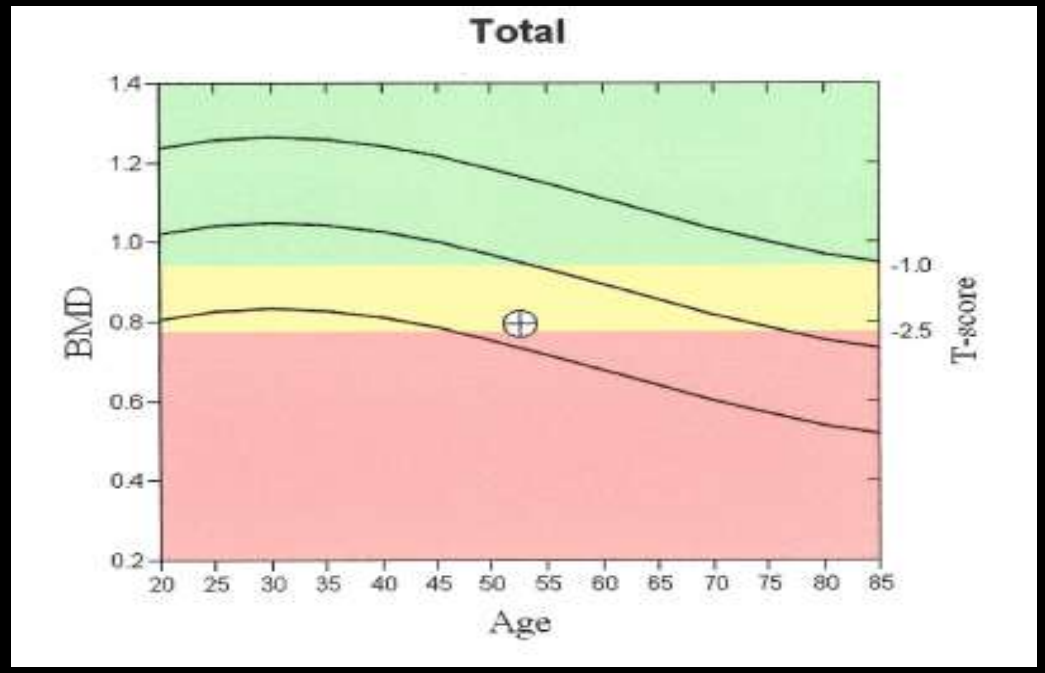
Follow-up Scan



(Baseline DXA L1-L4 T-score -1.2)

DXA Results Summary:

Region	Area (cm^2)	EMC (g)	BMD (g/cm^2)	T-score	Z-score
L1	13.56	10.00	0.737	-2.3	-1.5
L2	11.69	9.08	0.777	-2.3	-1.4
L3	11.68	9.20	0.787	-2.7	-1.8
L4	15.04	13.04	0.867	-1.8	-0.8
Total	**51.96**	**41.31**	**0.795**	**-2.3**	**-1.4**



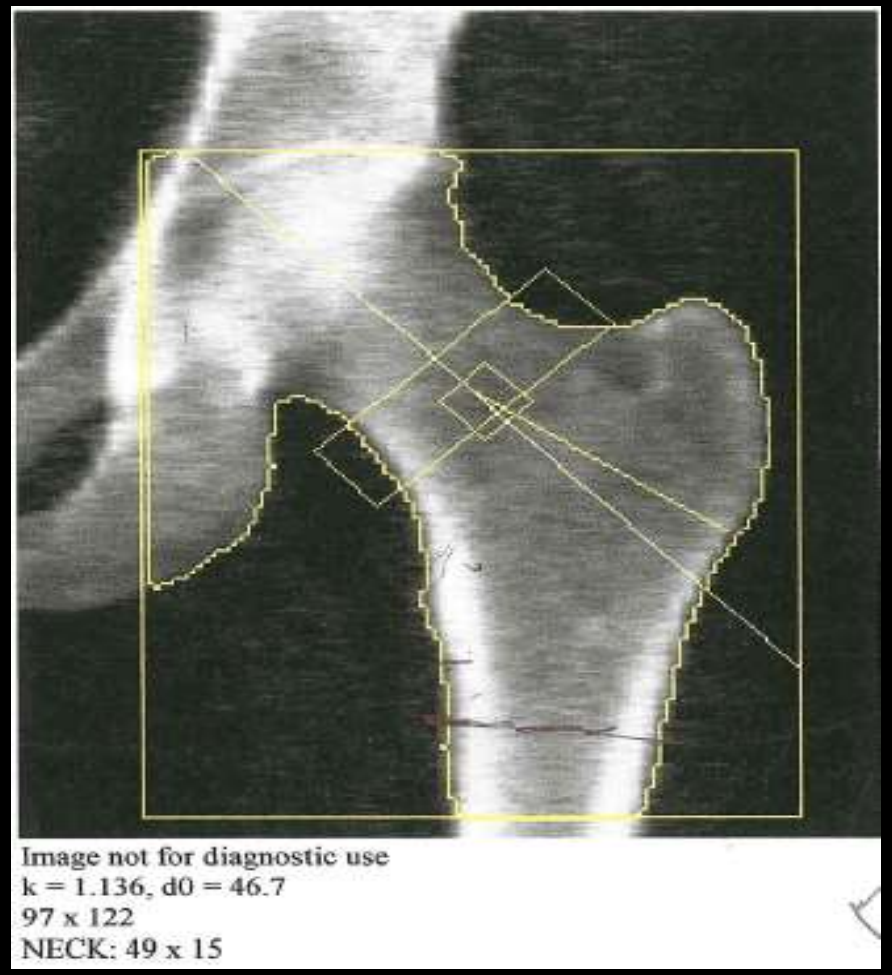
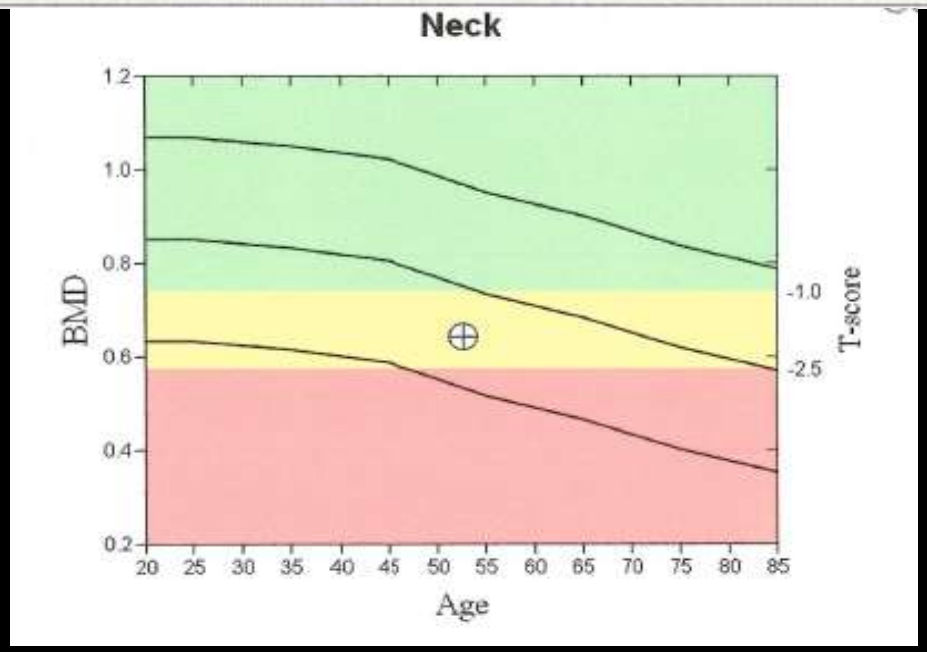


Image not for diagnostic use
k = 1.136, d0 = 46.7
97 x 122
NECK: 49 x 15

DXA Results Summary:

Region	Area (cm^2)	BMC (g)	BMD (g/cm^2)	T - score	Z - score
Neck	5.18	3.34	0.644	-1.8	-0.9
Total	39.15	33.61	0.859	-0.7	-0.1



FRAX® WHO Fracture Risk Assessment Tool

10-year Fracture Risk[1]

Major Osteoporotic Fracture	**6.1%**
Hip Fracture	**0.6%**

Reported Risk Factors:
US (Caucasian), Neck BMD=0.644, BMI=28.2

[1] FRAX® Version 3.01. Fracture probability calculated for an untreated patient. Fracture probability may be lower if the patient has received treatment.

**(Baseline DXA:
Femoral neck T = -1.5
Total hip T = -1.1)**

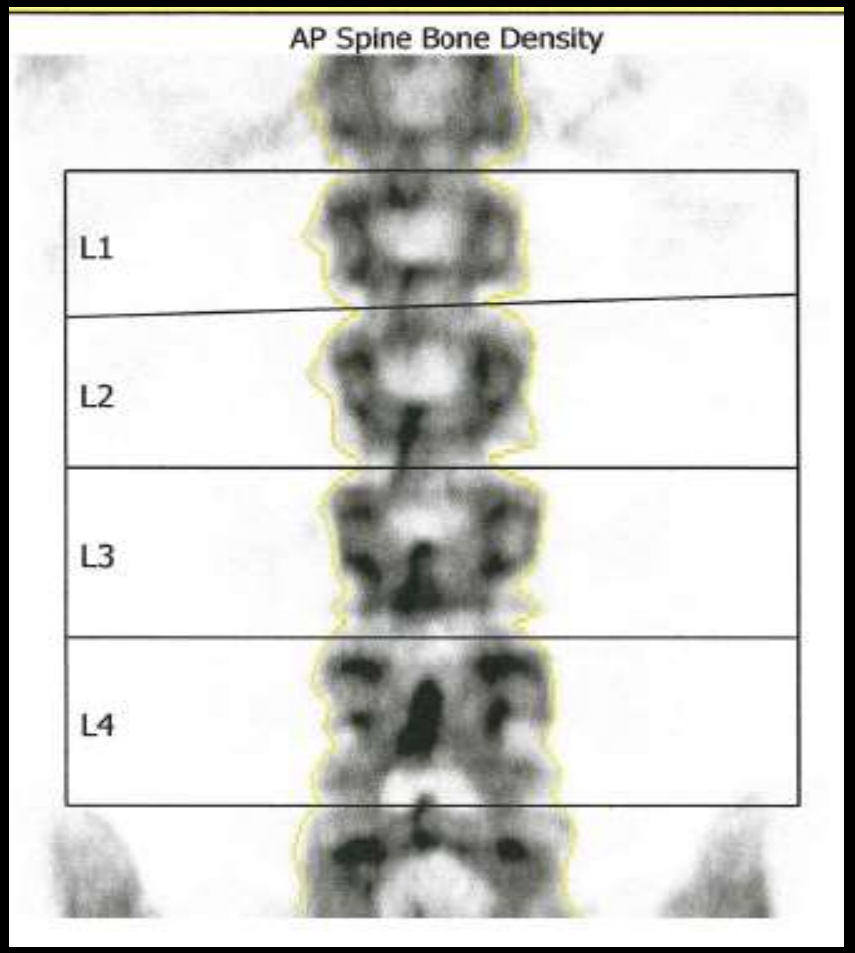
Patient asks:
Why have I gotten worse (particularly at my spine)?

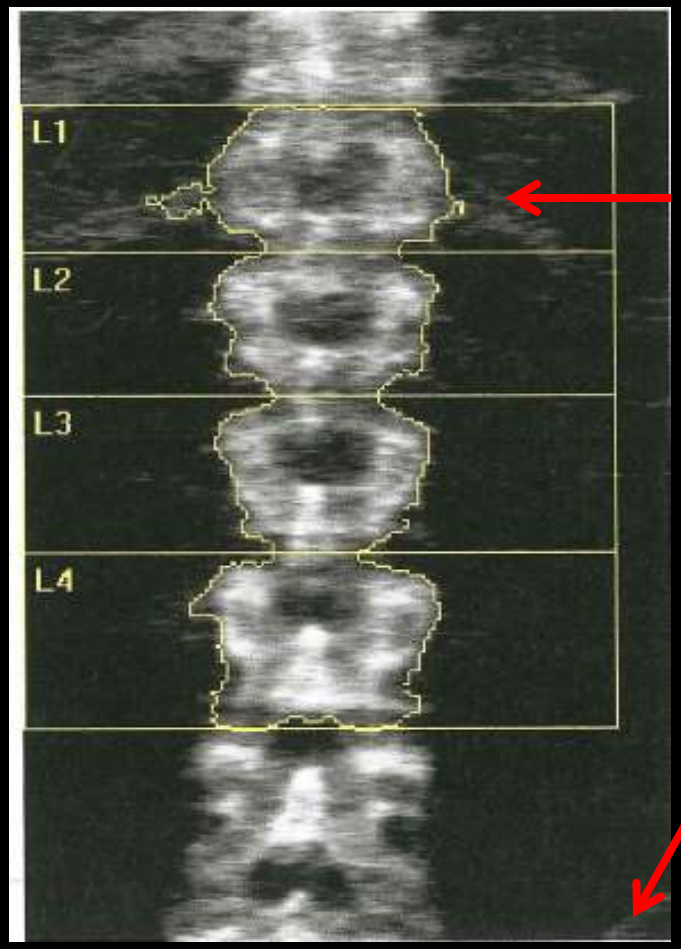
DXA Technical Aspects
Questions To Ask

1) Similar technology/manufacturer?
2) Similar regions of interest? (assess the positioning and quality of acquired scans)

Baseline

Follow-Up

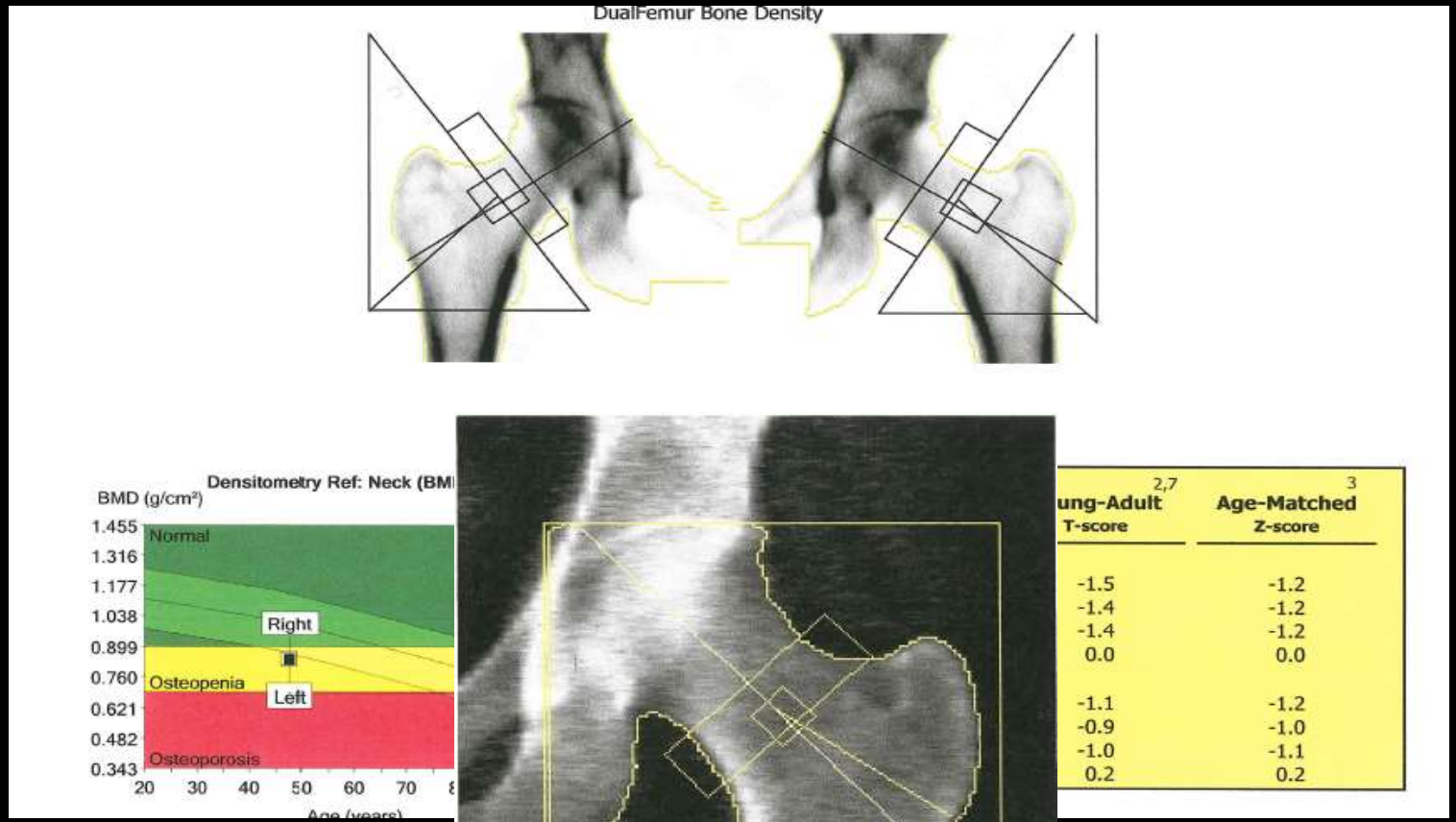




Rib

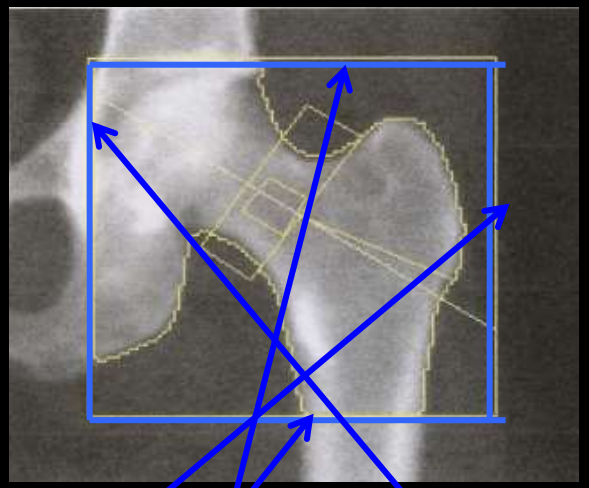
Iliac crest at junction of L4-L5

Different regions of interest scanned
<u>AND</u> baseline DXA on GE/Lunar, follow–up scan on Hologic

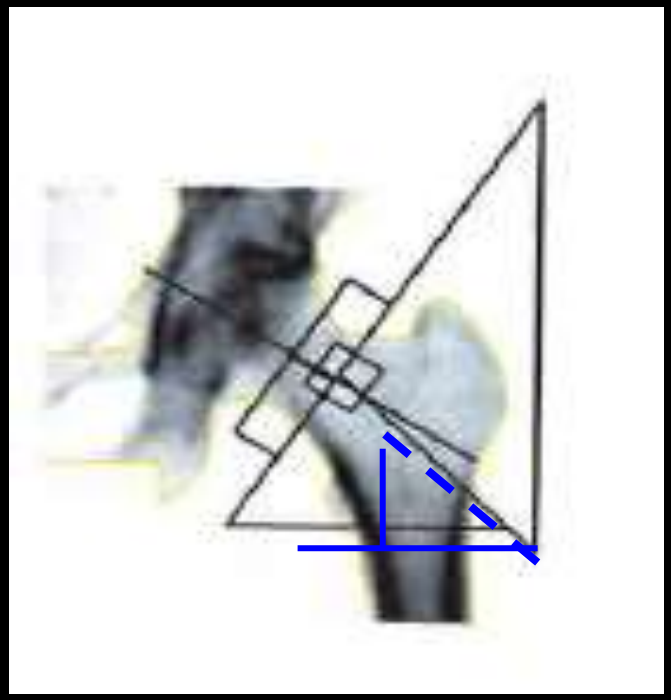


Different manufacturers & Hologic ROI is wrong!

Hip Analysis
Total Hip ROI Placement

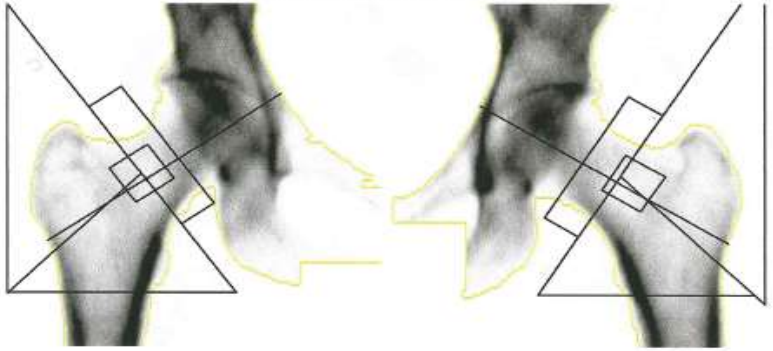


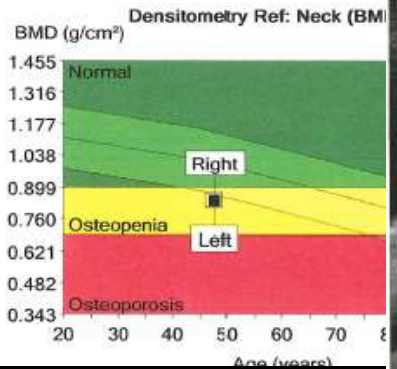
- Hologic global ROI 5 pixels (0.5 cm) medial and superior to femoral head and lateral to greater trochanter, and bottom 1 cm below base of lesser trochanter
- Bottom line is most important one



- Bottom of GE Healthcare ROI triangle 5 cm below intersection of trochanteric line with Ward's region

DualFemur Bone Density





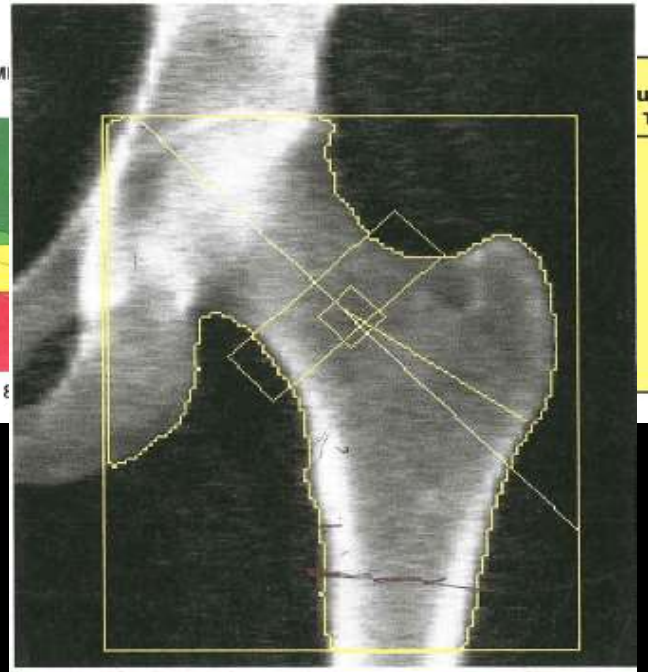
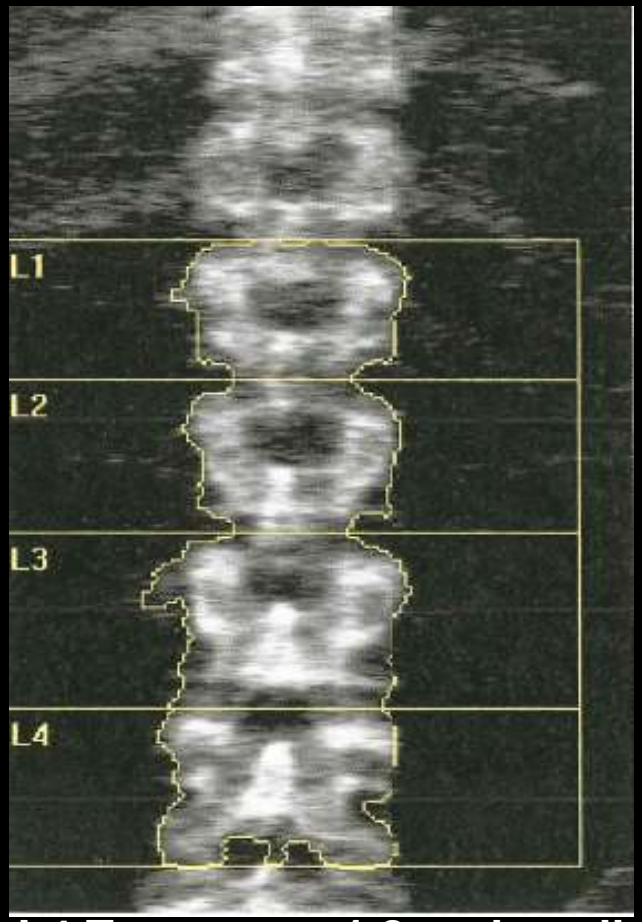


Image not for diagnostic use
k = 1.136, d0 = 46.7
97 x 122
NECK: 49 x 15

[2,7] ung-Adult T-score	[3] Age-Matched Z-score
-1.5	-1.2
-1.4	-1.2
-1.4	-1.2
0.0	0.0
-1.1	-1.2
-0.9	-1.0
-1.0	-1.1
0.2	0.2

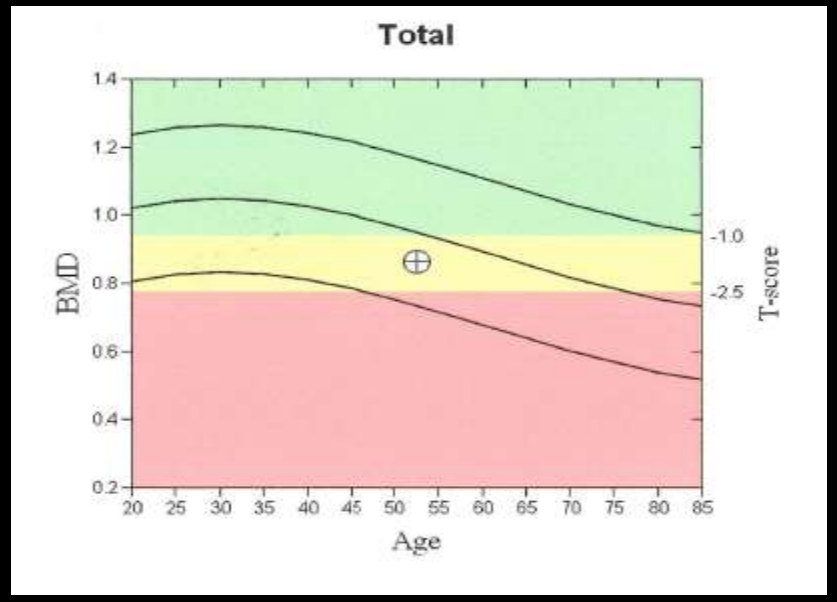
LS spine Scan Reanalysis Follow-Up



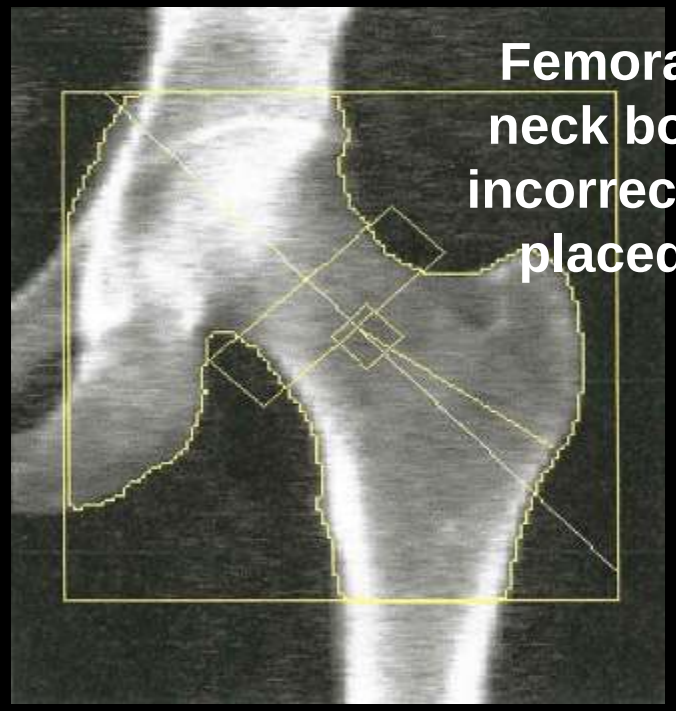
L1-L4 T-score = -1.2 on baseline scan

DXA Results Summary:

Region	Area (cm^2)	BMC (g)	BMD (g/cm^2)	T - score	Z - score
L1	12.12	10.15	0.837	-1.4	-0.6
L2	12.65	10.53	0.832	-1.8	-0.9
L3	17.13	14.96	0.874	-1.9	-1.0
L4	15.23	13.67	0.897	-1.5	-0.5
Total	**57.14**	**49.31**	**0.863**	**-1.7**	**-0.8**



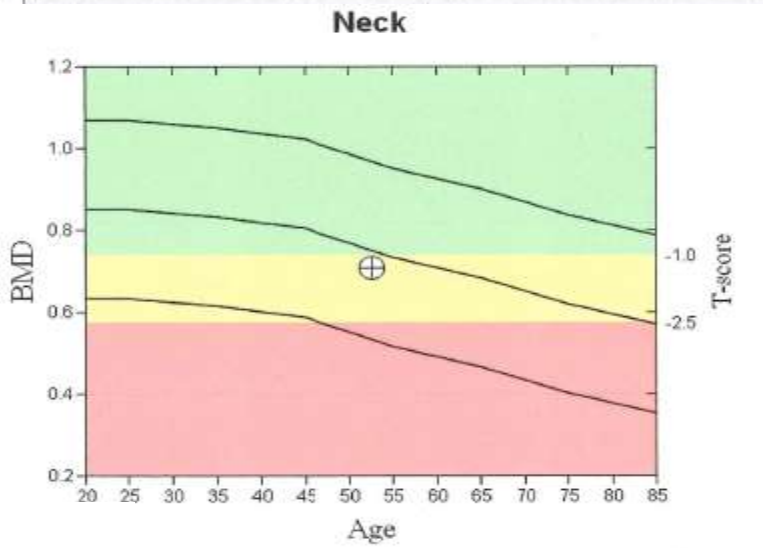
Reanalyzed Hip Scan



Femoral neck box incorrectly placed

DXA Results Summary:

Region	Area (cm^2)	BMC (g)	BMD (g/cm^2)	T-score	Z-score
Neck	5.04	3.57	0.708	-1.3	-0.4
Total	35.41	27.92	0.788	-1.3	-0.7



FRAX® WHO Fracture Risk Assessment Tool

10-year Fracture Risk[1]

Major Osteoporotic Fracture	**5.1%**
Hip Fracture	**0.3%**

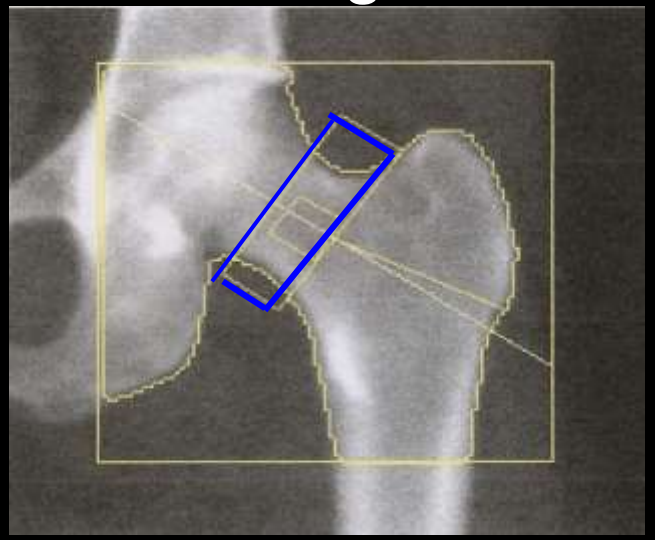
Reported Risk Factors:

US (Caucasian), Neck BMD=0.708, BMI=28.2

What is now wrong with this scan analysis?

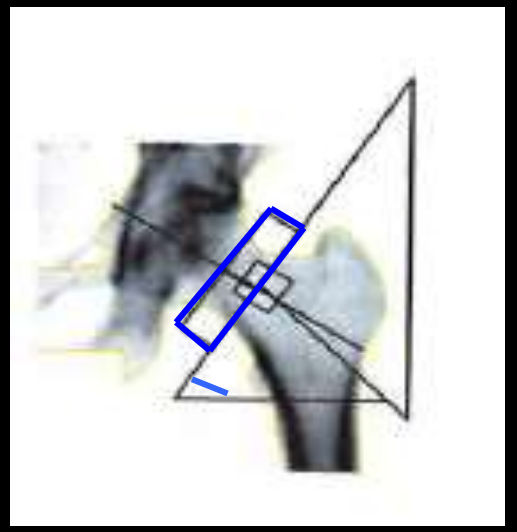
Hip Analysis
Femoral Neck ROI Placement

Hologic



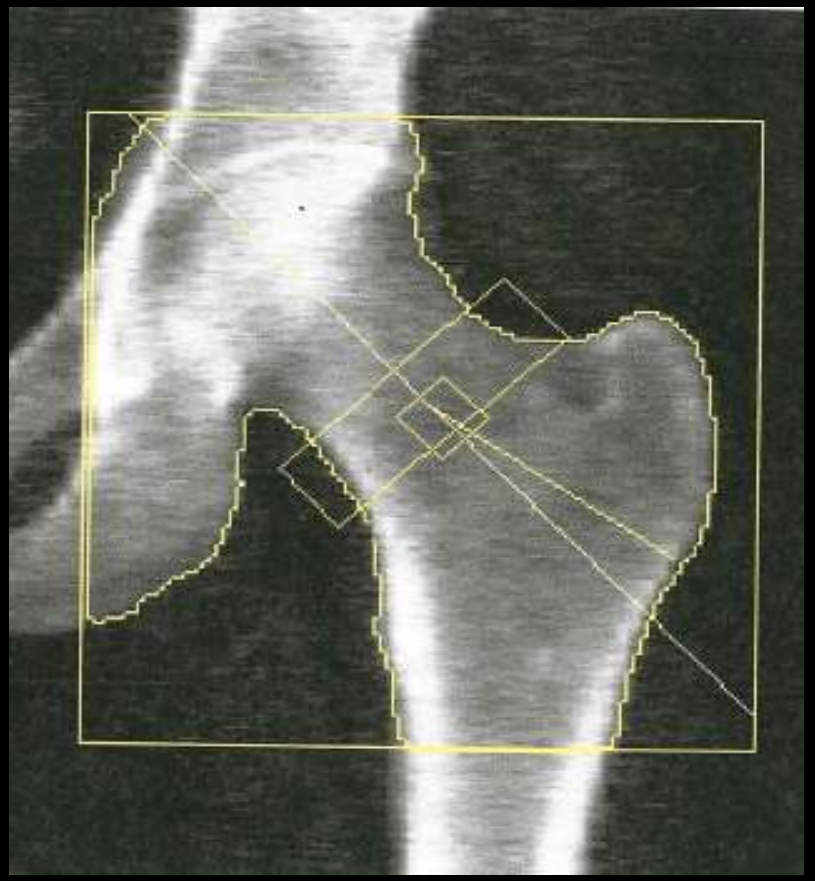
Femoral neck box anchored against greater trochanter and other 3 edges in soft tissue.
Default size - 1.5 X 4.9 cm
(however, length of the box won't affect results)

GE



Femoral neck box halfway between acetabulum and greater trochanter, at narrowest aspect of femoral neck
Default size - 1.5 x 6 cm

Final Hip Reanalysis



Baseline scan results:
Femoral neck T = -1.5
Total hip T = -1.1

Region	Area (cm^2)	BMC (g)	BMD (g/cm^2)	T-score	Z-score
Neck	5.20	3.38	0.649	-1.8	-0.9
Total	33.39	26.22	0.785	-1.3	-0.7

10-year Fracture Risk[1]

Major Osteoporotic Fracture	**5.9%**
Hip Fracture	**0.6%**

Reported Risk Factors:
US (Caucasian), Neck BMD=0.649, BMI=28.2

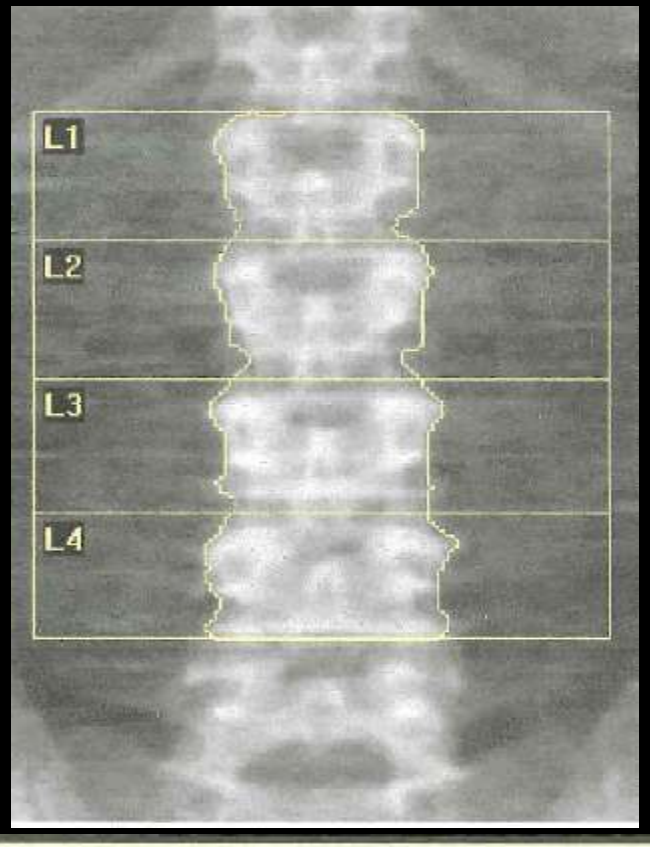
DXA Case 1 Summary

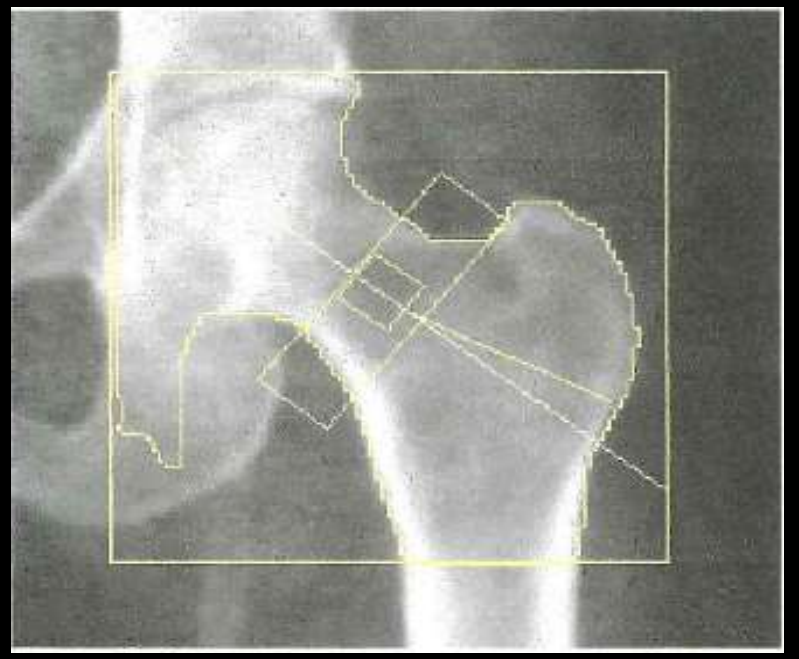
- Can’t statistically compare change between 2 different DXA manufacturers
  - Not possible to conclude significant loss of BMD
  - Keep patients on same scanner
  - To assess interval change, send patient back to baseline scanner, if at all possible
- Understand ROIs and technical aspects of scan
- Be thorough in evaluating technical aspects and persistent when evaluating/re-evaluating DXA scans

DXA Case 2

- 70 yo woman, sent for evaluation of bone mineral density
- No history of fractures
- Low 25-OH vitamin D level found and corrected
- Now taking adequate calcium and vitamin D
- Bisphosphonate started

Baseline DXA Scan





Region	Area (cm^2)	BMC (g)	BMD (g/cm^2)	T-score	PR (%)	Z-score	AM (%)
L1	11.05	8.73	0.790	-1.2	85	0.0	100
L2	12.34	11.16	0.905	-1.1	88	0.2	103
L3	12.85	12.68	0.987	-0.9	91	0.6	107
L4	13.67	13.25	0.969	-1.3	87	0.1	102
Total	**49.91**	**45.83**	**0.918**	**-1.2**	**88**	**0.2**	**103**

Region	Area (cm^2)	BMC (g)	BMD (g/cm^2)	T-score	PR (%)	Z-score	AM (%)
Neck	4.60	1.86	0.405	-4.0	48	-2.4	54
Total	26.59	13.45	0.506	-3.6	54	-2.2	59

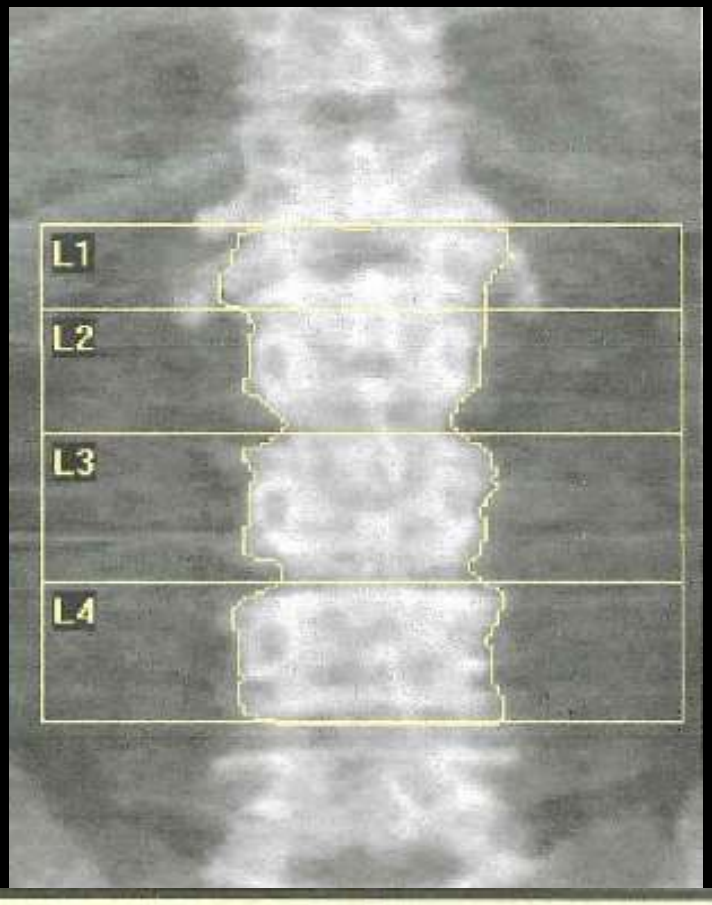
Bone density very discordant at lumbar spine and hip – reason?

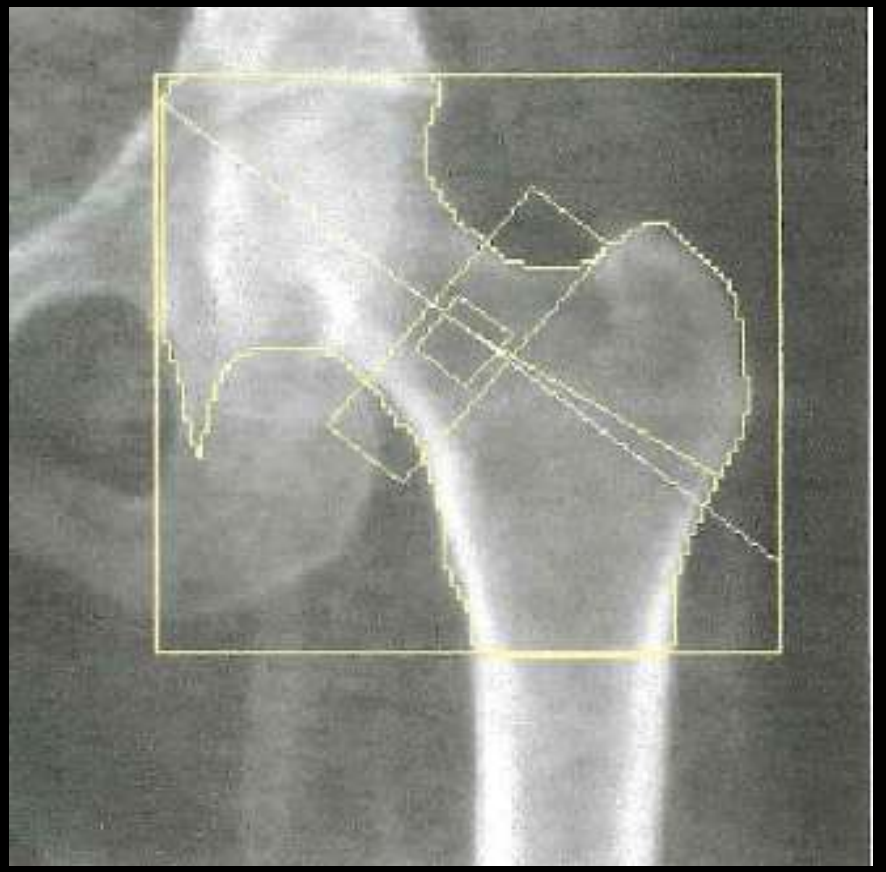
Follow-up Visit/Scan

- She returns in follow-up
- She reports not always taking her medications
- Report notes “Apparently improved in bone mineral density T scores at spine”
  - Spine -0.9 (was -1.2),
  - Femoral neck -5.0 (was -4.0)
  - Total hip -4.6 (was -3.6)
- What do you do? What do you tell her?

Get the Images and Data!

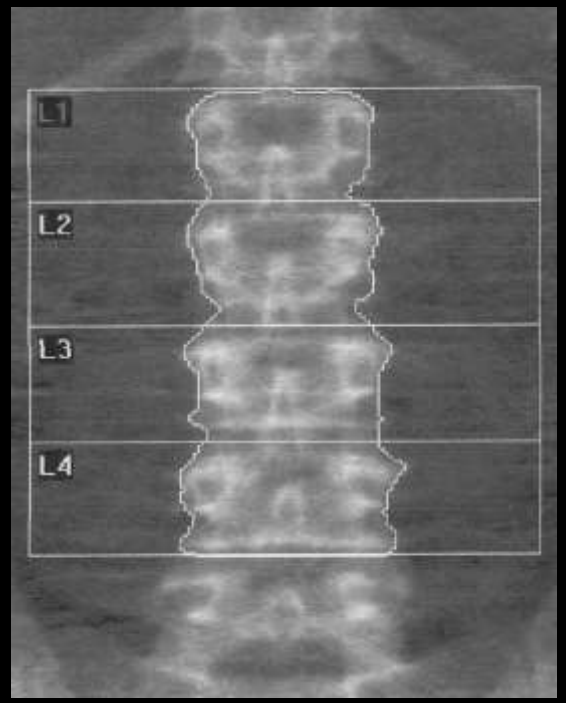
Follow-up Images

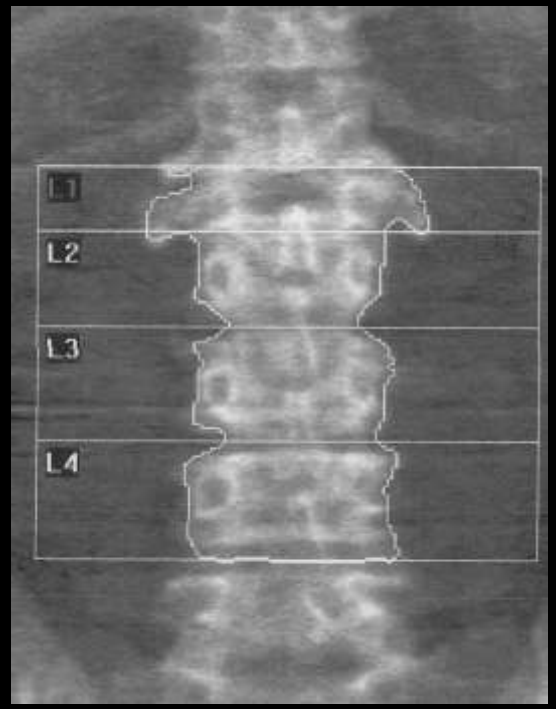




Region	Area (cm^2)	BMC (g)	BMD (g/cm^2)	T-score	PR (%)	Z-score	AM (%)
L1	8.32	8.17	0.982	0.5	106	1.9	127
L2	10.10	10.21	1.011	-0.2	98	1.4	118
L3	12.72	11.61	0.913	-1.6	84	0.1	101
L4	13.54	12.60	0.930	-1.7	83	0.0	100
Total	**44.68**	**42.59**	**0.953**	**-0.9**	**91**	**0.7**	**109**

Region	Area (cm^2)	BMC (g)	BMD (g/cm^2)	T-score	PR (%)	Z-score	AM (%)
Neck	**4.80**	**1.40**	**0.292**	**-5.0**	**34**	**-3.1**	**40**
Total	26.96	10.39	0.385	-4.6	41	-2.9	46





Baseline

Region	Area (cm^2)	BMC (g)	BMD (g/cm^2)	T-score	PR (%)	Z-score	AM (%)
L2	12.64	11.35	0.898	-1.2	87	0.2	102
L3	12.85	12.72	0.990	-0.9	91	0.6	107
L4	14.14	13.58	0.960	-1.4	86	0.0	100
Total	**39.63**	**37.65**	**0.950**	**-1.2**	**88**	**0.2**	**103**

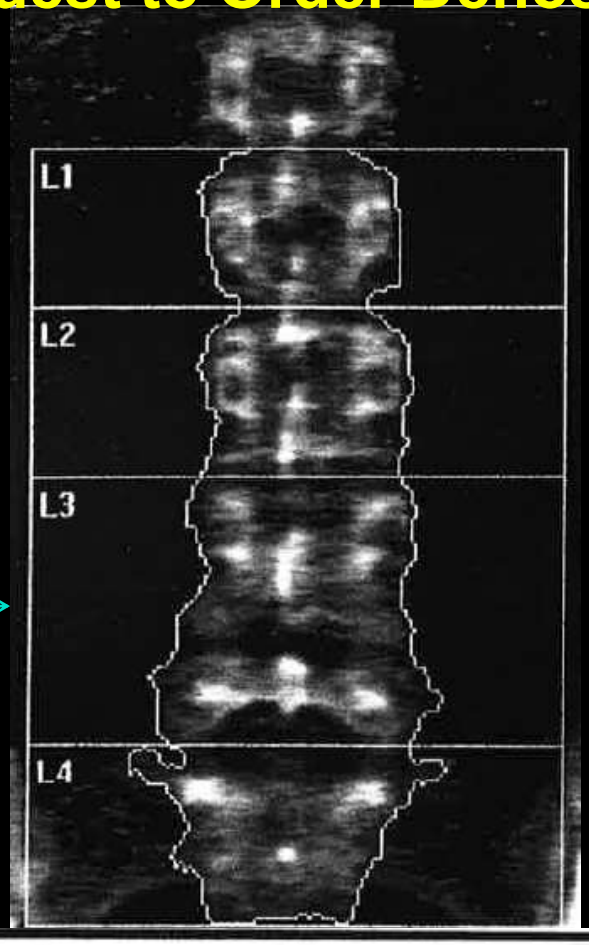
Follow-up

Region	Area (cm^2)	BMC (g)	BMD (g/cm^2)	T-score	PR (%)	Z-score	AM (%)
L2	10.49	10.69	1.019	-0.1	99	1.5	119
L3	12.76	11.80	0.925	-1.4	85	0.2	102
L4	14.75	13.42	0.910	-1.9	82	-0.2	98
Total	**38.00**	**35.90**	**0.945**	**-1.2**	**88**	**0.4**	**105**

DXA Case 2 Summary

- Look at images!
- Do not trust report without images and data
- New fracture L1 and likely significant loss at hip (need short term precision values)
- Additional secondary work-up needed
- Consider alternate therapies when fracture and/or significant BMD decline despite current adherence to Rx and no secondary causes

DXA Case 3- 35 yo Premenopausal Woman Sent with Request to Order Denosumab



2 vertebral bodies in this ROI

This is sacrum – L4 drawn in sacrum!

Correct lumbar spine ROI not scanned

DXA Tech has L2 – sacrum instead of L1-L4 ROI

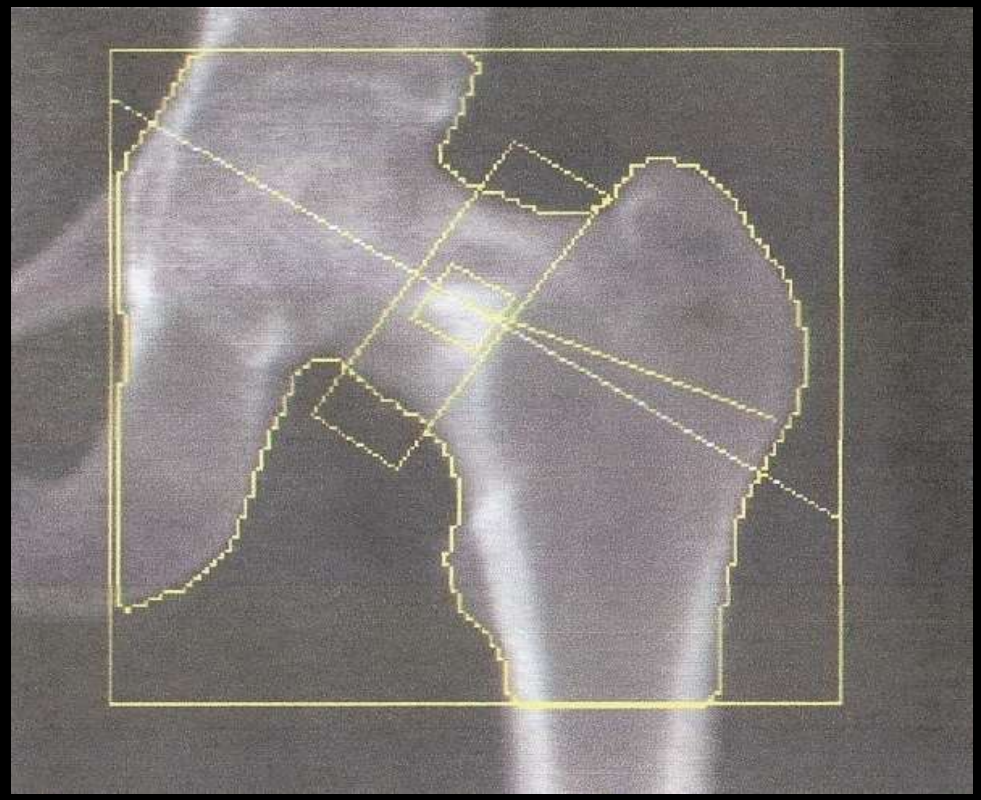
Region	Area (cm^2)	BMC (g)	BMD (g/cm^2)	T - score	Z - score
L1	13.31	13.40	1.007		0.8
L2	15.22	14.59	0.958		-0.6
L3	29.55	27.77	0.940		-1.3
L4	17.95	12.46	0.694		-3.8
Total	**76.03**	**68.21**	**0.897**		**-1.3**

Referring physician concerned about Z= -3.8

DXA Case 4

- DXA presented for routine analysis
- Postmenopausal woman
- On no medications

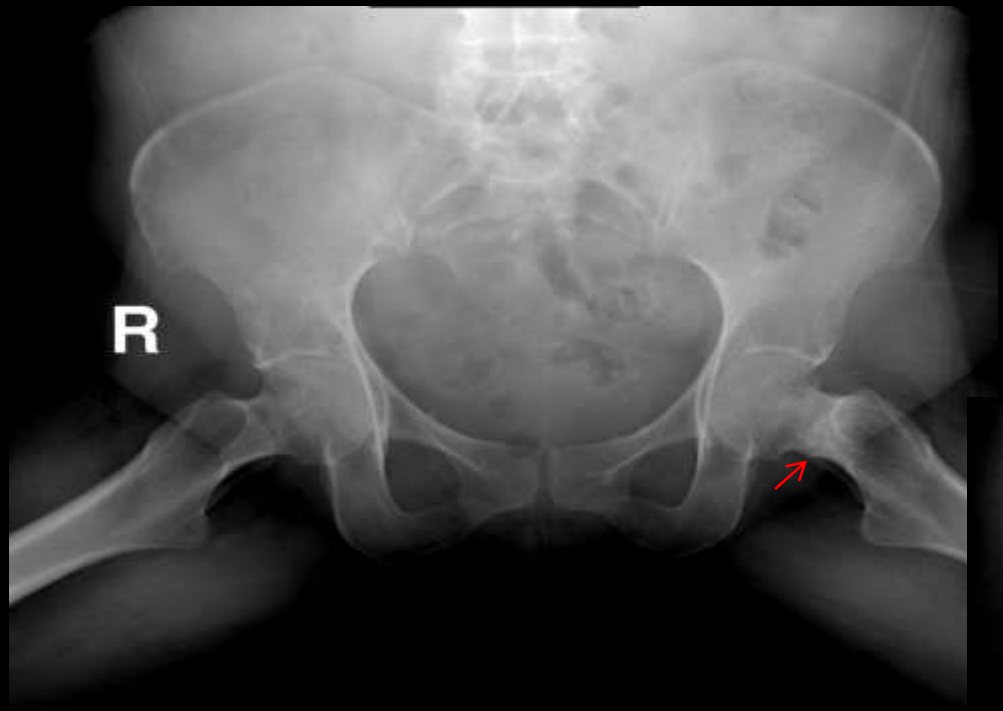
Hip Scan

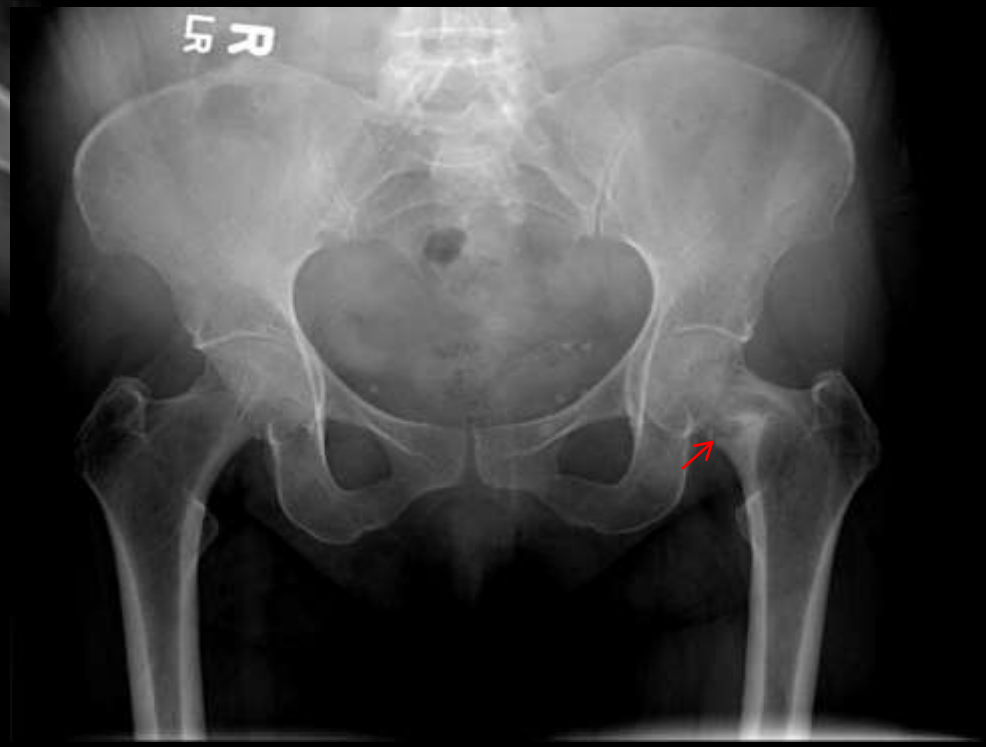


Region	Area (cm^2)	BMC (g)	BMD (g/cm^2)	T - score	PR (%)	Z - score	AM (%)
Neck	5.04	6.18	1.226	3.4	144	3.1	157
Troch	9.86	6.58	0.667	-0.4	95	0.1	102
Inter	17.12	15.09	0.881	-1.4	80	-0.9	83
Total	**32.03**	**27.85**	**0.870**	**-0.6**	**92**	**-0.1**	**98**

What is cause of so much discordance at femoral neck and total hip?

Fracture of the Femoral Neck

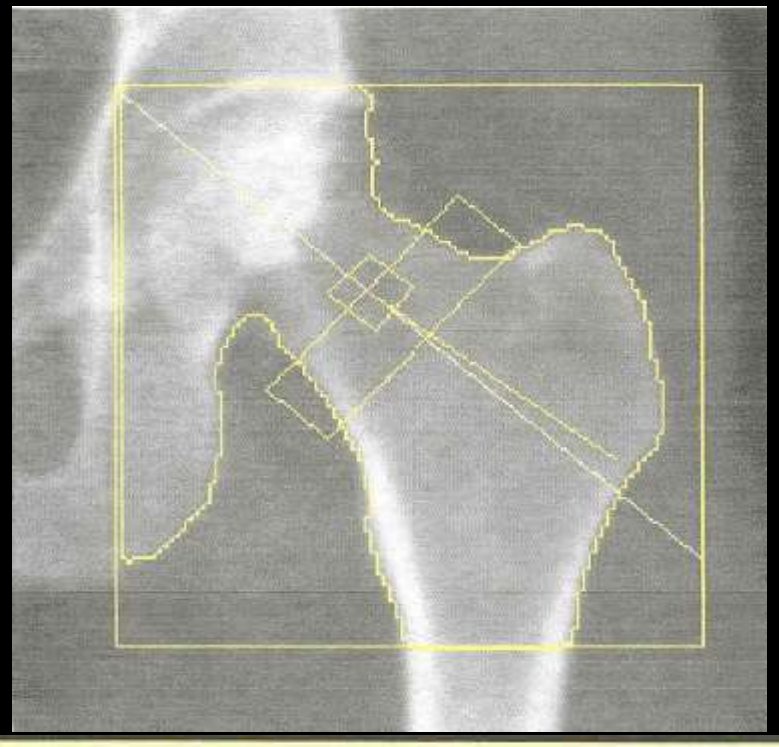




DXA Case 4 Summary

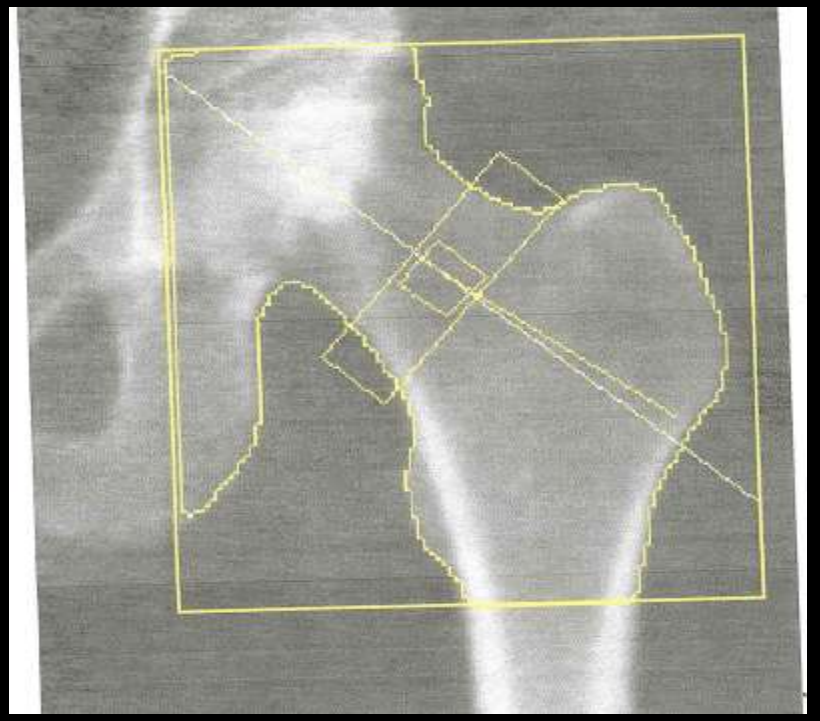
- While most DXA scanners place disclaimer that says “not for diagnostic use” on DXA images there is a great deal to learn from images

Case 5- Differences in Hip Rotation Limit Hip Comparison



Region	Area (cm^2)	BMC (g)	BMD (g/cm^2)	T - score	PR (%)	Z - score	AM (%)
Neck	5.09	2.62	0.516	-3.0	55	-2.0	65
Total	34.11	24.80	0.727	-2.0	70	-1.5	76

Baseline

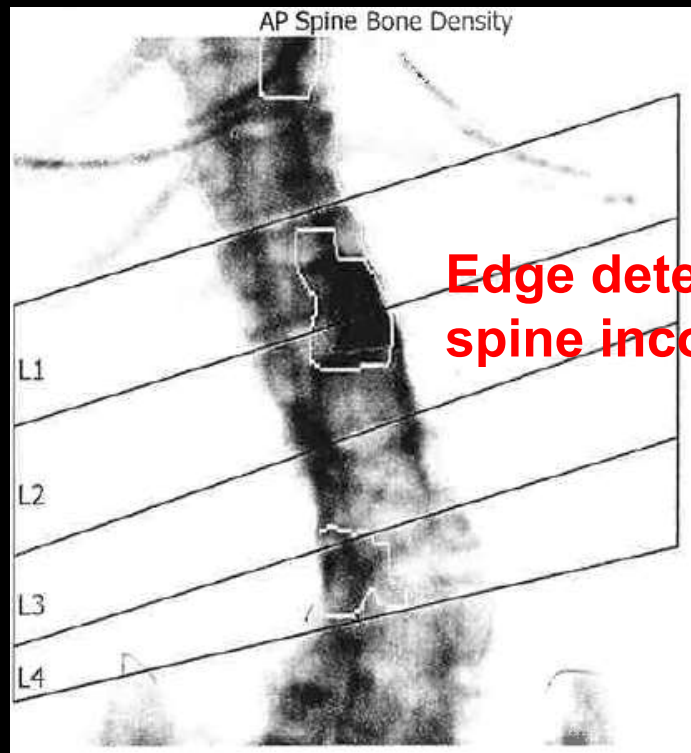


Region	Area (cm^2)	BMC (g)	BMD (g/cm^2)	T - score	PR (%)	Z - score	AM (%)
Neck	5.16	2.47	0.478	-3.3	51	-2.2	61
Total	35.24	24.67	0.700	-2.2	68	-1.7	74

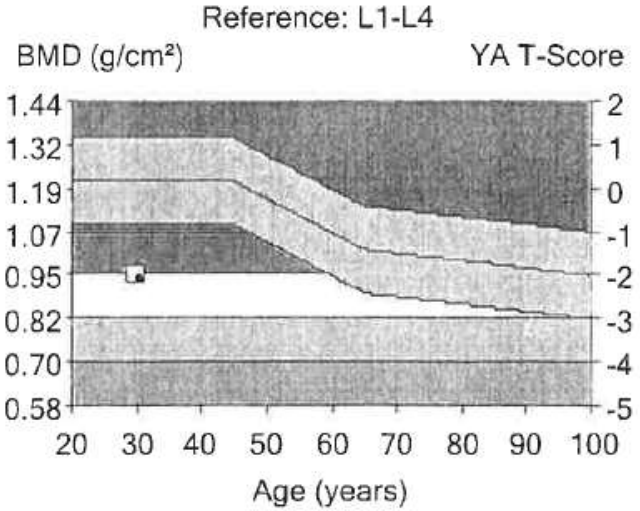
Follow-up scan

DXA Case 6

34 yo woman, in an MVA with spiral forearm fracture
DXA ordered because of fracture and chart reads that she likely has "osteogenesis imperfect"

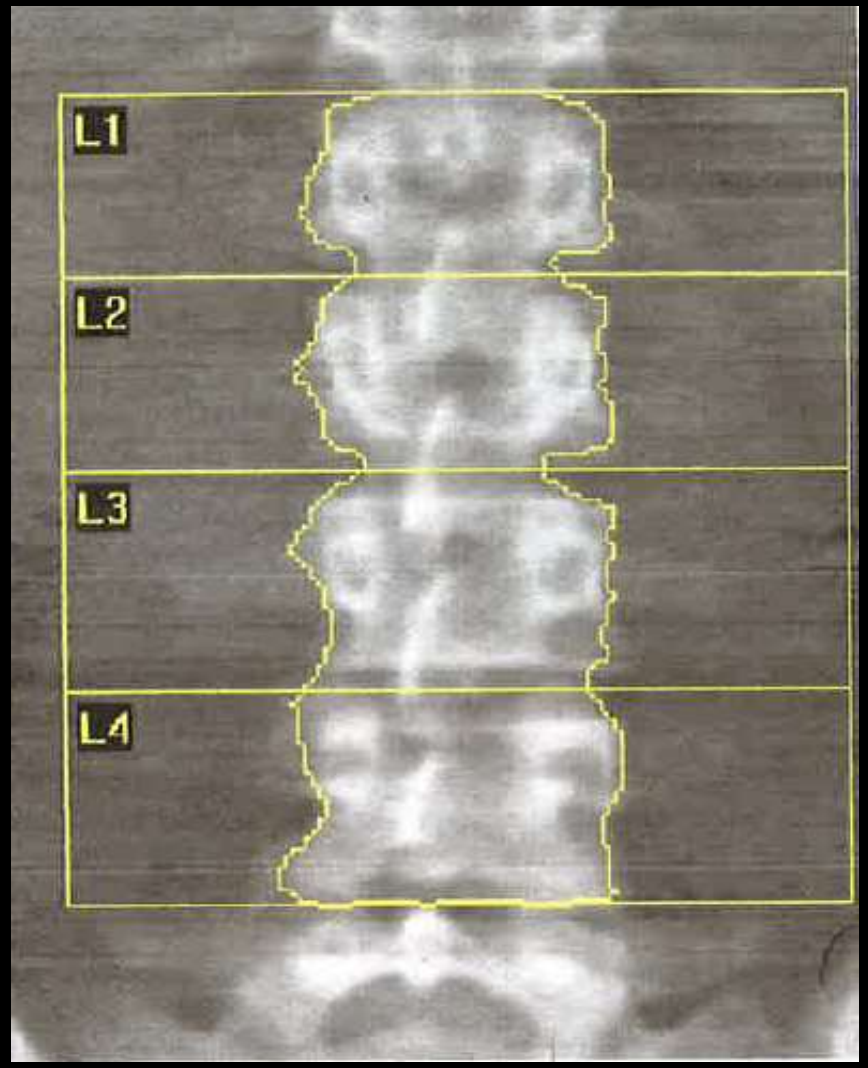


Edge detection of spine incorrect



Region	BMD [1] (g/cm²)	Young-Adult [2] T-Score	Age-Matched [3] Z-Score
L1	0.954	-1.5	-1.7
L2	1.123	-0.7	-0.9
L3	0.966	-2.0	-2.2
L4	0.652	-4.4	-4.6
L1-L4	0.948	-2.0	-2.1

Repeat DXA at UAB



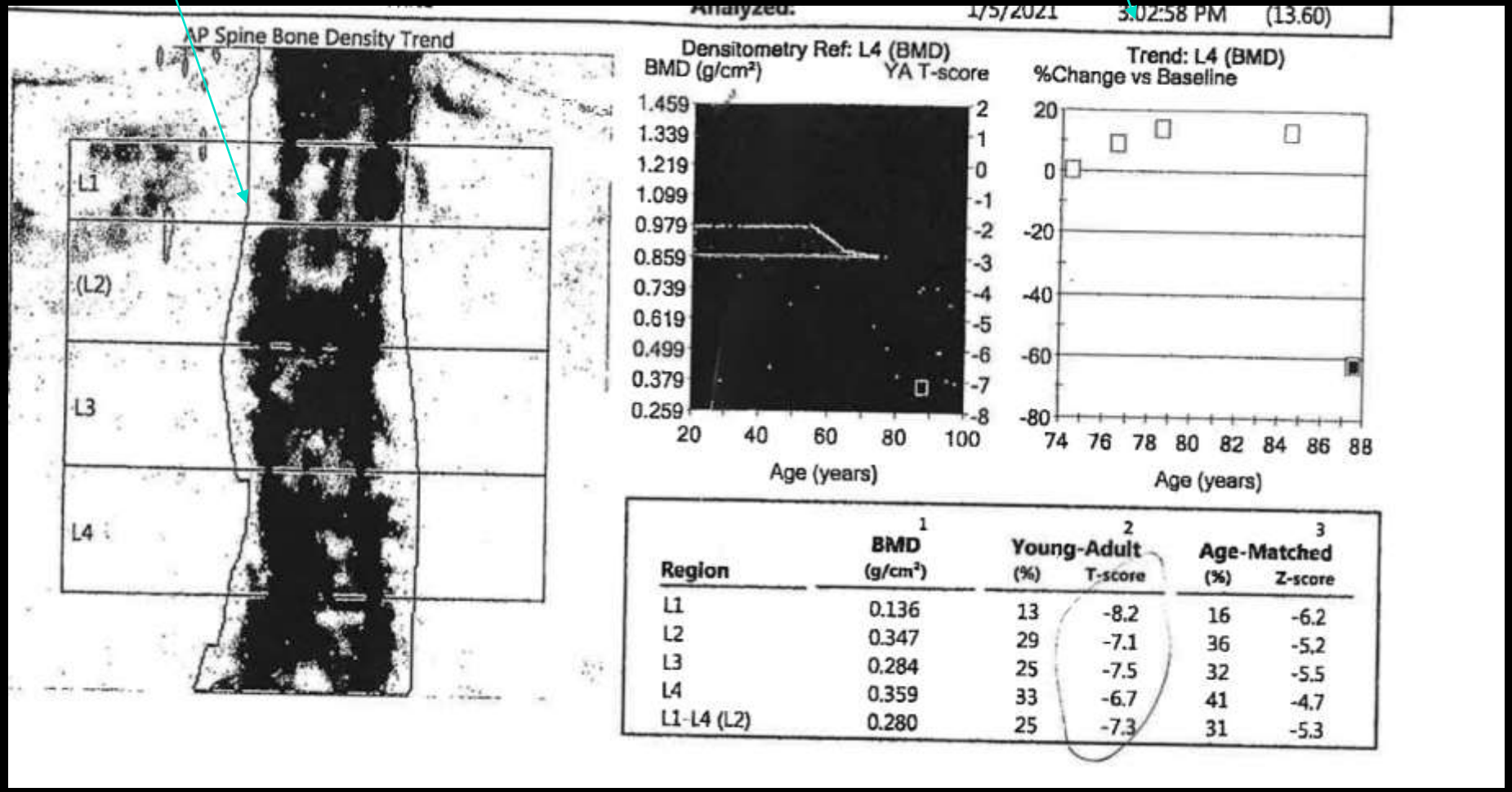
Femoral neck Z-score -1.0
Total hip Z-score -0.4

Region	Area (cm^2)	BMC (g)	BMD (g/cm^2)	T-score	PR (%)	Z-score	AM (%)
L1	12.00	10.98	0.915	-0.7	92	-0.7	93
L2	13.04	13.36	1.025	0.0	100	0.0	100
L3	14.94	14.53	0.972	-1.0	90	-1.0	90
L4	16.12	14.77	0.917	-1.3	86	-1.3	87
Total	**56.10**	**53.64**	**0.956**	**-0.8**	**91**	**-0.8**	**92**

Repeat DXA scan – using "Z-scores – bone mineral density within the expected range for age"
Denosumab not reordered

Point typing of edges is too wide – adding area with no BMD

L4 is trended – need at least 2 vertebral bodies to make a diagnosis



Region	1 BMD (g/cm²)	2 Young-Adult (%)	2 Young-Adult T-score	3 Age-Matched (%)	3 Age-Matched Z-score
L1	0.136	13	-8.2	16	-6.2
L2	0.347	29	-7.1	36	-5.2
L3	0.284	25	-7.5	32	-5.5
L4	0.359	33	-6.7	41	-4.7
L1-L4 (L2)	0.280	25	-7.3	31	-5.3

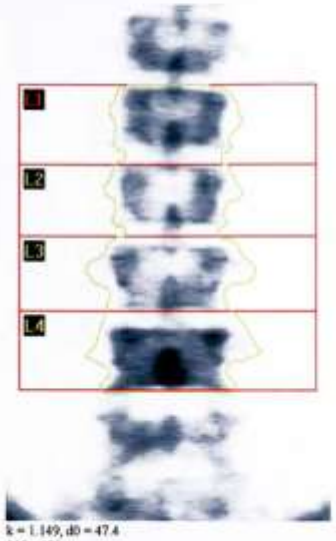
DXA Case 7

- 48 yo woman
- Upper back pain with thoracic spine imaing showed wedge fracture of T7
- General practice doctor obtained a DXA BMD

National University Hospital
BMD @ DDI
67724424 (Ext. 2207)

Name: Patient ID: DOB: 23 July 1957	Sex: Female Ethnicity: S'pore Ref	Height: 150.2 cm Weight: 52.2 kg Age: 48

Referring Physician:



k = 1.149, d0 = 47.4
116 x 120

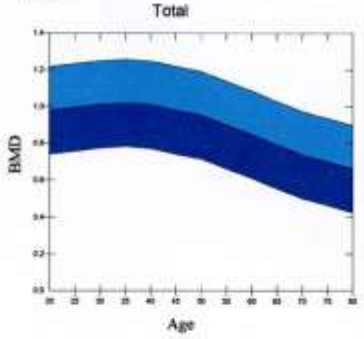
Scan Information:

Scan Date: 19 July 2006 ID: A07190608
Scan Type: f Lumbar Spine
Analysis: 19 July 2006 09:58 Version 12.4:5
Lumbar Spine
Operator: el
Model: Discovery Wi (S/N 81703)
Comment:

DXA Results Summary:

Region	Area (cm²)	BMC (g)	BMD (g/cm²)	T-Score	Z-Score
L2	13.11	19.25	1.469	3.8	4.3
L3	15.82	23.58	1.491	3.6	4.1
L4	18.07	35.63	1.972	7.2	7.6
Total	**47.00**	**78.47**	**1.670**	**5.5**	**6.0**

Total BMD CV 1.0%, ACF = 1.035, BCF = 1.013, TH = 6.122



Reference curve and scores matched to S'pore Ref Female

Source: Singapore Reference

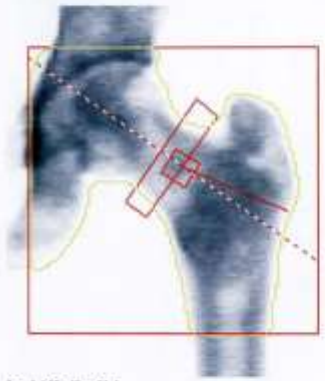
Physician's Comment:

HOLOGIC

National University Hospital
BMD @ DDI
67724424 (Ext. 2207)

Name: Patient ID: DOB: 23 July 1957	Sex: Female Ethnicity: S'pore Ref	Height: 150.2 cm Weight: 52.2 kg Age: 48

Referring Physician:



k = 1.152, d0 = 51.1
99 x 98

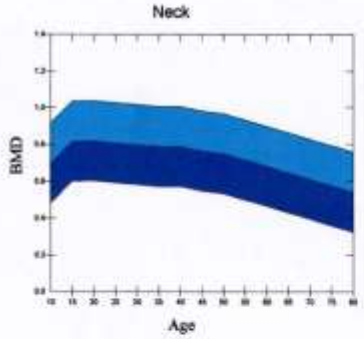
Scan Information:

Scan Date: 19 July 2006 ID: A07190609
Scan Type: f Left Hip
Analysis: 19 July 2006 10:00 Version 12.4:5
Left Hip
Operator: el
Model: Discovery Wi (S/N 81703)
Comment:

DXA Results Summary:

Region	Area (cm²)	BMC (g)	BMD (g/cm²)	T-Score	Z-Score
Neck	2.81	4.18	1.486	6.1	6.7
Troch	9.90	18.17	1.835	11.7	12.3
Inter	17.17	33.75	1.965	6.4	6.8
Total	**29.89**	**56.10**	**1.877**	**8.4**	**8.9**
Ward's	1.01	1.97	1.954	8.9	9.8

Total BMD CV 1.0%, ACF = 1.035, BCF = 1.013, TH = 5.160



Reference curve and scores matched to S'pore Ref Female

Source: Singapore Reference

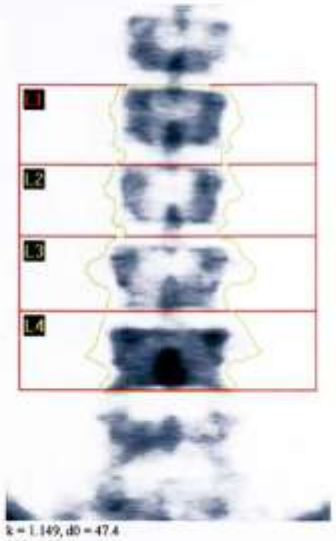
HOLOGIC

	T-score
Neck	6.1
Troch	11.7
Inter	6.4
Total	8.4
Ward's	8.9

National University Hospital
BMD @ DDI
67724424 (Ext. 2207)

Name:	Sex: Female	Height: 150.2 cm
Patient ID:	Ethnicity: S'pore Ref	Weight: 52.2 kg
DOB: 23 July 1957		Age: 48

Referring Physician:



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116 x 120

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Analysis: 19 July 2006 09:58 Version 12.4:5
Lumbar Spine
Operator: el
Model: Discovery Wi (S/N 81703)
Comment:

DXA Results Summary:

Region	Area (cm^2)	BMC (g)	BMD (g/cm^2)	T-Score	Z-Score
L2	13.11	19.25	1.469	3.8	4.3
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L4	18.07	35.63	1.972	7.2	7.6
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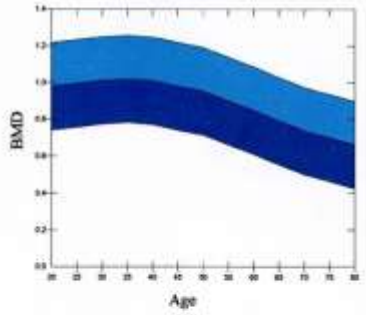
Total BMD CV 1.0%, ACF = 1.035, BCF = 1.013, TH = 6.122

Total



Reference curve and scores matched to S'pore Ref Female

Source: Singapore Reference

Physician's Comment:

HOLOGIC

National University Hospital
BMD @ DDI
67724424 (Ext. 2207)

Name:	Sex: Female	Height: 150.2 cm
Patient ID:	Ethnicity: S'pore Ref	Weight: 52.2 kg
DOB: 23 July 1957		Age: 48

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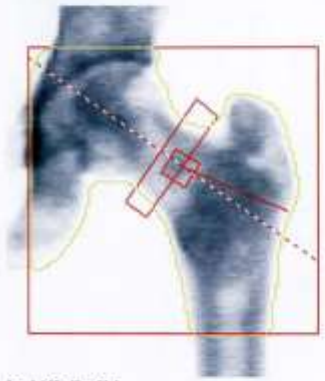

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Scan Date: 19 July 2006 ID: A07190609
Scan Type: f Left Hip
Analysis: 19 July 2006 10:00 Version 12.4:5
Left Hip
Operator: el
Model: Discovery Wi (S/N 81703)
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DXA Results Summary:

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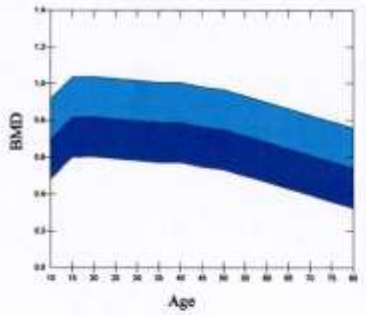
Neck



Reference curve and scores matched to S'pore Ref Female

Source: Singapore Reference

	T-score
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HOLOGIC

National University Hospital
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67724424 (Ext. 2207)

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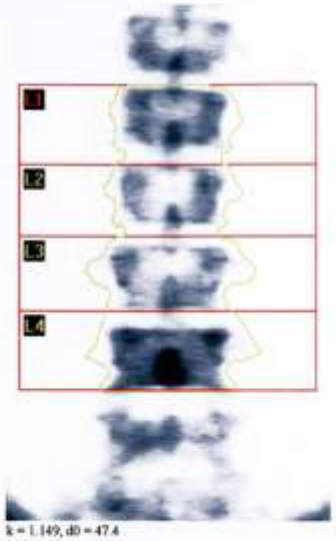

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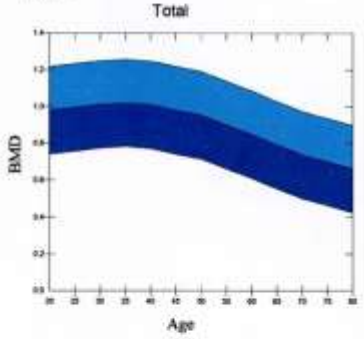


Reference curve and scores matched to S'pore Ref Female

Source: Singapore Reference

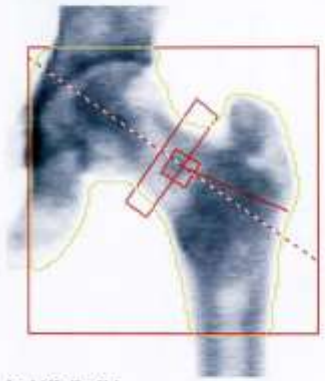
Physician's Comment:

HOLOGIC

National University Hospital
BMD @ DDI
67724424 (Ext. 2207)

Name: Patient ID: DOB: 23 July 1957	Sex: Female Ethnicity: S'pore Ref	Height: 150.2 cm Weight: 52.2 kg Age: 48

Referring Physician:



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Left Hip
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Model: Discovery Wi (S/N 81703)
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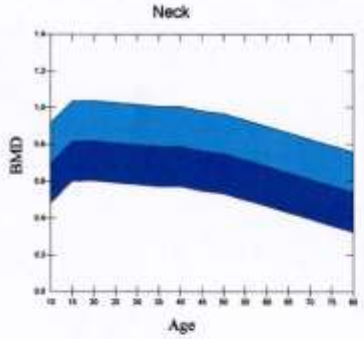


Reference curve and scores matched to S'pore Ref Female

Source: Singapore Reference

HOLOGIC

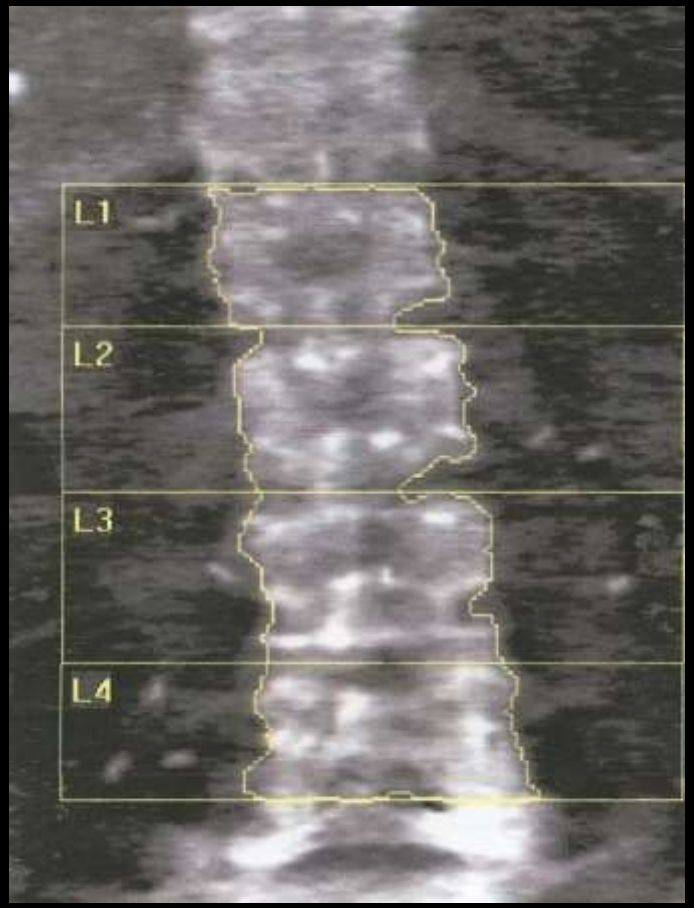
	T-score
Neck	6.1
Troch	11.7
Inter	6.4
Total	8.4
Ward's	8.9

DXA Case 7 Summary

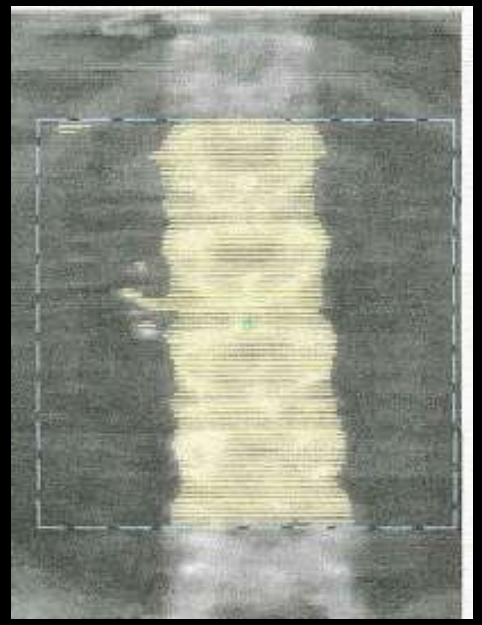
- DXA may provide clues to etiology of pathological fxs due to sclerotic bone metastases in this case
- Focal/ diffuse abnormalities causing high BMD should be investigated for
  - Malignancies such prostate, breast, kidney, thyroid, lung (PB-KTL)
  - Paget's disease
  - Tuberous Sclerosis
  - SAPHO
  - Sclerosing bone dysplasias like osteopetrosis

Spine Artifacts

Surgical Clips

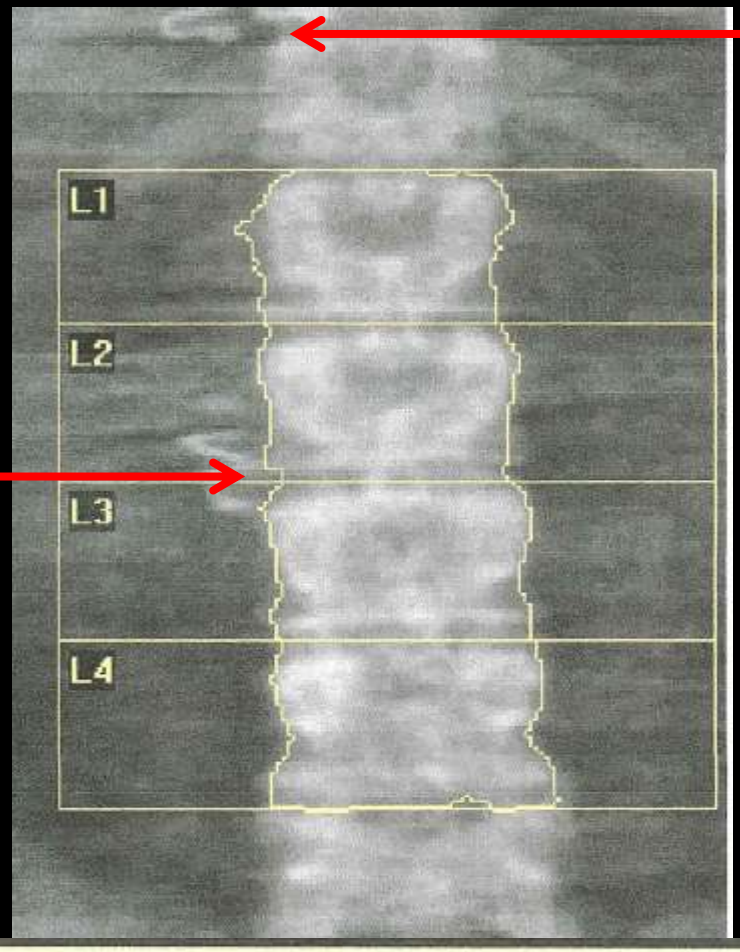


Should you omit L2 and L3 from analysis since there is something that will alter the soft tissue BMD?



L2 and L3 were not omitted from analysis because after hitting the "undo" button artifacts were omitted by the software

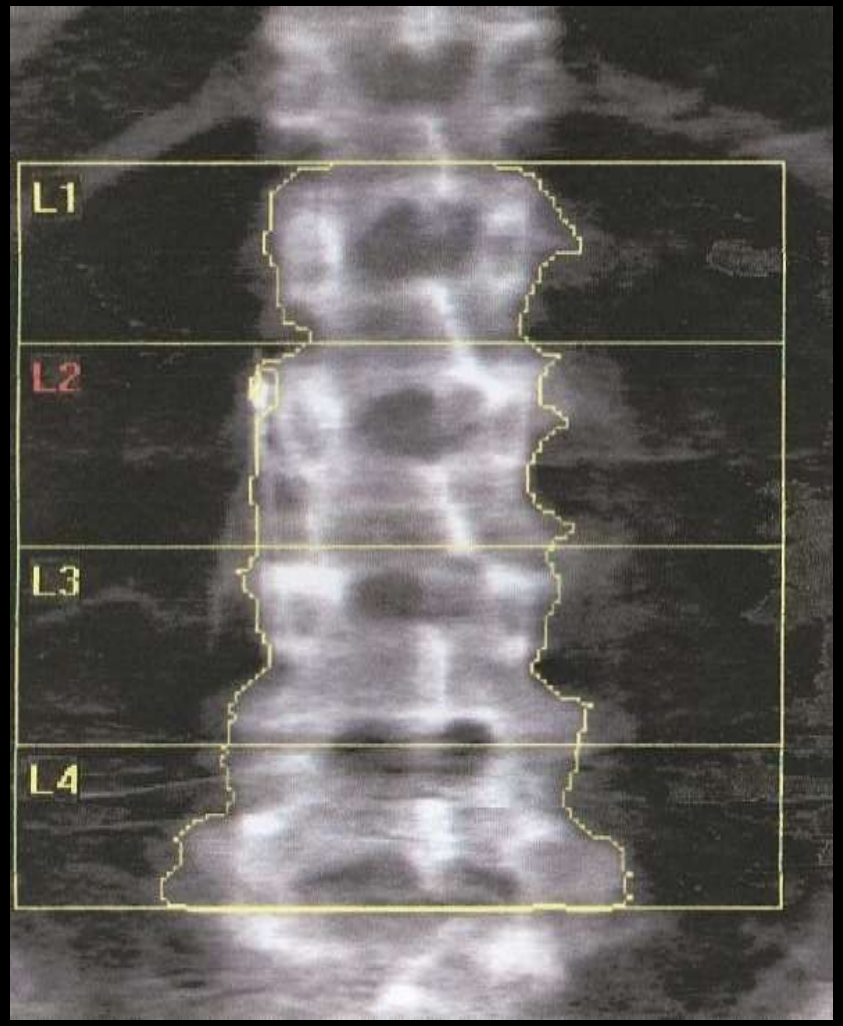
Likely Surgical clips

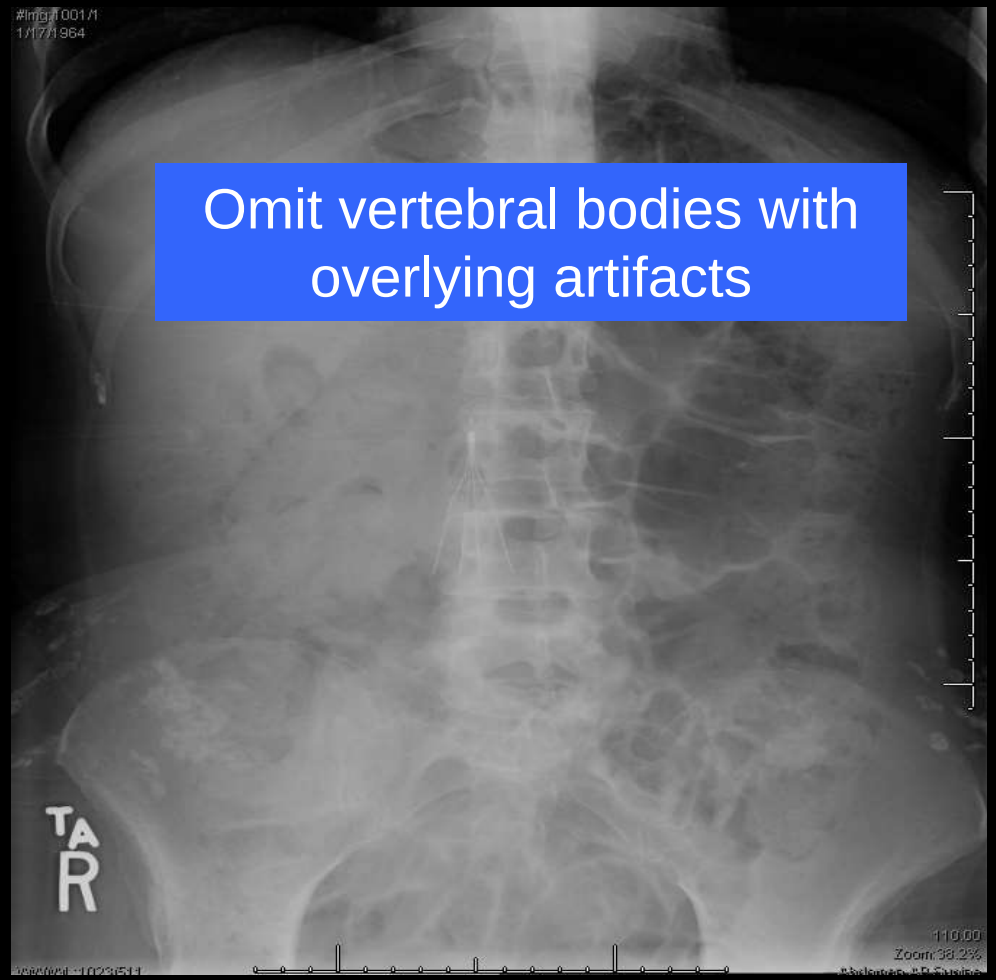


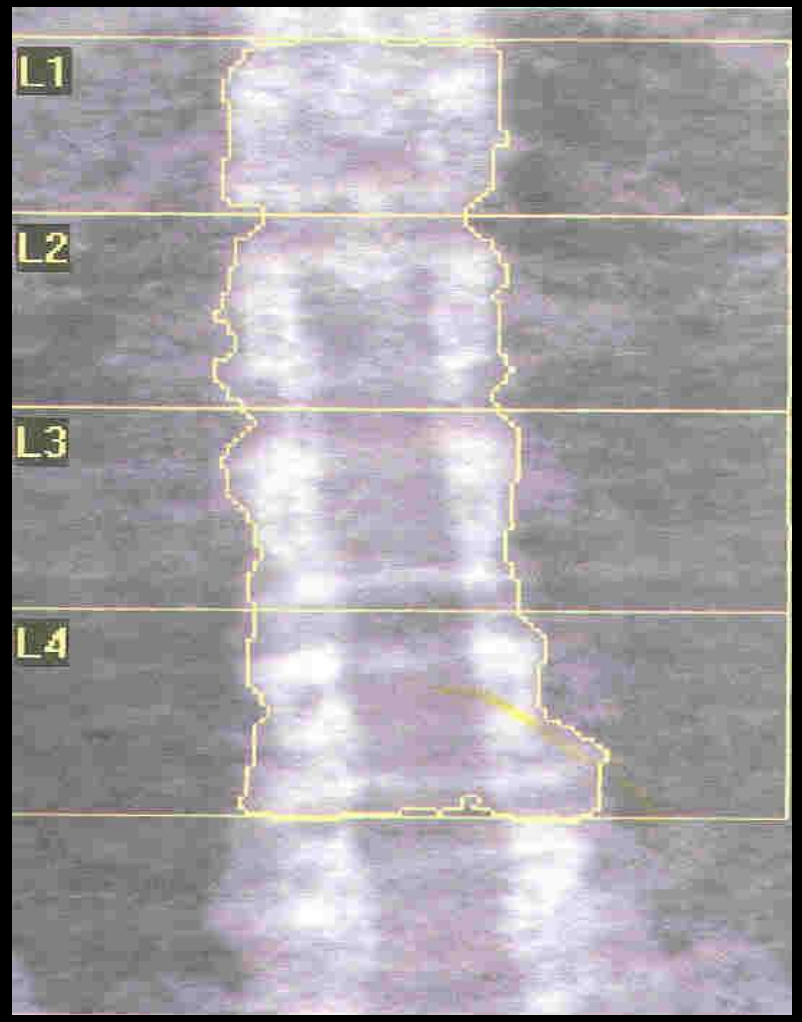
Bra clips not in the ROI

Region	Area (cm^2)	BMC (g)	BMD (g/cm^2)	T - score	PR (%)	Z - score	AM (%)
L1	12.55	11.15	0.888	-0.9	90	0.4	105
L2	13.30	12.52	0.942	-0.8	92	0.7	109
L3	13.79	13.83	1.004	-0.7	93	0.8	110
L4	15.38	14.38	0.935	-1.1	88	0.4	105
Total	**55.01**	**51.89**	**0.943**	**-0.9**	**90**	**0.5**	**107**

Venacaval (Greenfield) Filter





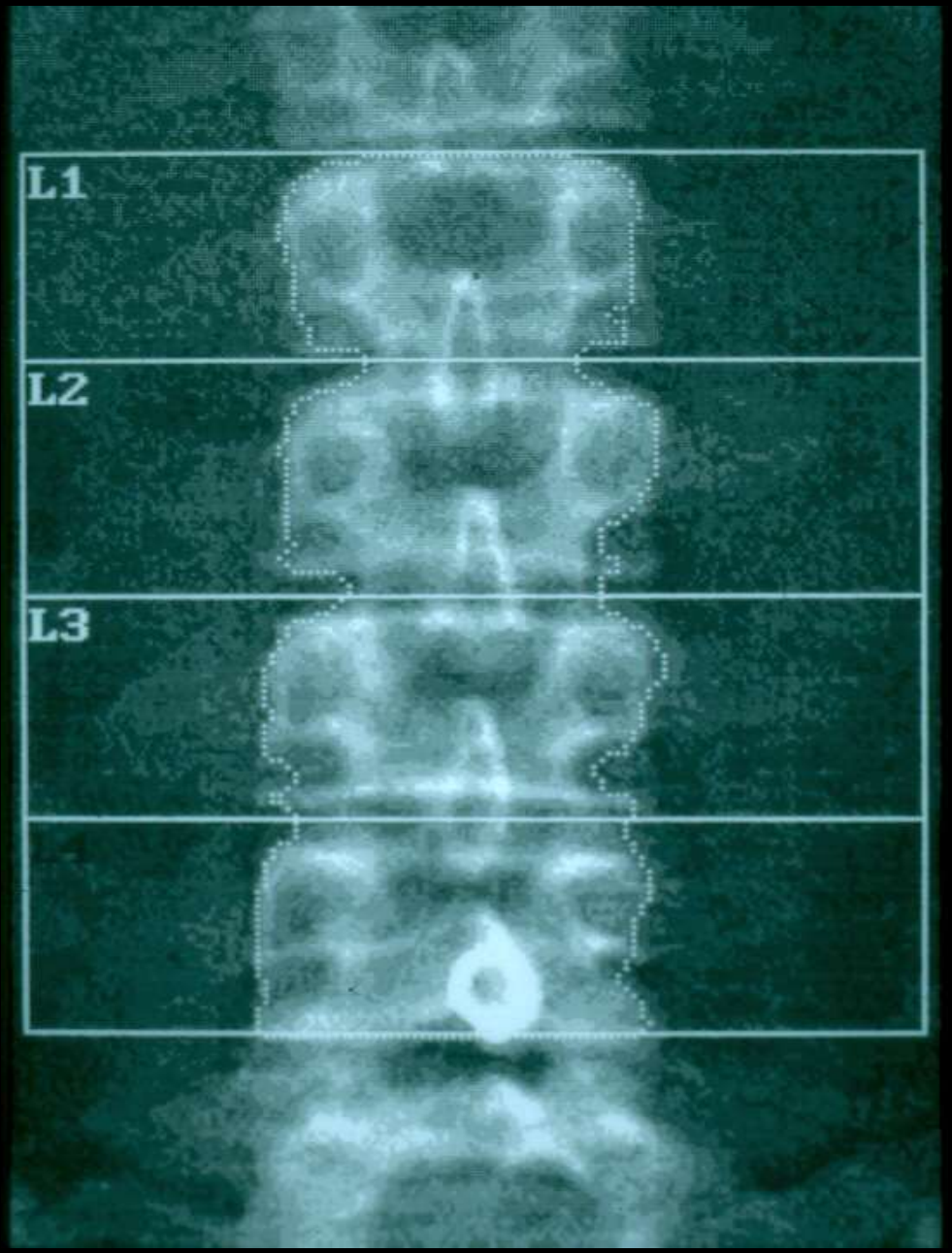


Laminectomy

DXA Results Summary:

Region	Area (cm^2)	BMC (g)	BMD (g/cm^2)	T - Score	PR (%)	Z - Score	AM (%)
L1	11.31	10.08	0.891	-0.3	96	0.9	112
L2	12.78	10.83	0.848	-1.6	82	-0.3	96
L3	13.39	10.85	0.810	-2.5	75	-1.1	87
L4	16.02	13.86	0.865	-2.3	78	-0.9	90
Total	**53.50**	**45.62**	**0.853**	**-1.8**	**81**	**-0.4**	**95**

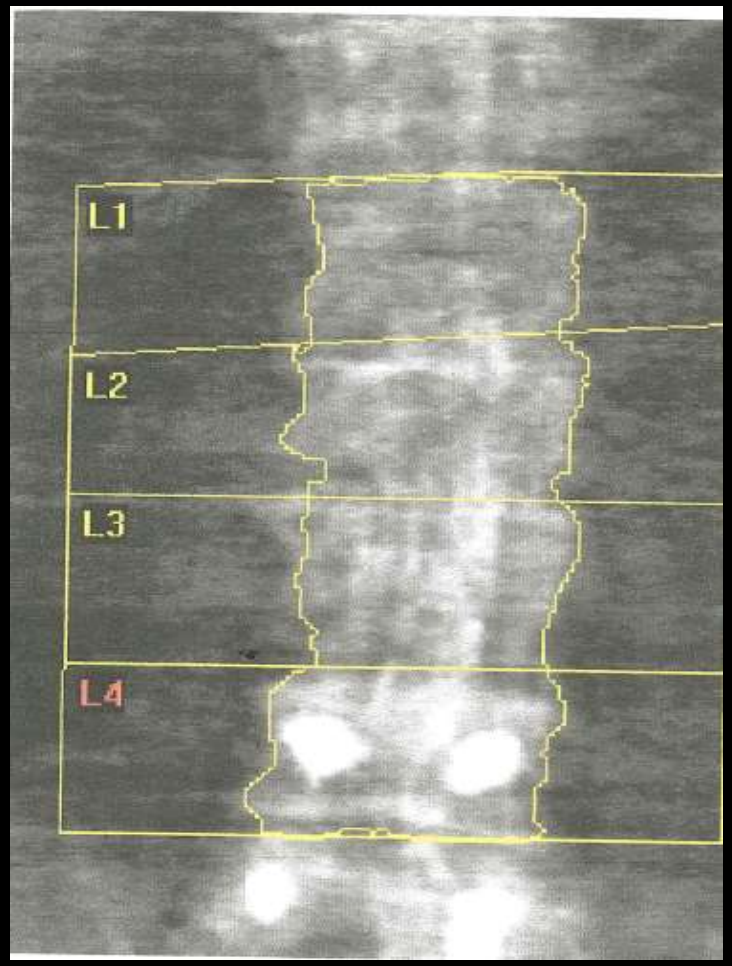
You need at least 2 vertebral bodies to make a spine diagnosis – Don't cherry pick!

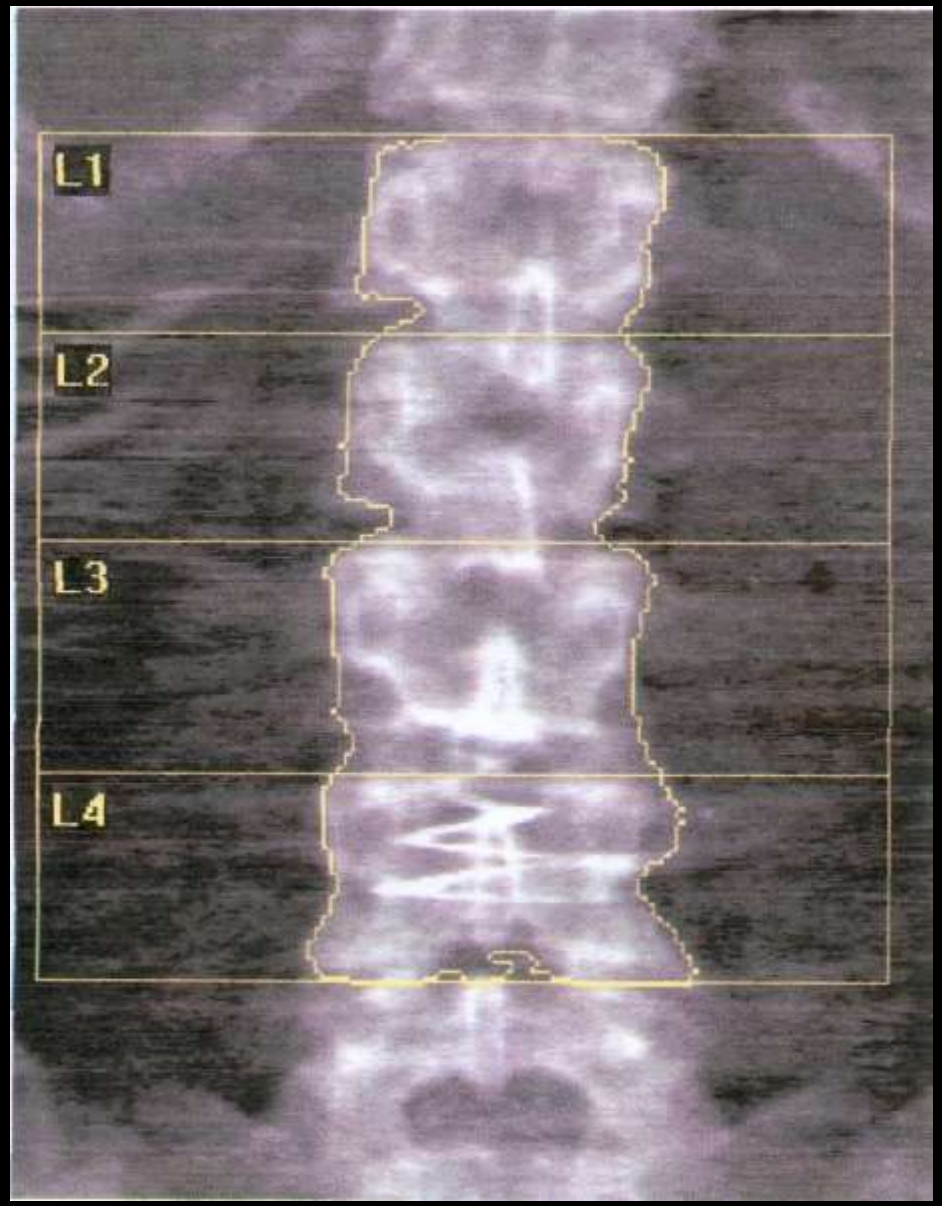


Belly Button Ring

Nerve Stimulator

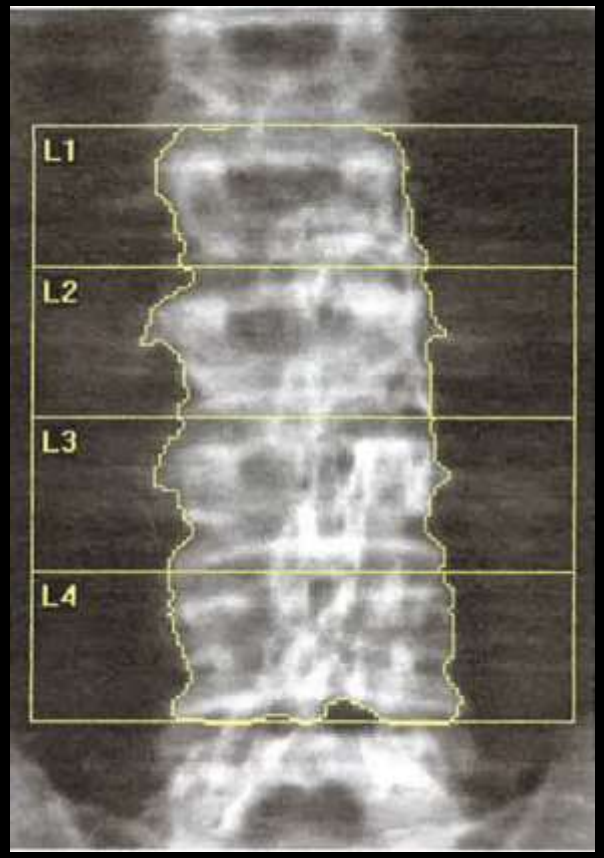
Vertebral Augmentation – Kyphoplasty





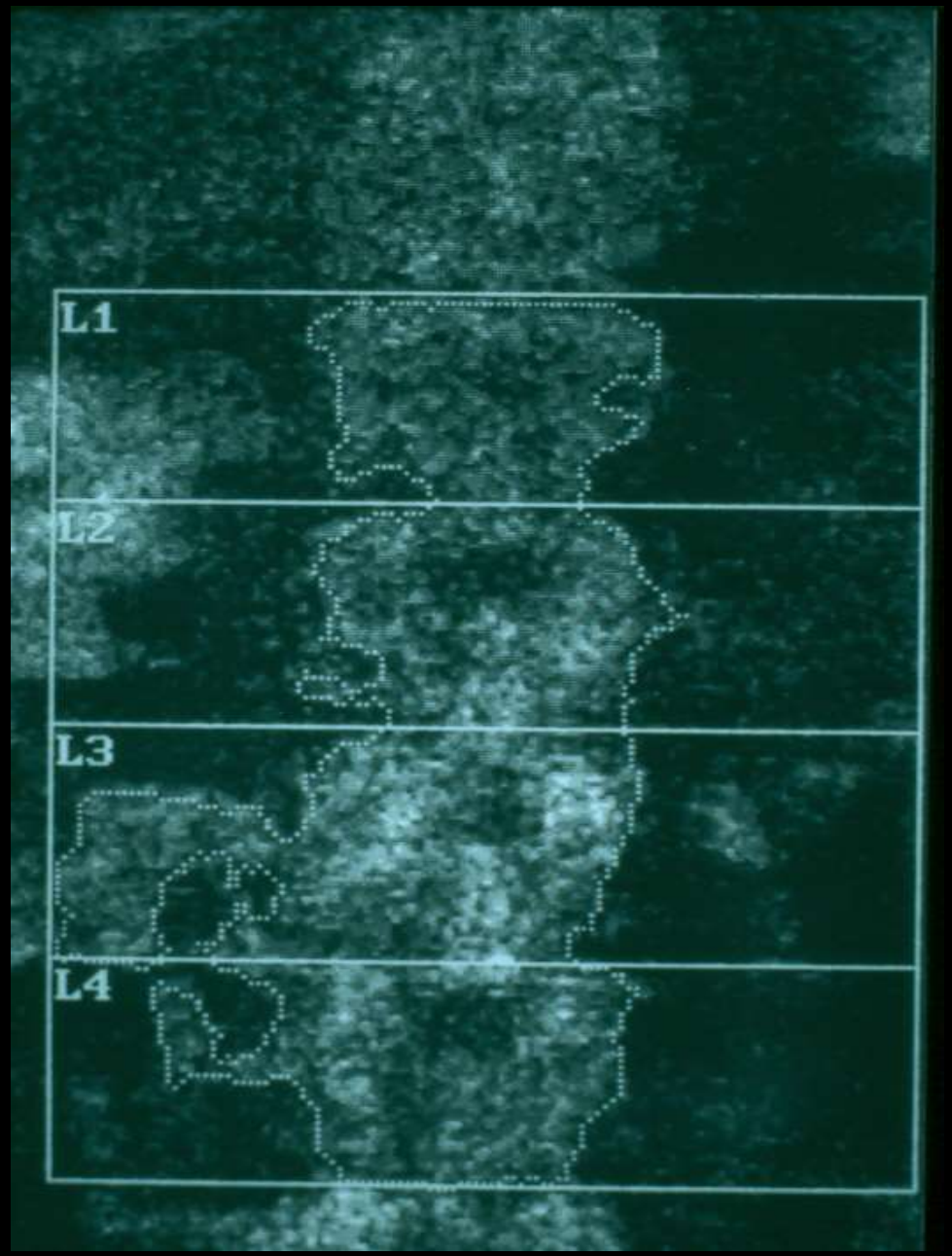
Retained Calcium Pills, Radiographically Proven

Vascular Endograft



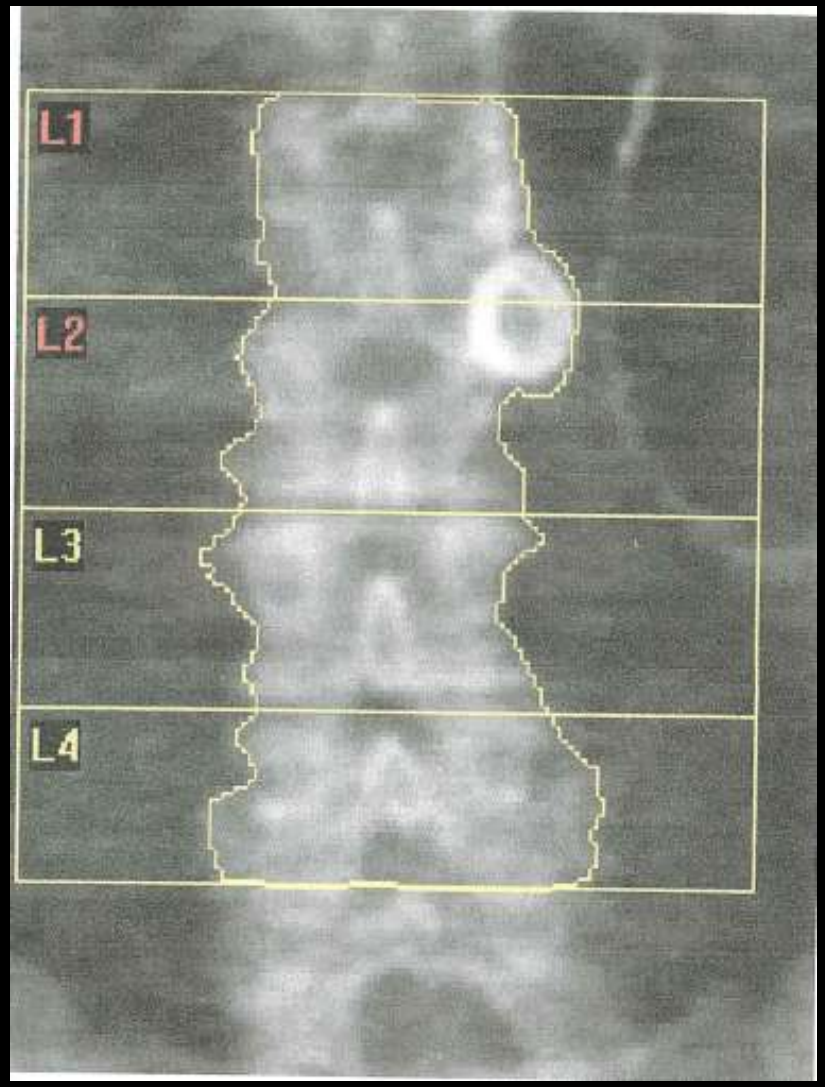
Region	Area (cm^2)	BMC (g)	BMD (g/cm^2)	T - score	PR (%)	Z - score	AM (%)
L1	17.21	16.03	0.931	-1.3	87	-0.1	99
L2	19.82	20.89	1.054	-0.4	96	1.0	111
L3	20.73	23.54	1.136	0.3	103	1.6	119
L4	20.92	22.42	1.072	-0.2	98	1.2	114
Total	**78.68**	**82.88**	**1.053**	**-0.3**	**97**	**1.0**	**111**

Spine not reported because of endograft



Radiographic Contrast in Bowel

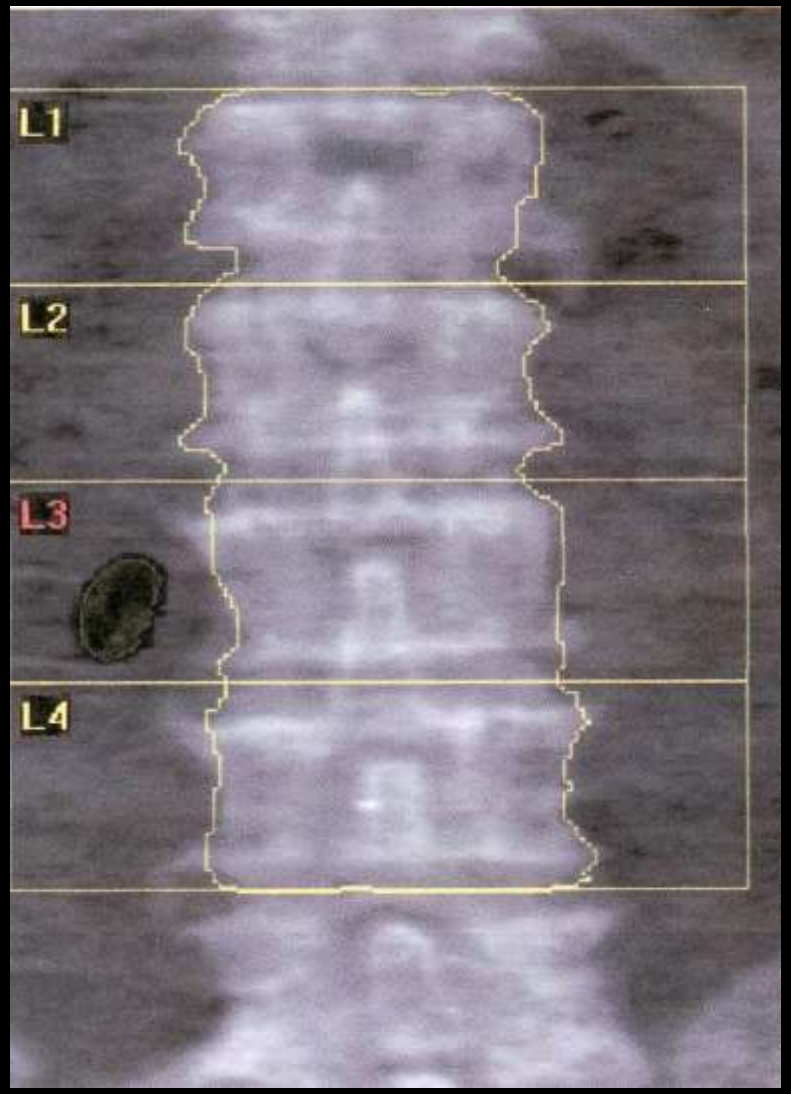
LapBand Obesity Surgery

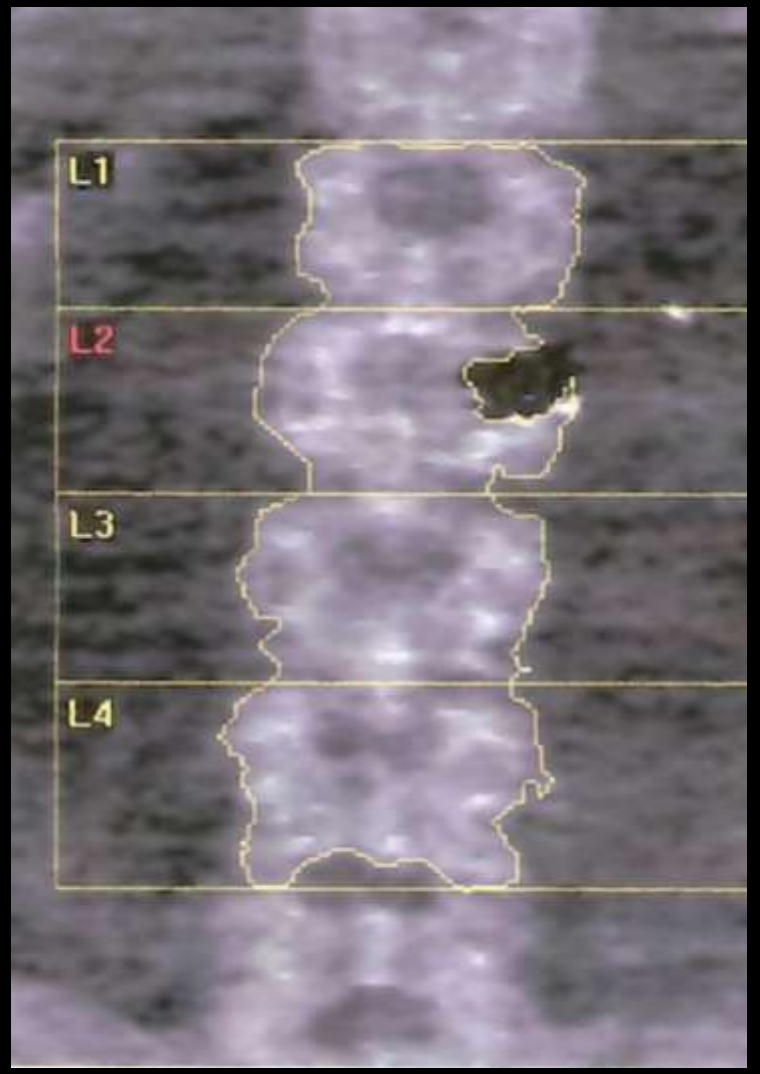


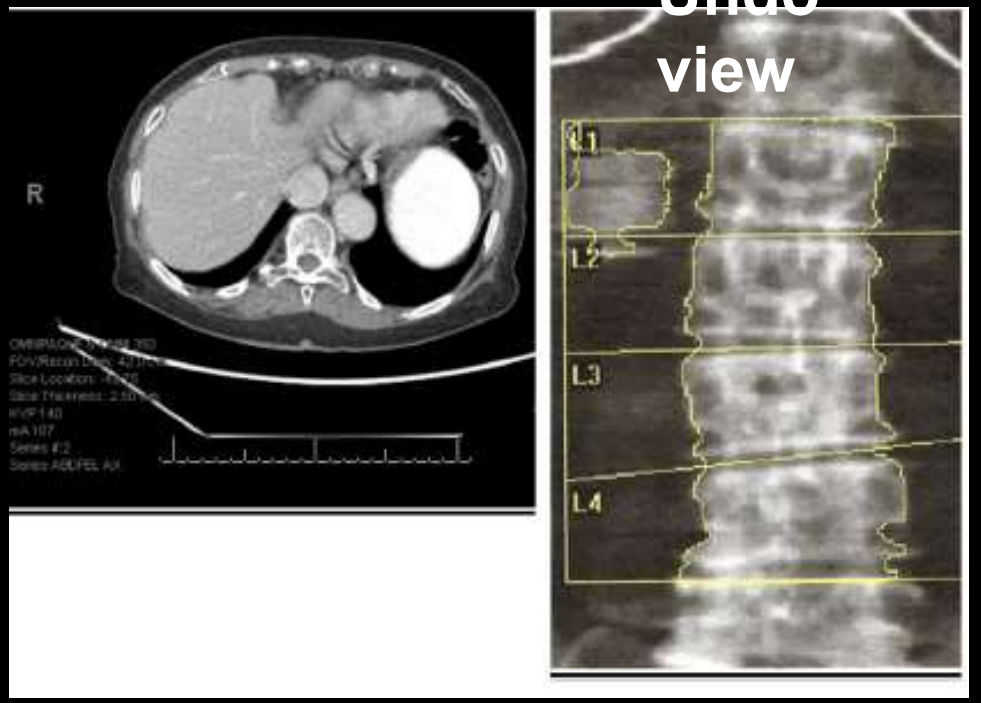
Region	Area (cm^2)	BMC (g)	BMD (g/cm^2)	T-score	PR (%)	Z-score	AM (%)
L3	13.97	17.64	1.262	1.6	116	3.1	137
L4	15.54	17.68	1.138	0.7	107	2.2	127
Total	29.51	35.32	1.197	0.9	109	2.3	128

Omit L1 and L2 because the overlying ring would artifactually increase BMD

Retained Bullets

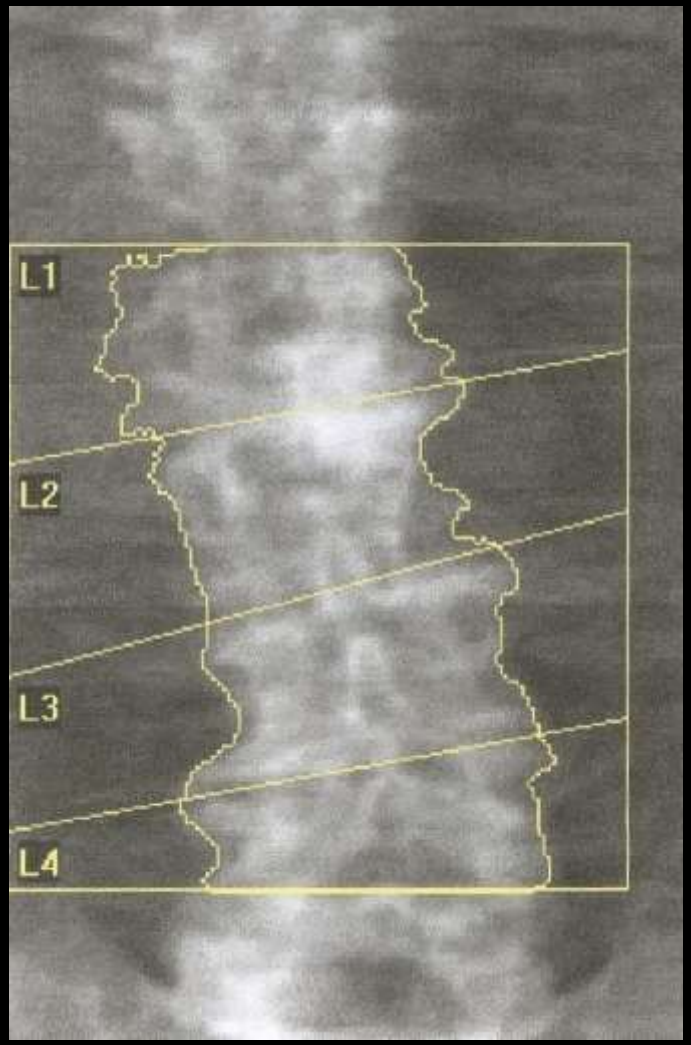






Undo view

Gall Stones - example of an artifact that won't affect accuracy because it can be removed from soft tissue baseline with undo view

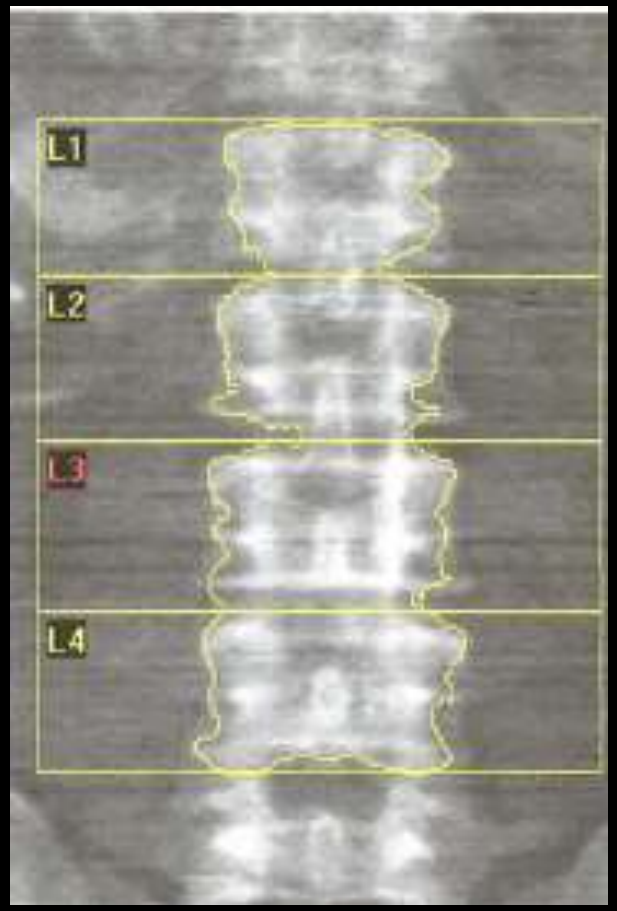


Region	Area (cm²)	BMC (g)	BMD (g/cm²)	T - score	PR (%)	Z - score	AM (%)
L1	18.31	23.31	1.273	1.8	119		
L2	17.59	24.11	1.371	2.5	125		
L3	19.40	25.98	1.340	2.2	121		
L4	15.13	18.41	1.217	1.2	112		
Total	**70.42**	**91.81**	**1.304**	**1.9**	**120**		

Spinal Degenerative Changes commonly affect accuracy and precision

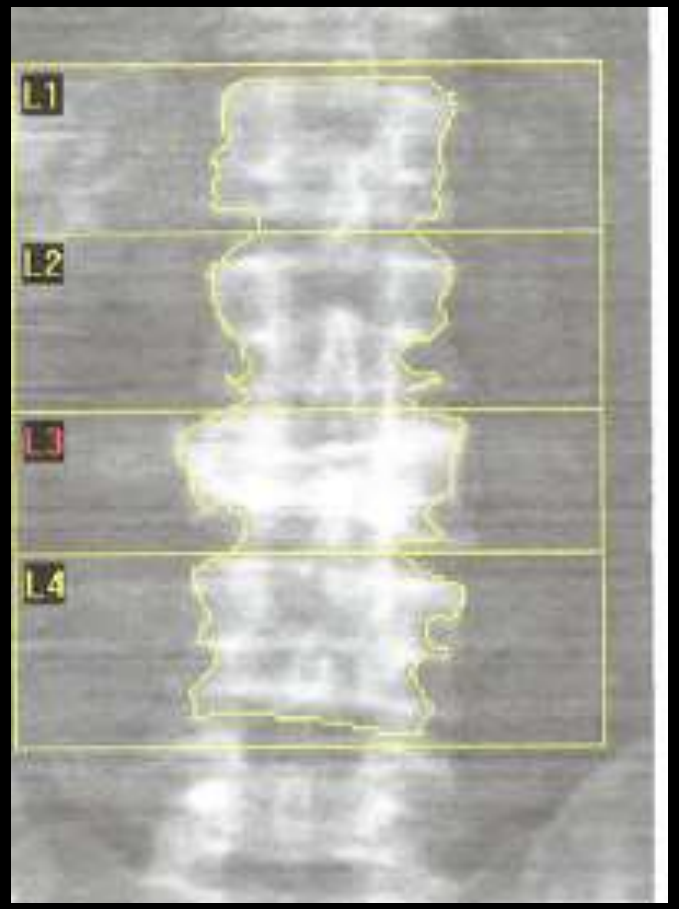
New Compression Fracture

Baseline



Region	Area (cm²)	BMC (g)	BMD (g/cm²)	T - score	PR (%)	Z - score	AM (%)
L1	11.73	6.71	0.572	-3.2	62	-3.0	63
L2	13.57	8.74	0.644	-3.5	63	-3.0	66
L4	15.74	11.58	0.736	-3.5	66	-2.6	72
Total	41.04	27.02	0.658	-3.4	64	-2.8	68

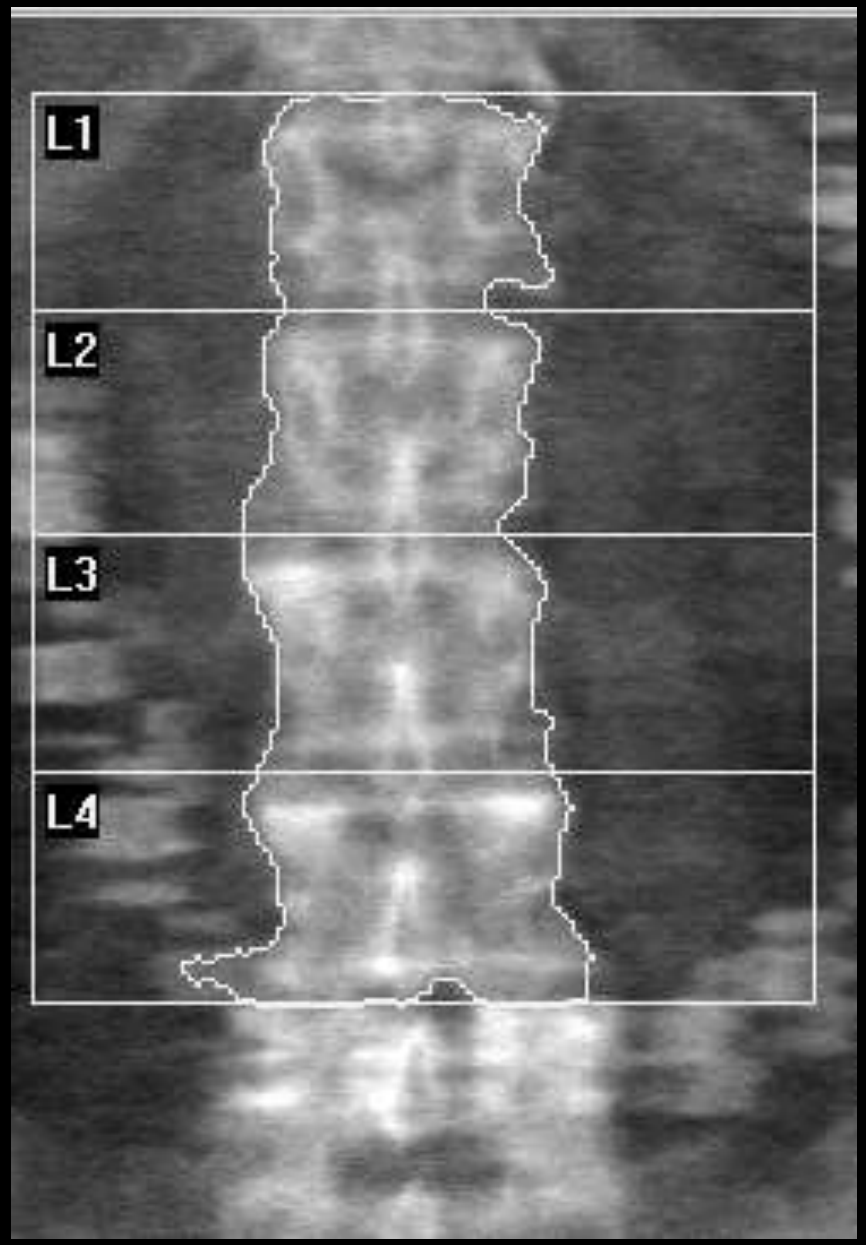
Follow-up



Region	Area (cm²)	BMC (g)	BMD (g/cm²)	T - score	PR (%)	Z - score	AM (%)
L1	12.66	6.38	0.504	-3.8	54	-3.6	56
L2	13.66	8.52	0.624	-3.7	61	-3.2	64
L4	15.13	10.92	0.722	-3.6	65	-2.7	71
Total	41.44	25.82	0.623	-3.7	60	-3.1	65

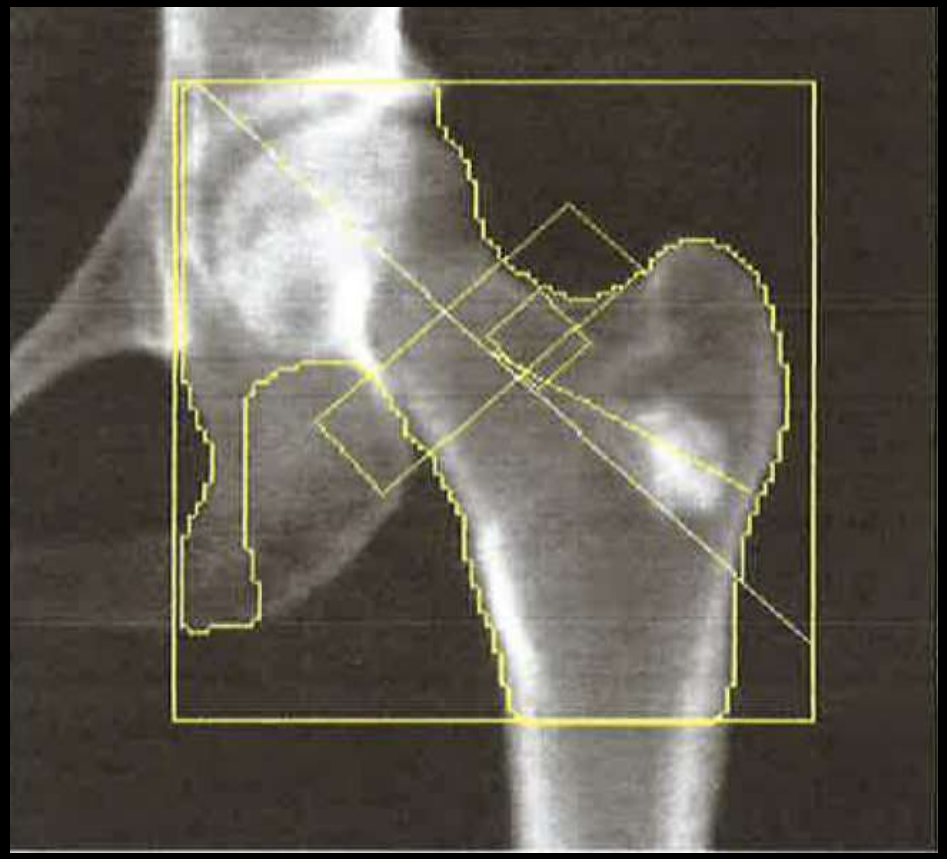
Leaving in level of compression overestimates BMD in lumbar spine

Omit vertebral bodies with overlying artifacts
– Need at least 2 vertebral bodies to read out a spine DXA



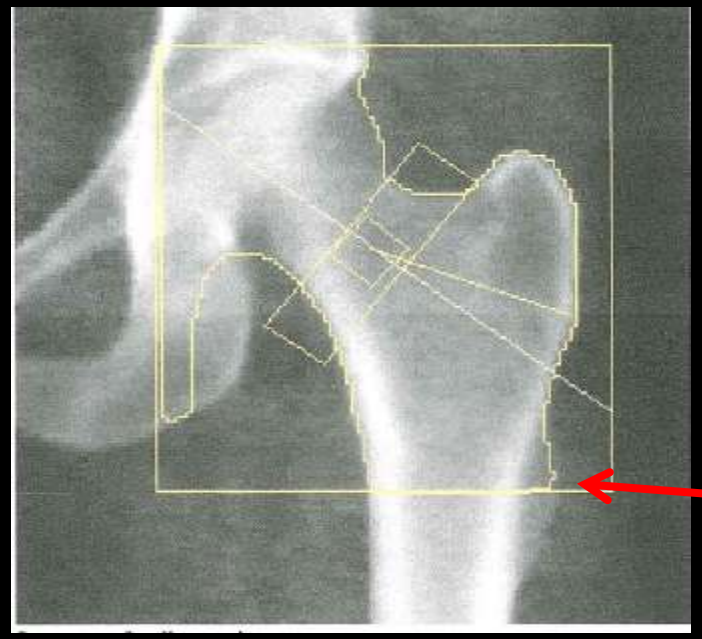
Proximal Femur Artifacts

Calcified Endochondroma



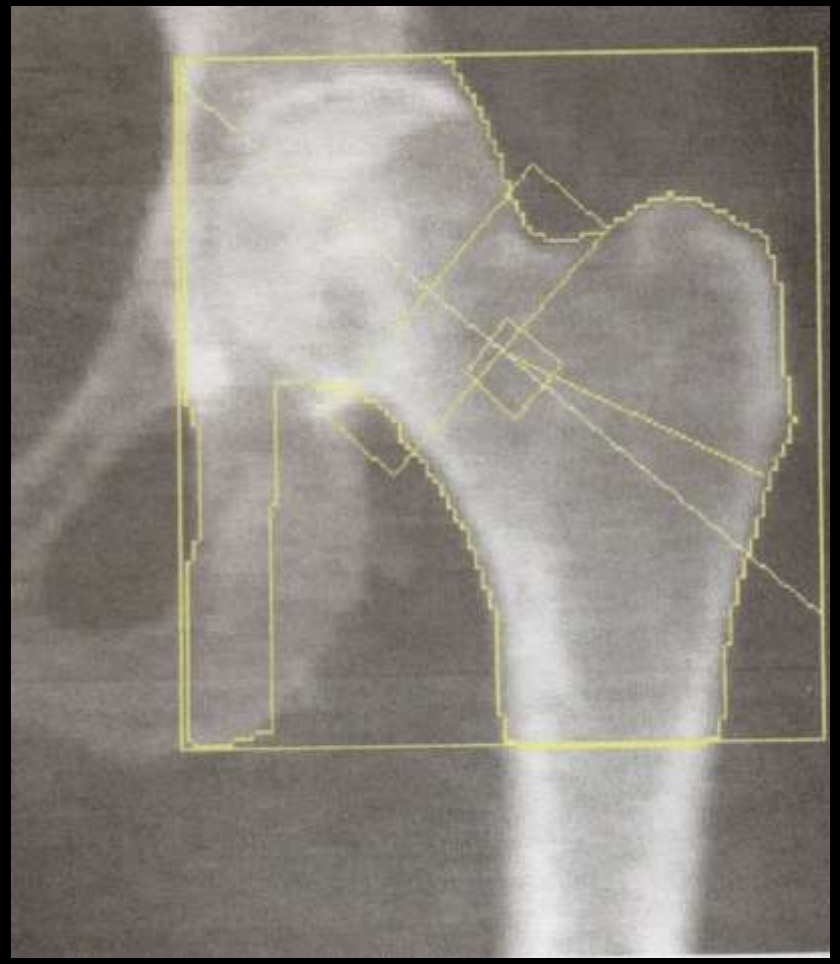
Sewing Needle Embedded in Left Side of Buttocks

What is the lateral rounded area on the lateral aspect of the left femur?

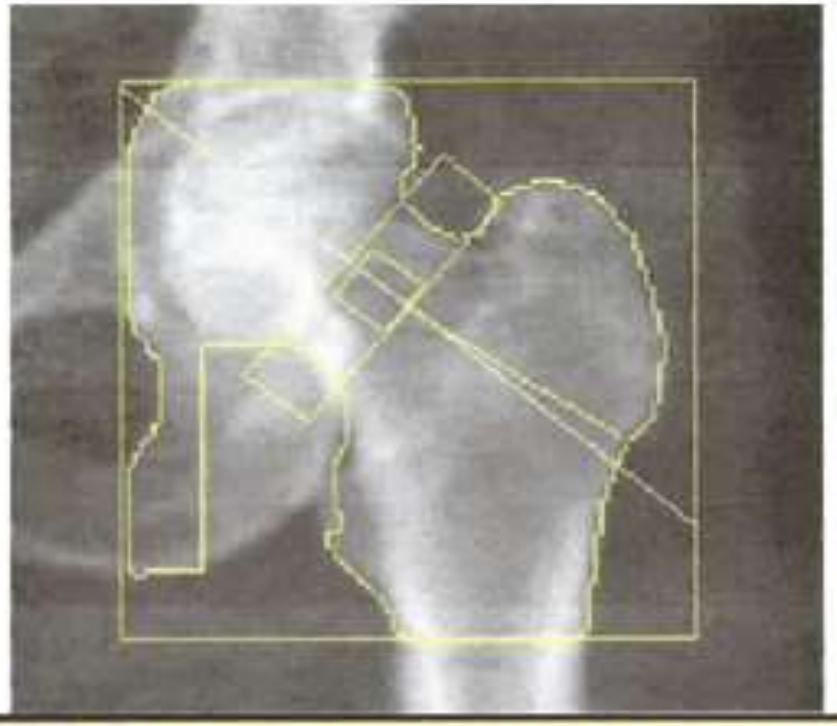


Region	Area (cm^2)	BMC (g)	BMD (g/cm^2)	T-score	PR (%)	Z-score	AM (%)
Neck	4.71	3.06	0.650	-1.8	77	-0.5	93
Total	27.90	20.76	0.744	-1.6	79	-0.6	91

3rd trochanter - gluteal tuberosity – an elongated tuberosity or discrete tubercule

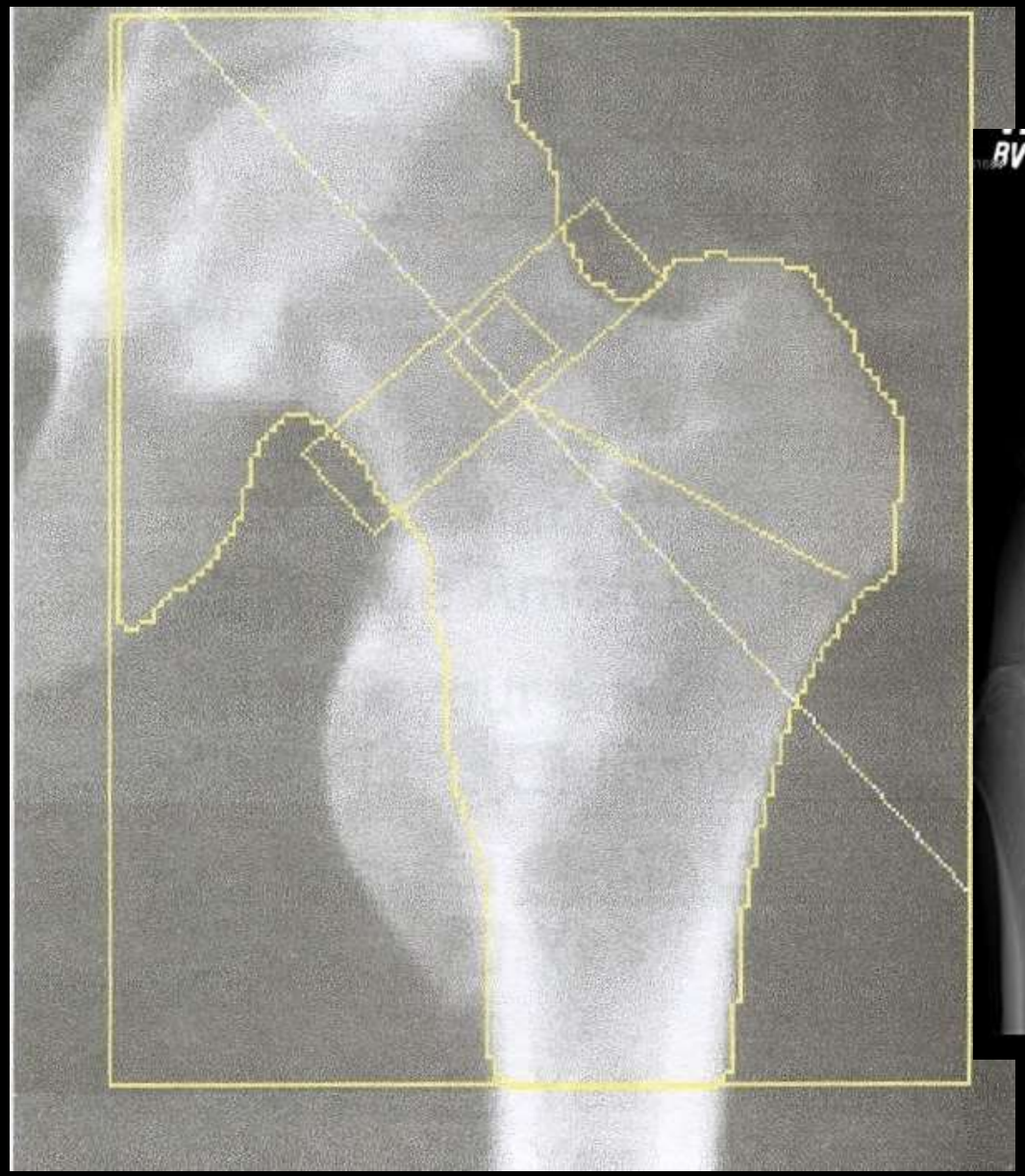


Region	Area (cm^2)	BMC (g)	BMD (g/cm^2)	T - score	PR (%)	Z - score	AM (%)
Neck	5.50	5.97	1.085	2.1	128	2.3	144
Total	36.47	36.34	0.996	0.4	106	0.9	116



Region	Area (cm^2)	BMC (g)	BMD (g/cm^2)	T - score	PR (%)	Z - score	AM (%)
Neck	3.96	4.72	1.192	3.1	140	2.8	151
Total	32.74	33.20	1.014	0.6	108	0.7	113

Degenerative changes – cause buttressing at the femoral neck - affect accuracy at hip



Dystrophic Calcification – will affect accuracy at hip

External Artifacts

Wallet

Pills in a pocket

What Can Be Done to Assure DXA Quality?

LOOK AT THE DXA IMAGES AND DATA CAREFULLY

Arthritis&Rheumatology
AN OFFICIAL JOURNAL OF THE AMERICAN COLLEGE OF RHEUMATOLOGY

Expert Perspectives on Clinical Challenges | Open Access

Expert perspective: How, When, and Why to Potentially Stop Anti-resorptive Drugs in Osteoporosis

Giovanni Adami MD, PhD, Kenneth G Saag MD, M.Sc

First published: 11 April 2025 | https://doi.org/10.1002/art.43179

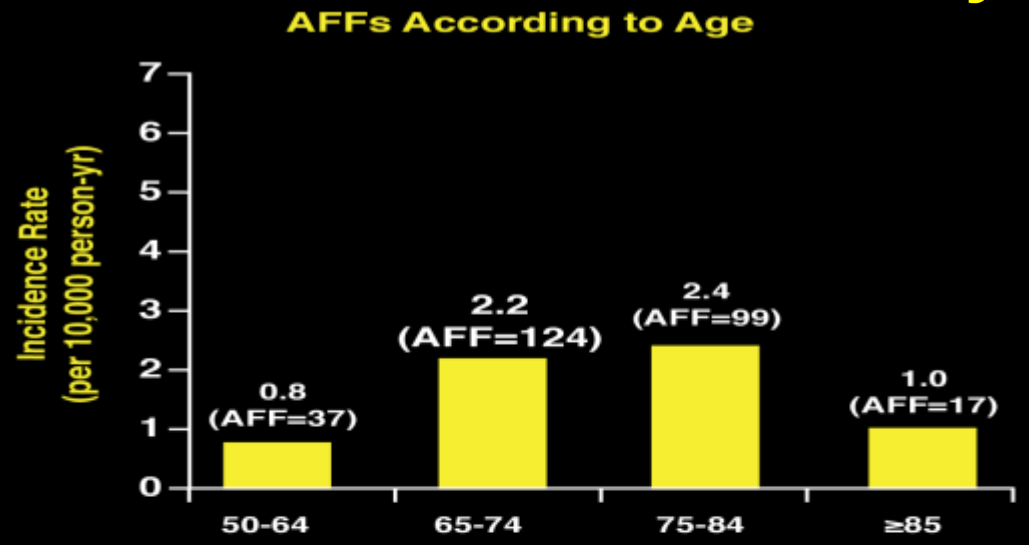
Full Text provided by University of Alabama at Birmingham

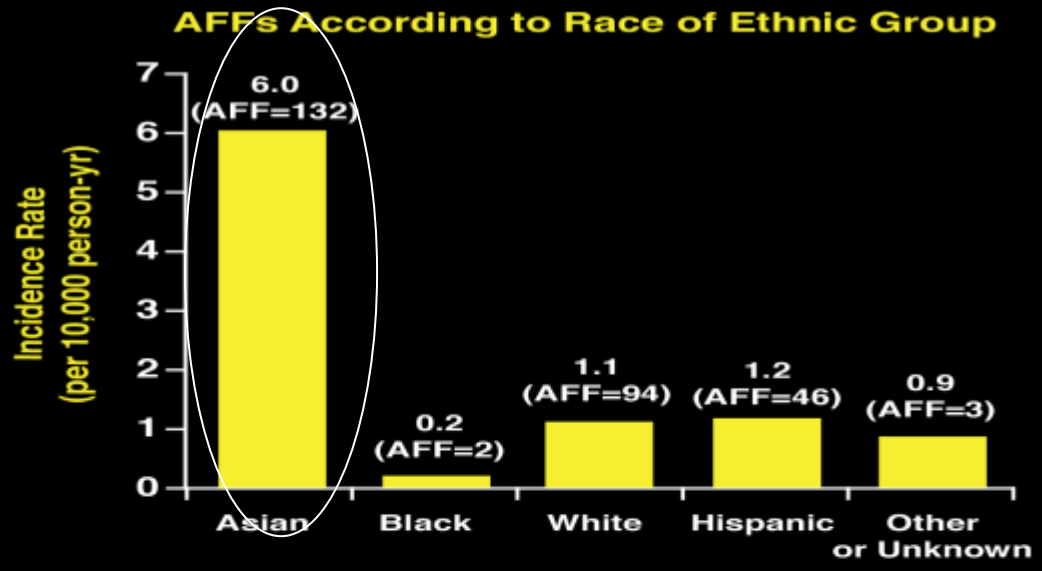
How Long Should we Use Bisphosphonates? How Can we Prevent Rare Side Effects?

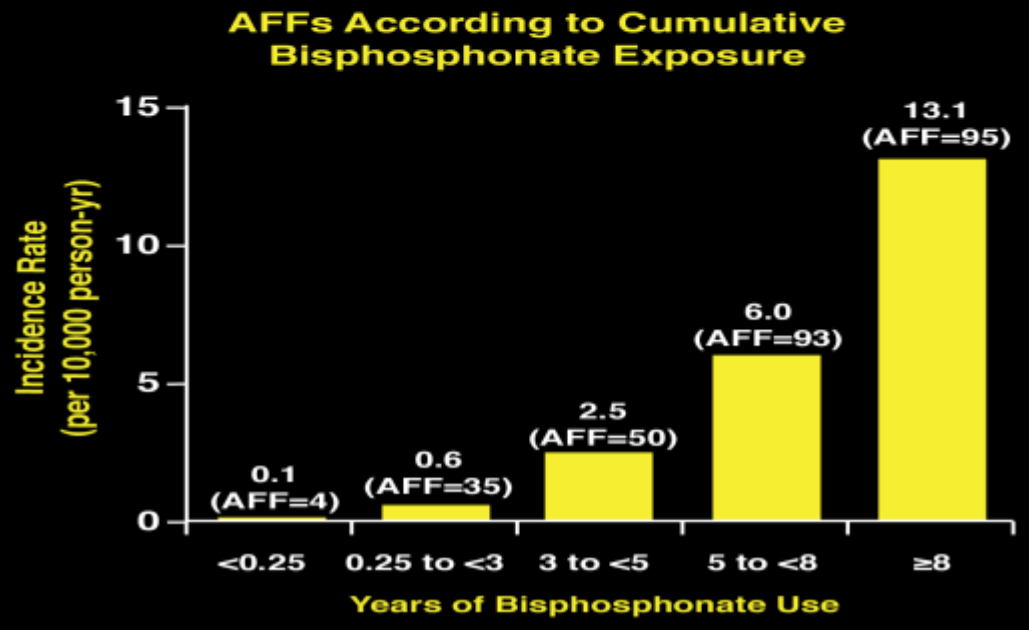
Bisphosphonate Potential Safety Issues

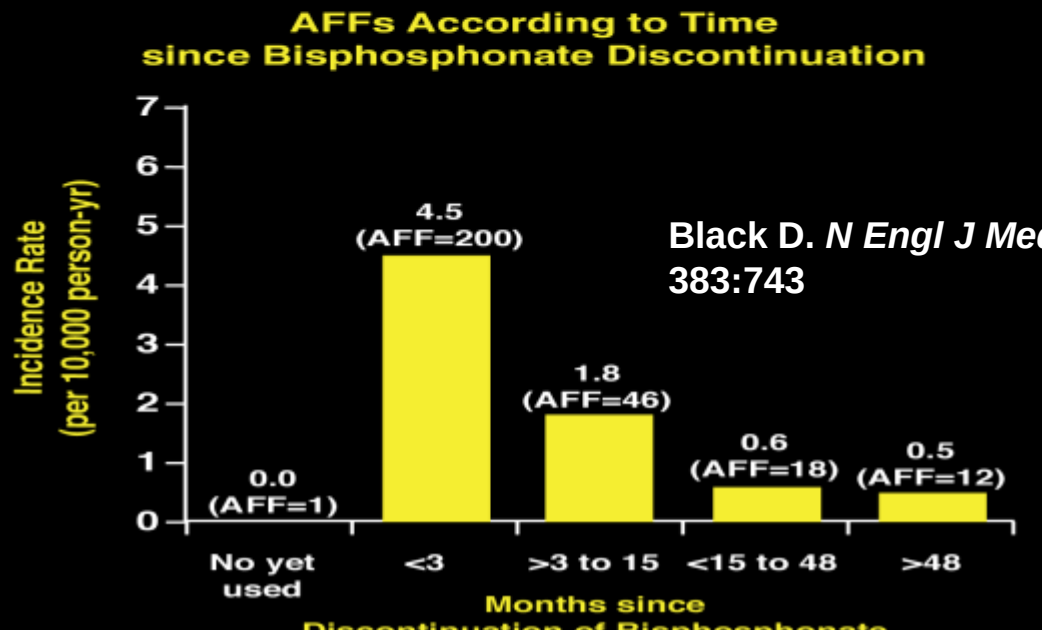
- Osteonecrosis of the Jaw (ONJ)
- Atypical Fractures
- Acute phase reactions
- Esophageal Cancer
- Atrial Fibrillation
- Fracture Non-union
- Uveitis

Atypical Femoral Fractures (AFFs) Vary by Age, Race/Ethnicity, and BP Duration





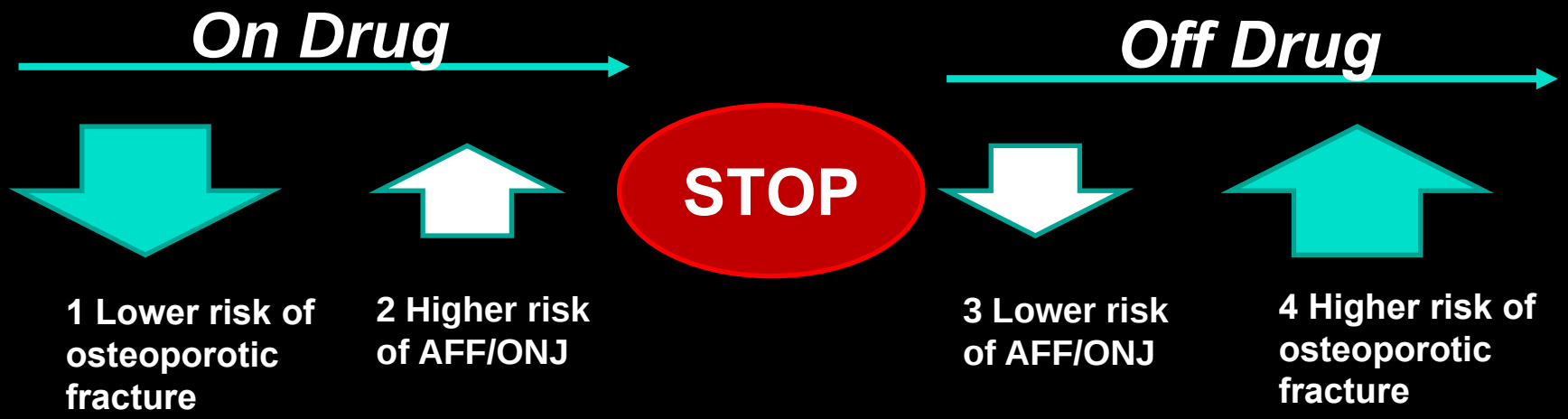




Black D. *N Engl J Med* 2020; 383:743

What are the Goals of "Drug Holidays" in Osteoporosis?

Expectation - risk of adverse events declines very rapidly and risk of osteoporotic fractures increases only slowly



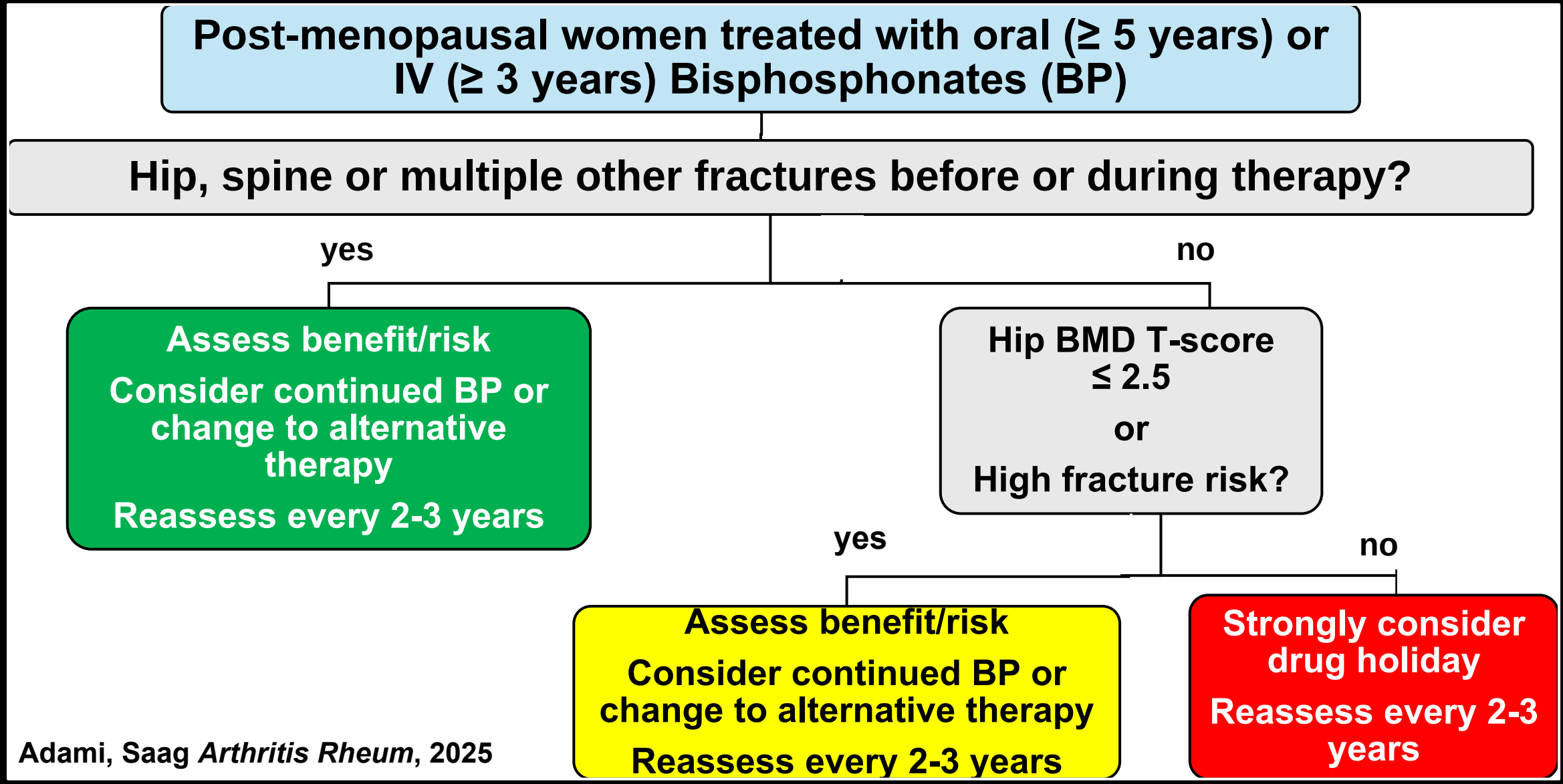
Fractures Return After a Bisphosponate Drug Holiday of > 2 yrs

US Medicare Data (n = 74K)

- Hip fracture (fx)
  - Alendronate (ALN)- 30% ↑
  - Risedronate (RIS)- 50% ↑
  - Zoledronic acid (ZA)- 30% ↑
- Vertebral fractures
  - ALN- 20% ↑
  - RIS- 60% ↑
  - ZA - 40% ↑
- Other fracture types
  - 0-40% ↑ depending on fx site

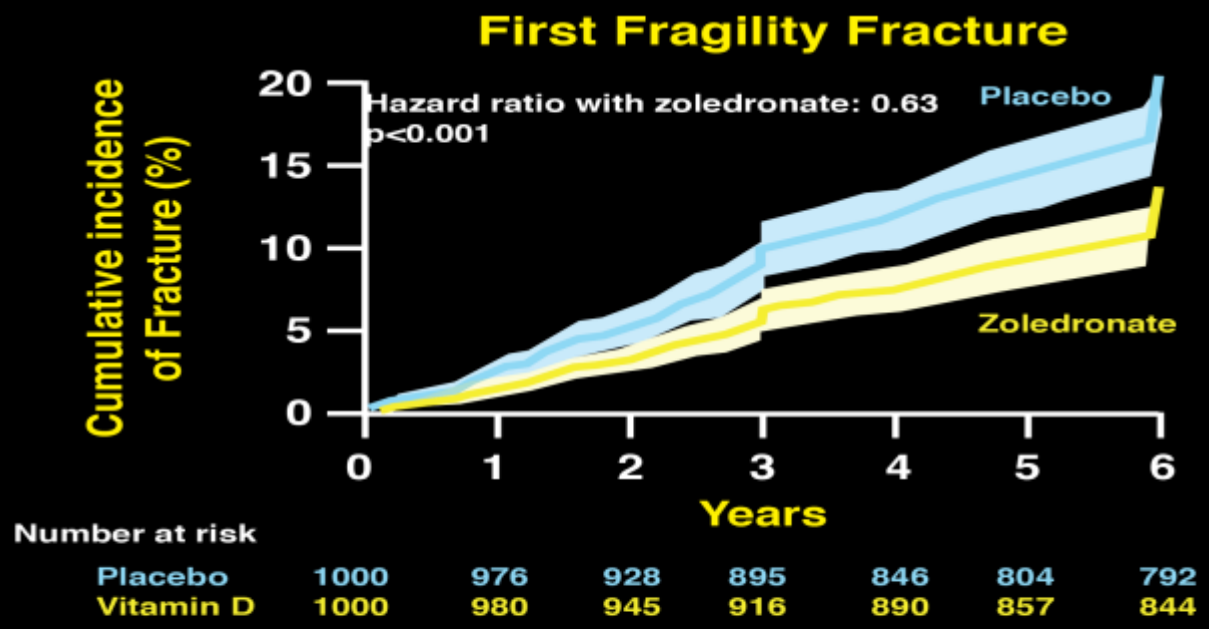
Curtis J. *Medical Care* 2020; 58:1
Black DM. *J Clin Endo Metab* 2000;85:4118

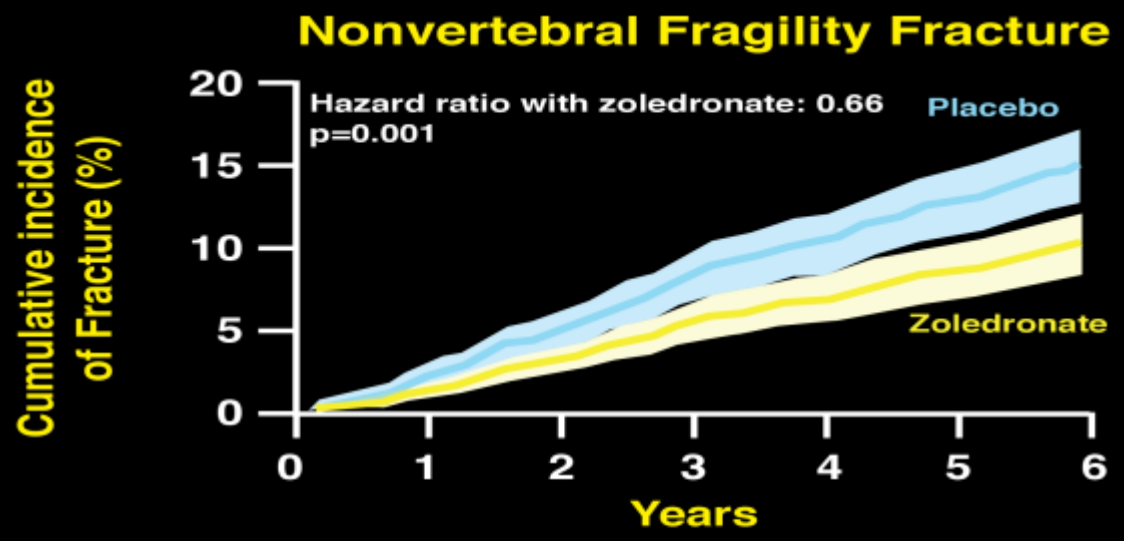
Algorithm for Management of Long Term Bisphosphonate (BP) Therapy (adapted from Adler)

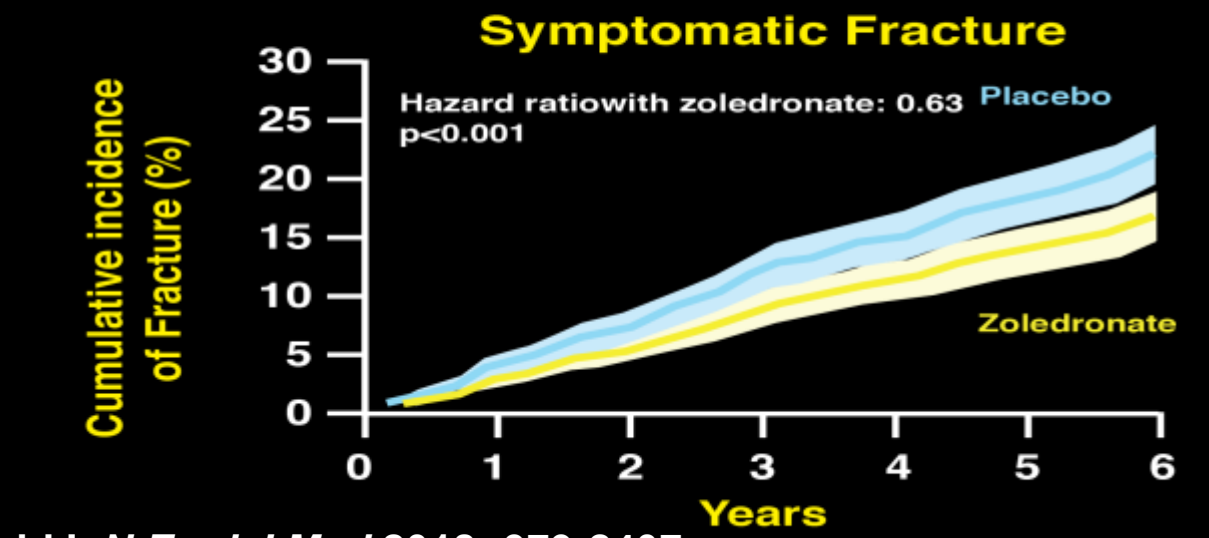


Adami, Saag *Arthritis Rheum*, 2025

Zoledronic Acid Prevents Fractures in Osteopenia







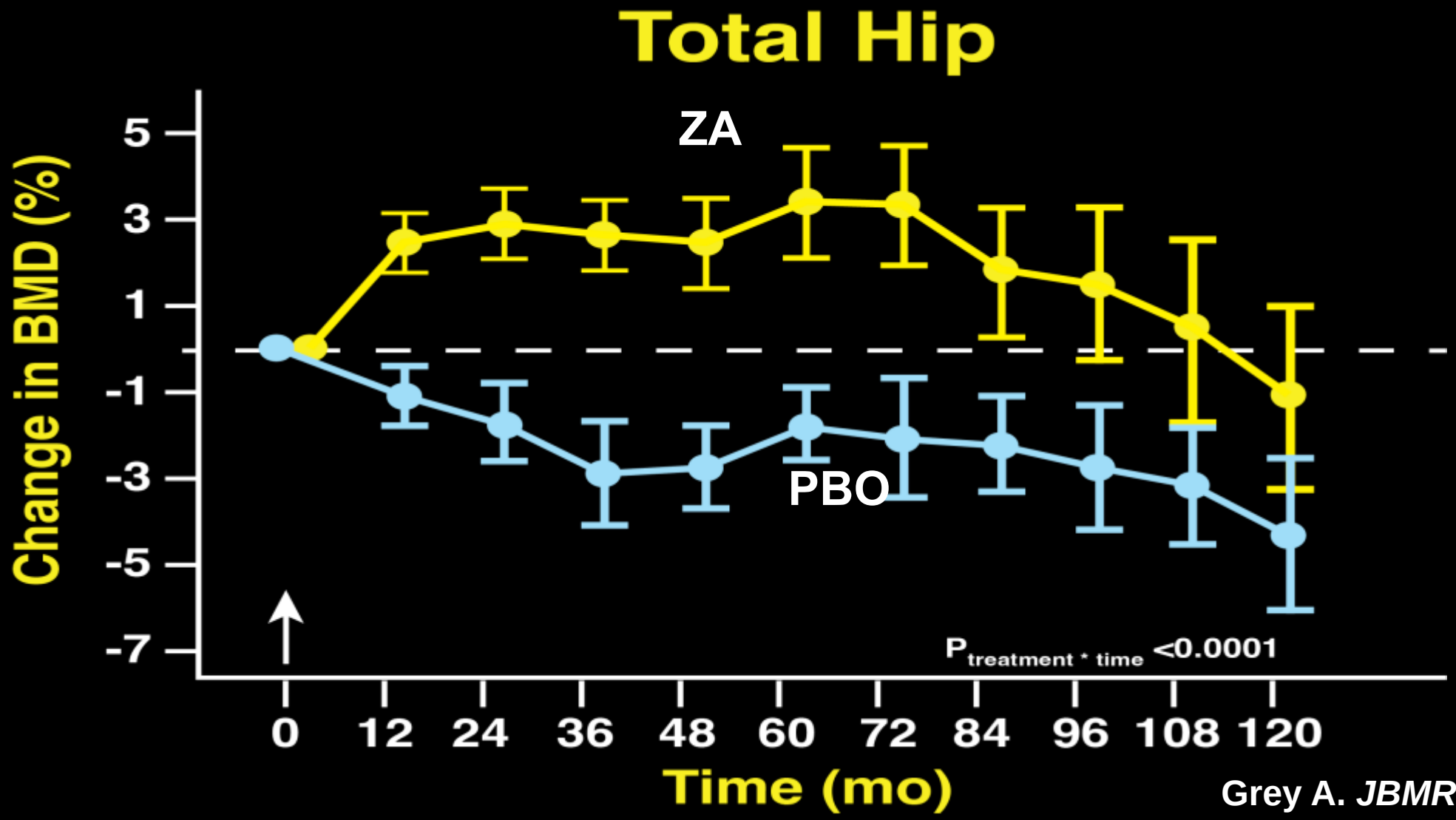
Reid I. *N Engl J Med* 2018; 379:2407

Long-term Extension to ZA Osteopenia Study Shows Persistent Bone Benefits

- Difference in BMD maintained on extended follow-up (after 4 doses of zoledronic acid)
- Reduced Risk of fractures for 3.5 yrs after last dose
- Suggests long-term effects on BMD translates into fracture risk reduction
- NO osteonecrosis of the jaw or atypical femoral fractures reported

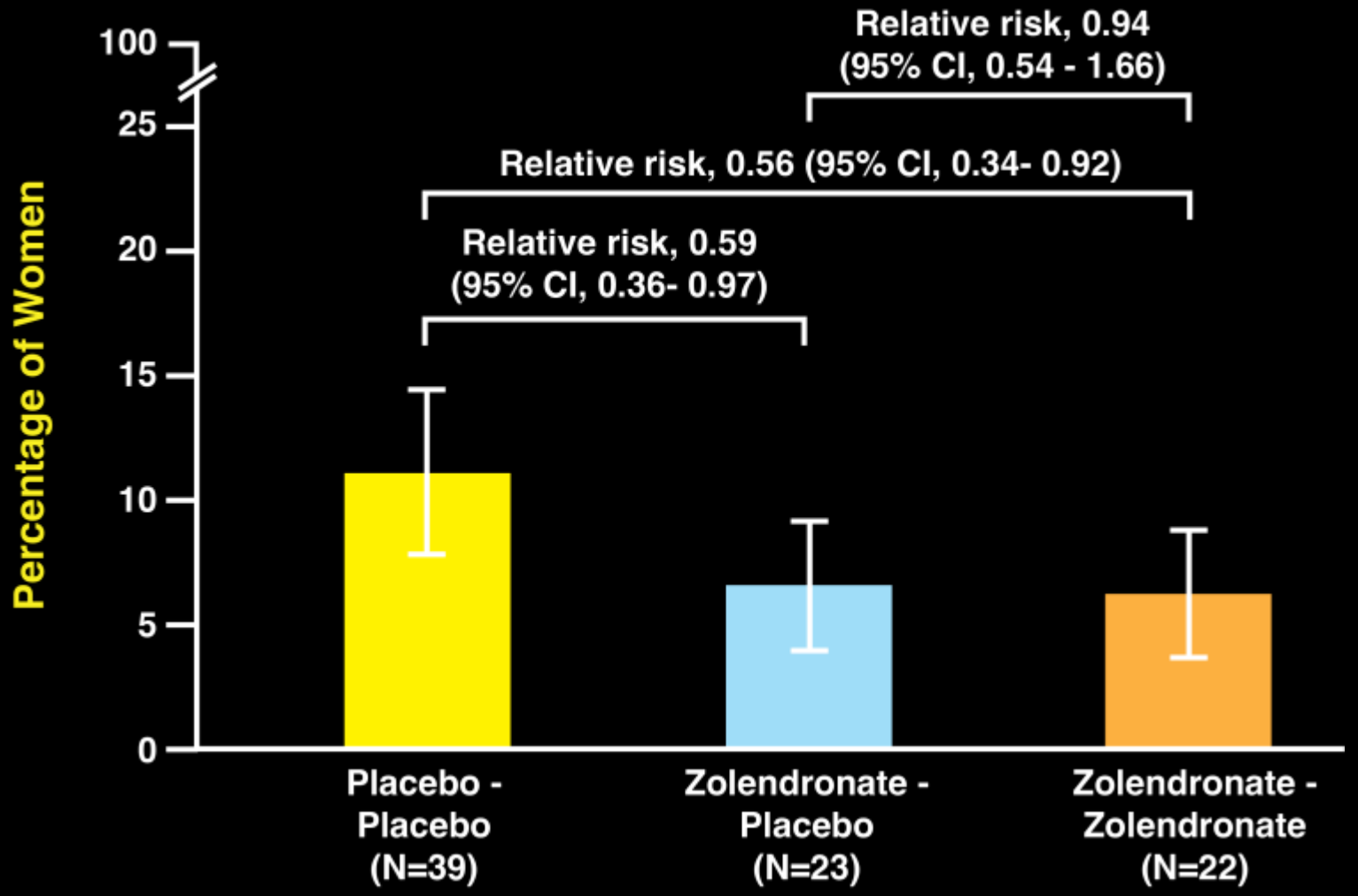
Reid I. *Lancet Diab Endo* 2024;12:247

Single 5 mg Zoledronic Acid Benefits BMD for up to 9 years



Grey A. *JBMR* 2022:37:3

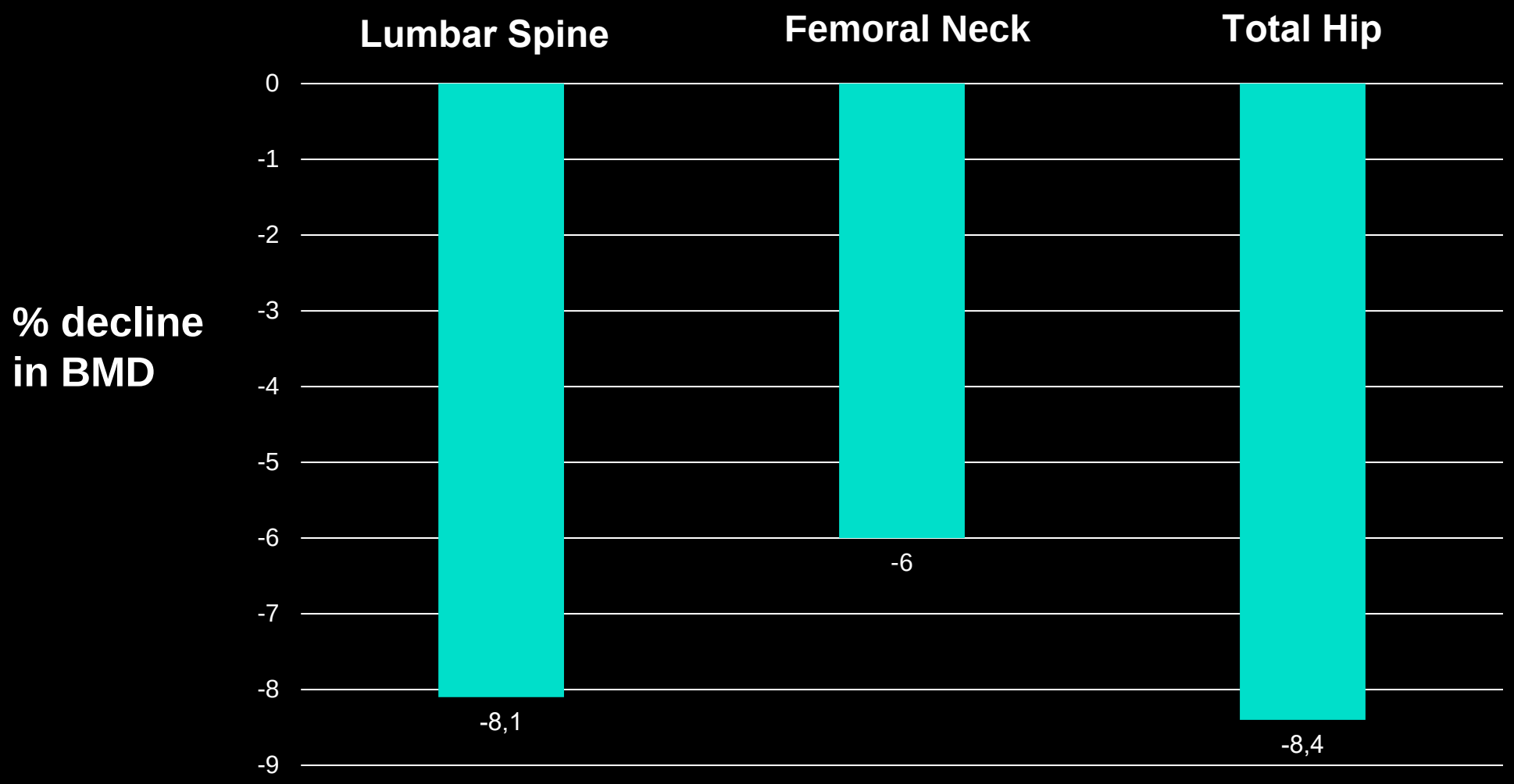
Reducing Morphometric Fractures in Women 50-60 without Osteoporosis with ZA every 5 yrs



Bolland M. *NEJM* 2025;392:239

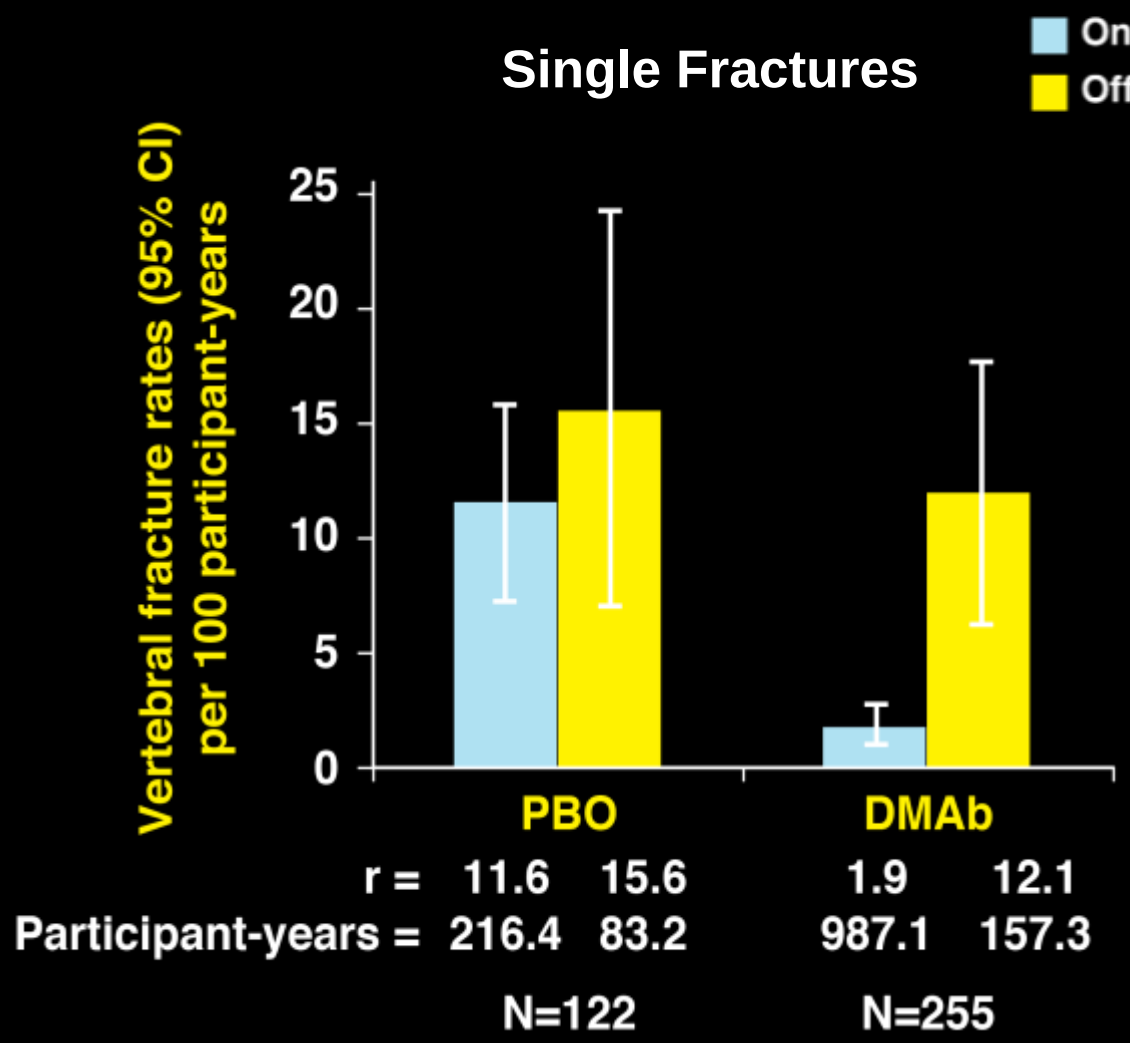
What Happens When Denosumab is Stopped? Why? Can we Prevent Post-Denosumab Fractures?

Bone Loss after Denosumab Stop



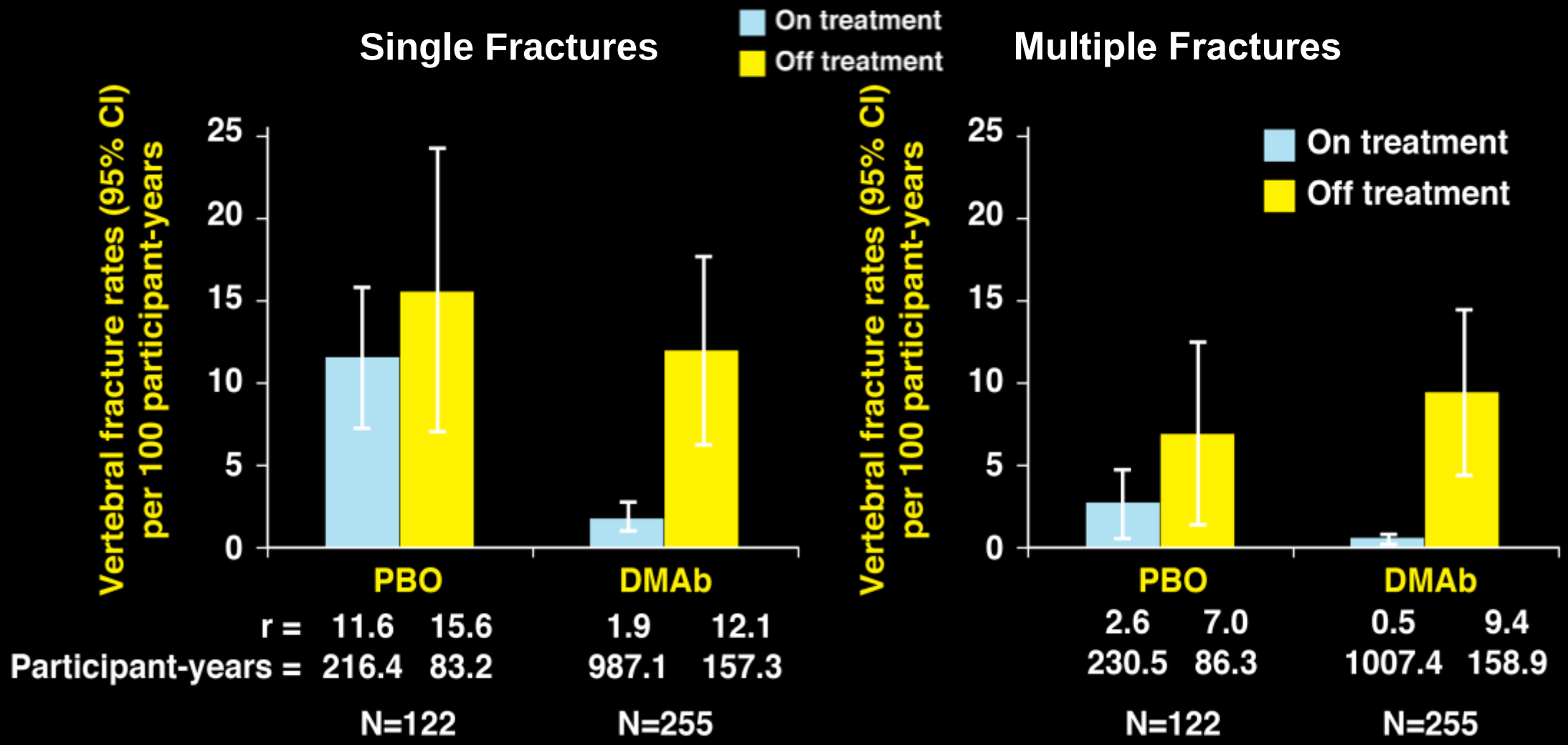
Zanchetta MB. *Osteoporos Int* 2018;29:41

Fractures Increase After Stopping Denosumab (DMAb)



Cummings S. *JBMR* 2018;33:190

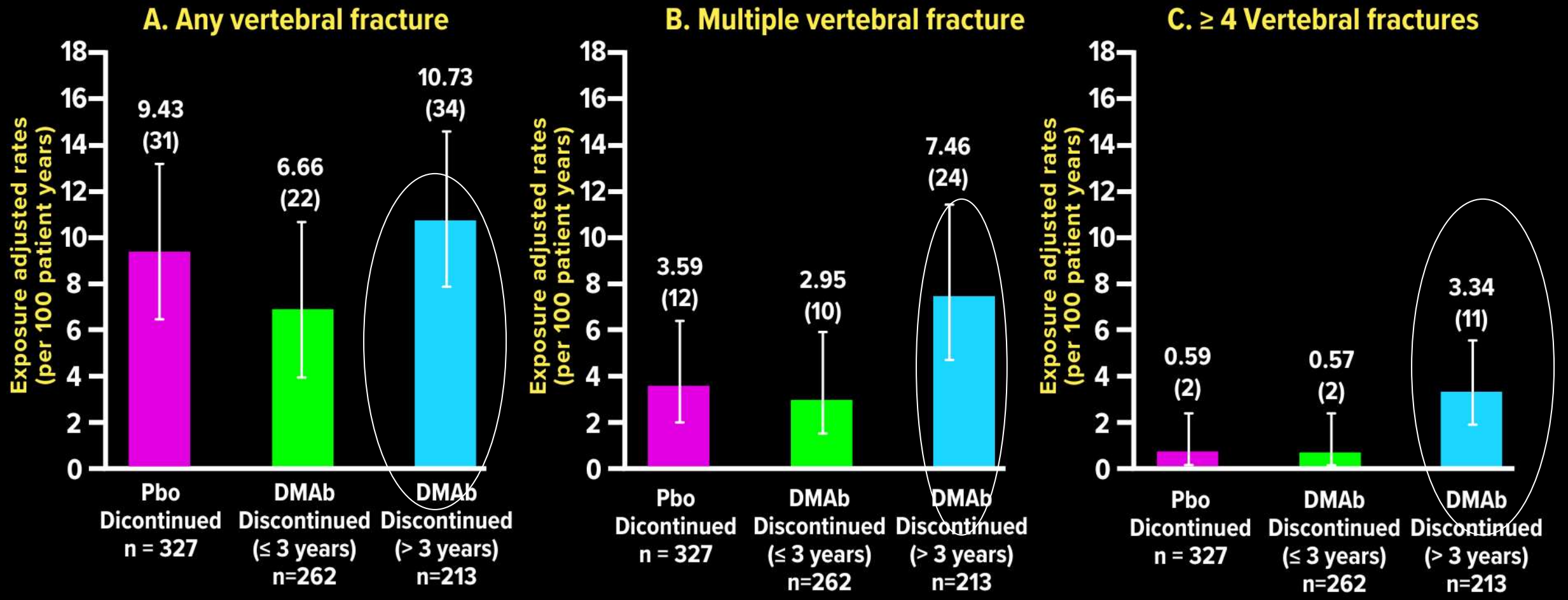
Fractures Increase After Stopping Denosumab (DMAb)



Cummings S. *JBMR* 2018;33:190

Rebound Greater with Longer DMAB Use

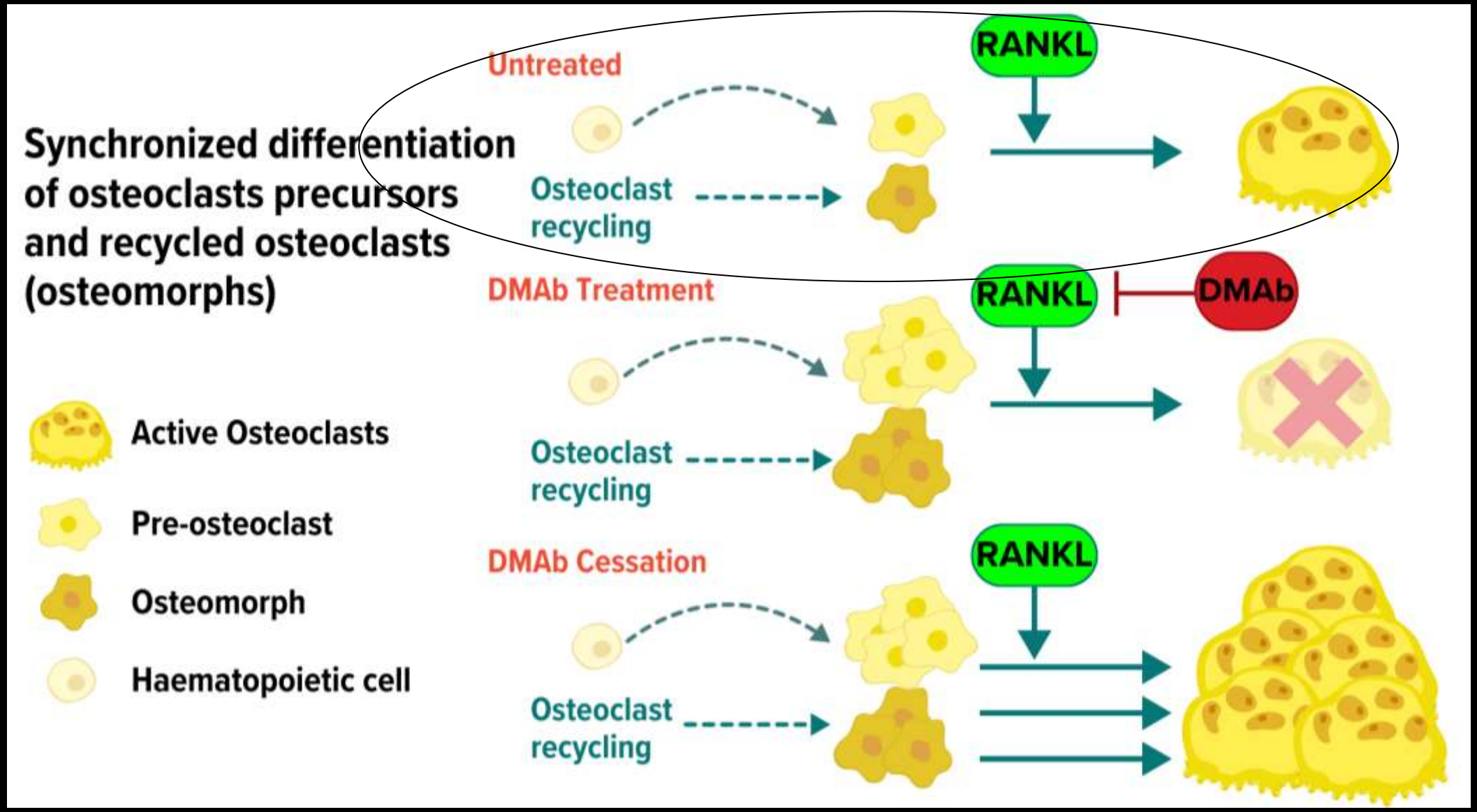
Exposure-adjusted annualized rates of fractures in Pbo and DMAb Discontinuation groups categorized by duration ≤ 3 years vs > 3 years



Multiple vertebral fractures were defined as 2 new and/or worsening vertebral fractures

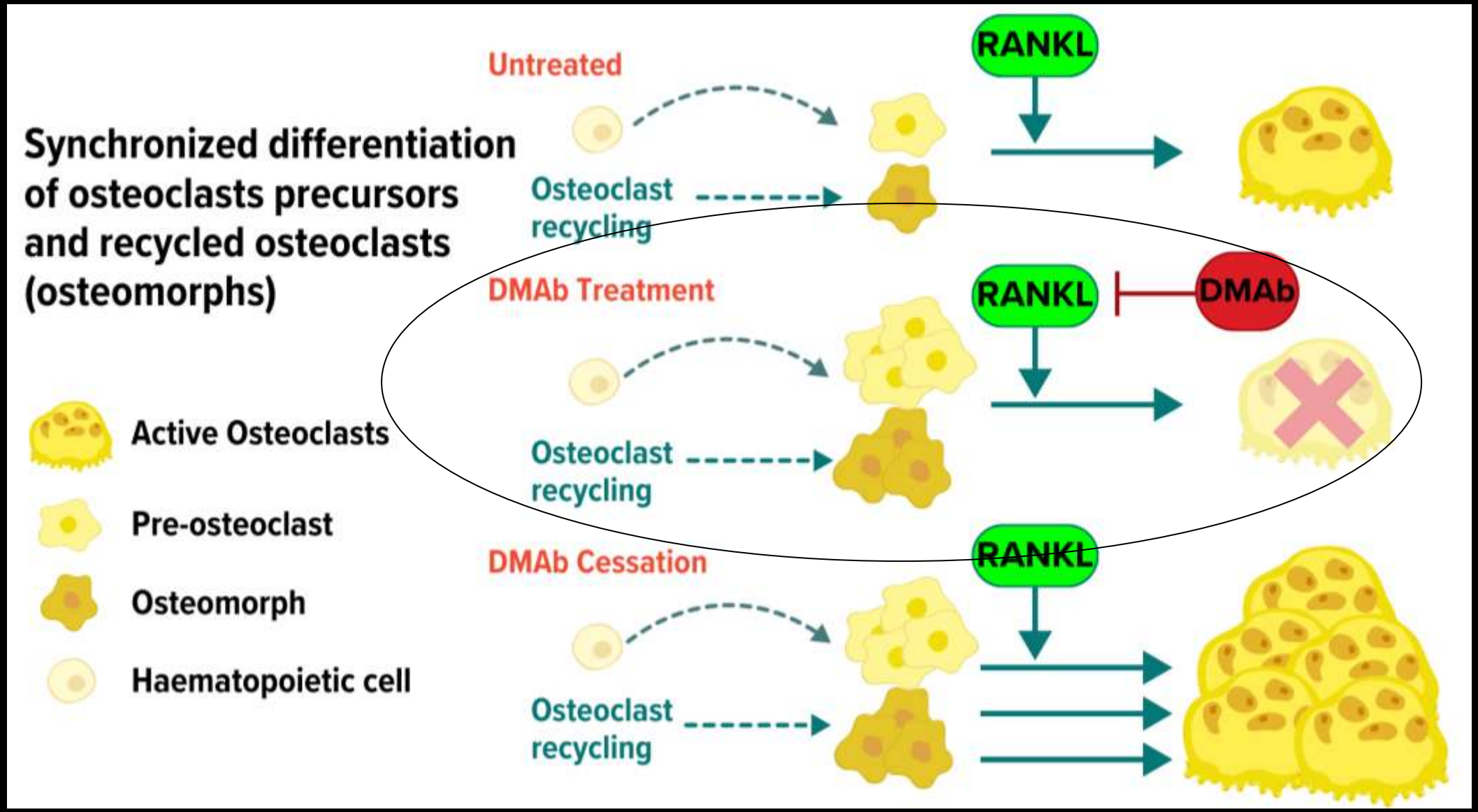
Cosman F. *J Bone Min Res* 2022;37;2112

Bone Loss on Denosumab Discontinuation
Potential Mechanism of Action



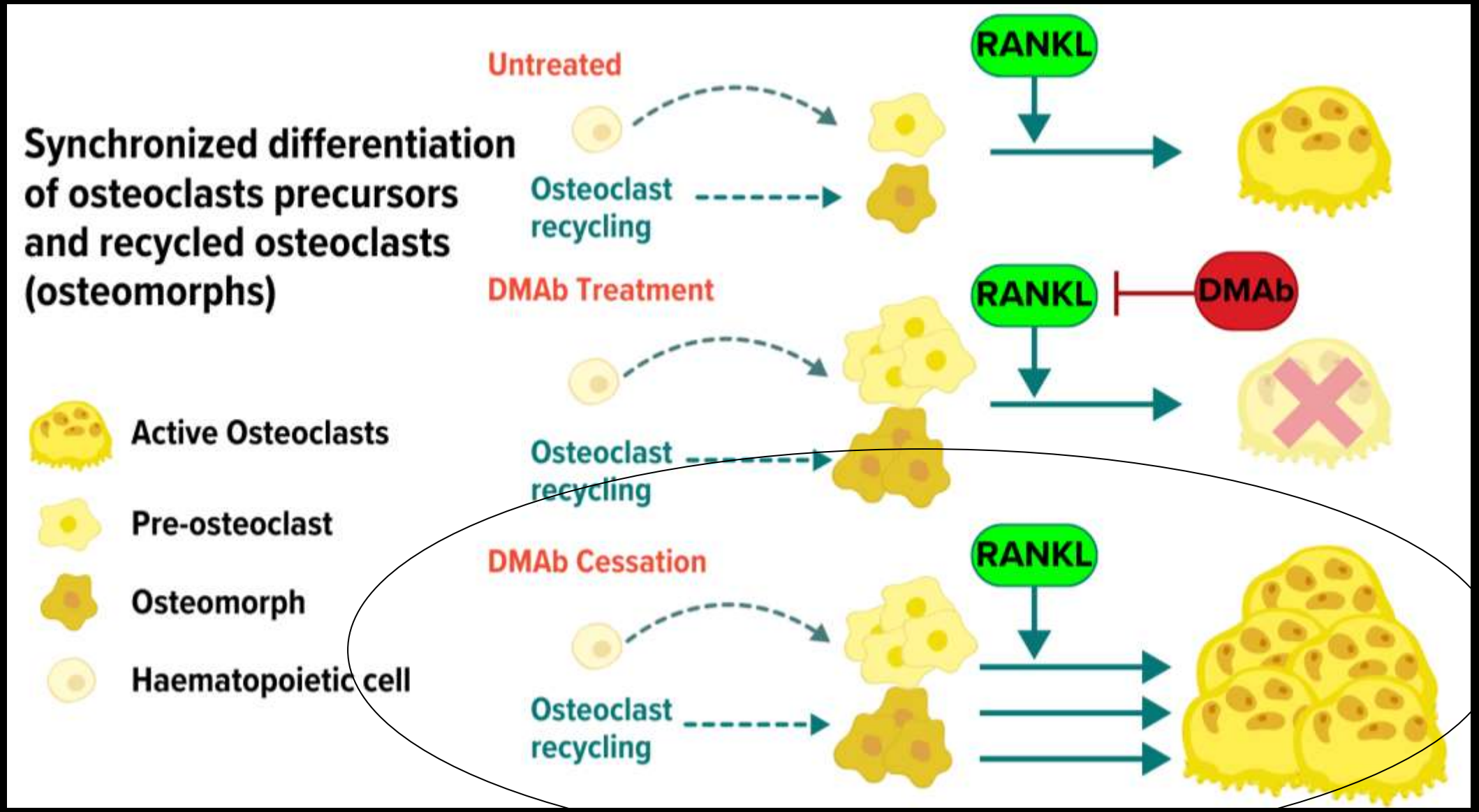
Ferrari S. *Nat Rheum Rev* 2023;19:307

Bone Loss on Denosumab Discontinuation
Potential Mechanism of Action



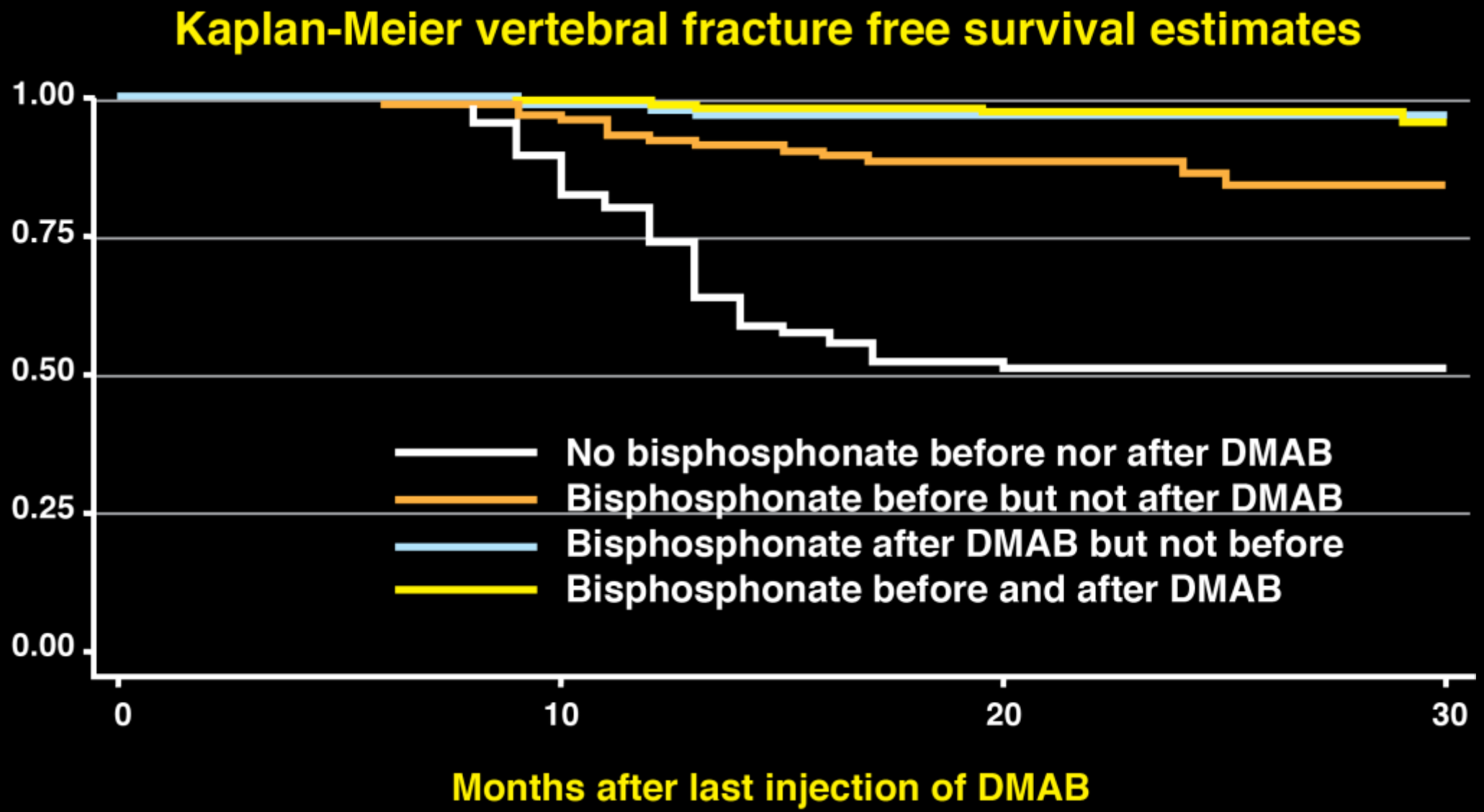
Ferrari S. *Nat Rheum Rev* 2023;19:307

Bone Loss on Denosumab Discontinuation
Potential Mechanism of Action



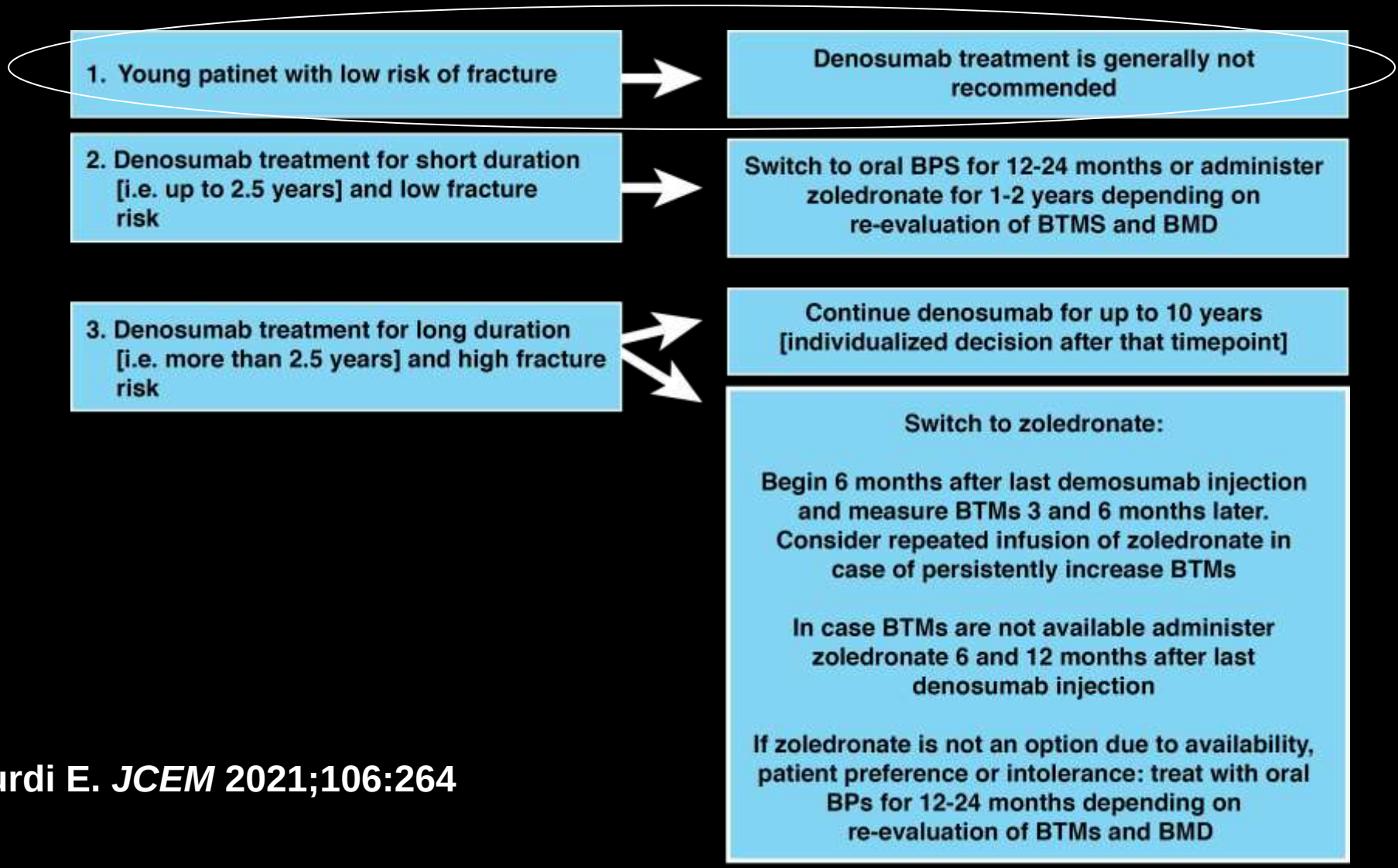
Ferrari S. *Nat Rheum Rev* 2023;19:307

Bisphosphonates Before or After DMAB, or NOT



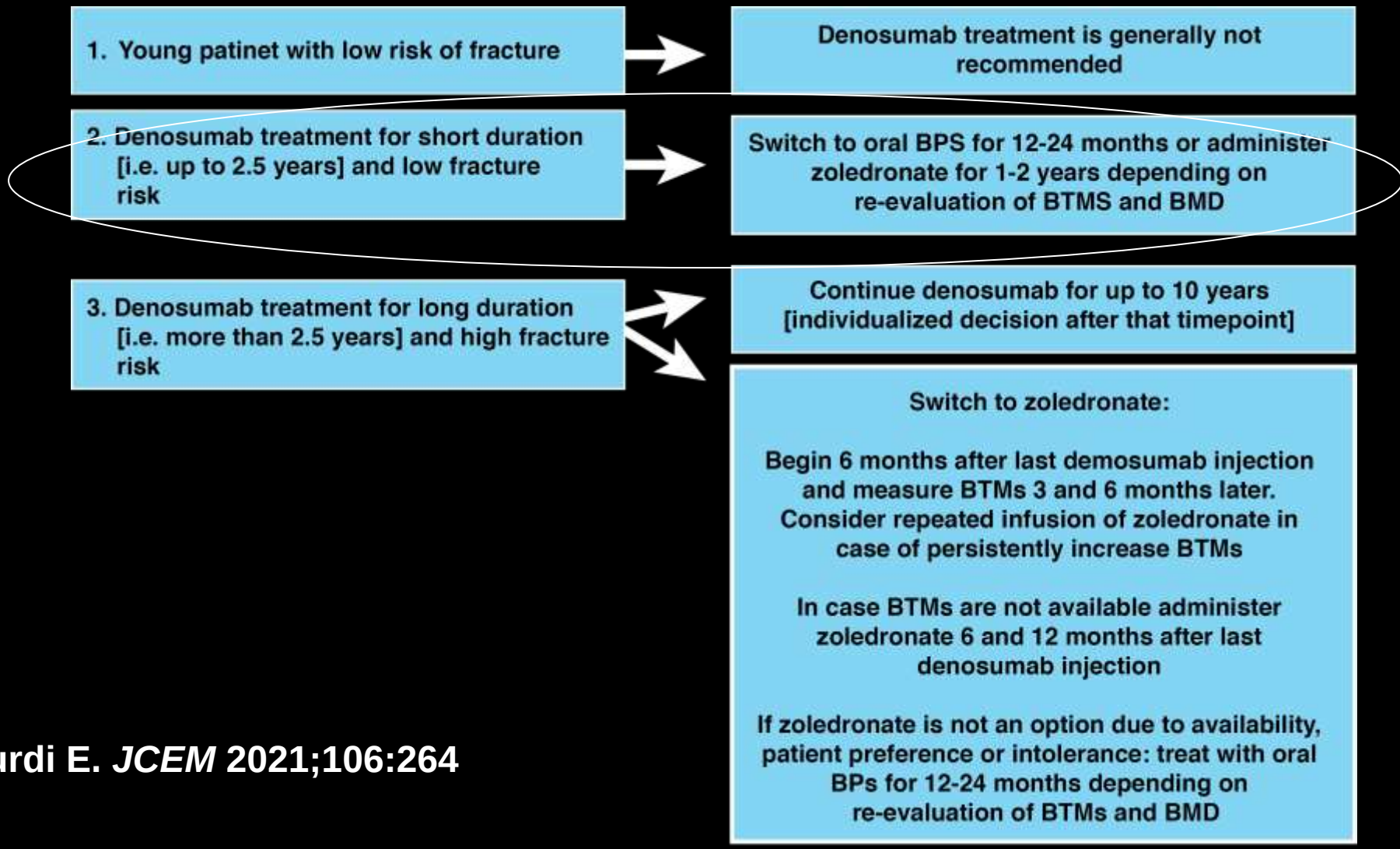
Burkhardt P. *JBMR* 36;2021:1717

European Calcified Tissue Society (ECTS) Post-Denosumab Rx Recs



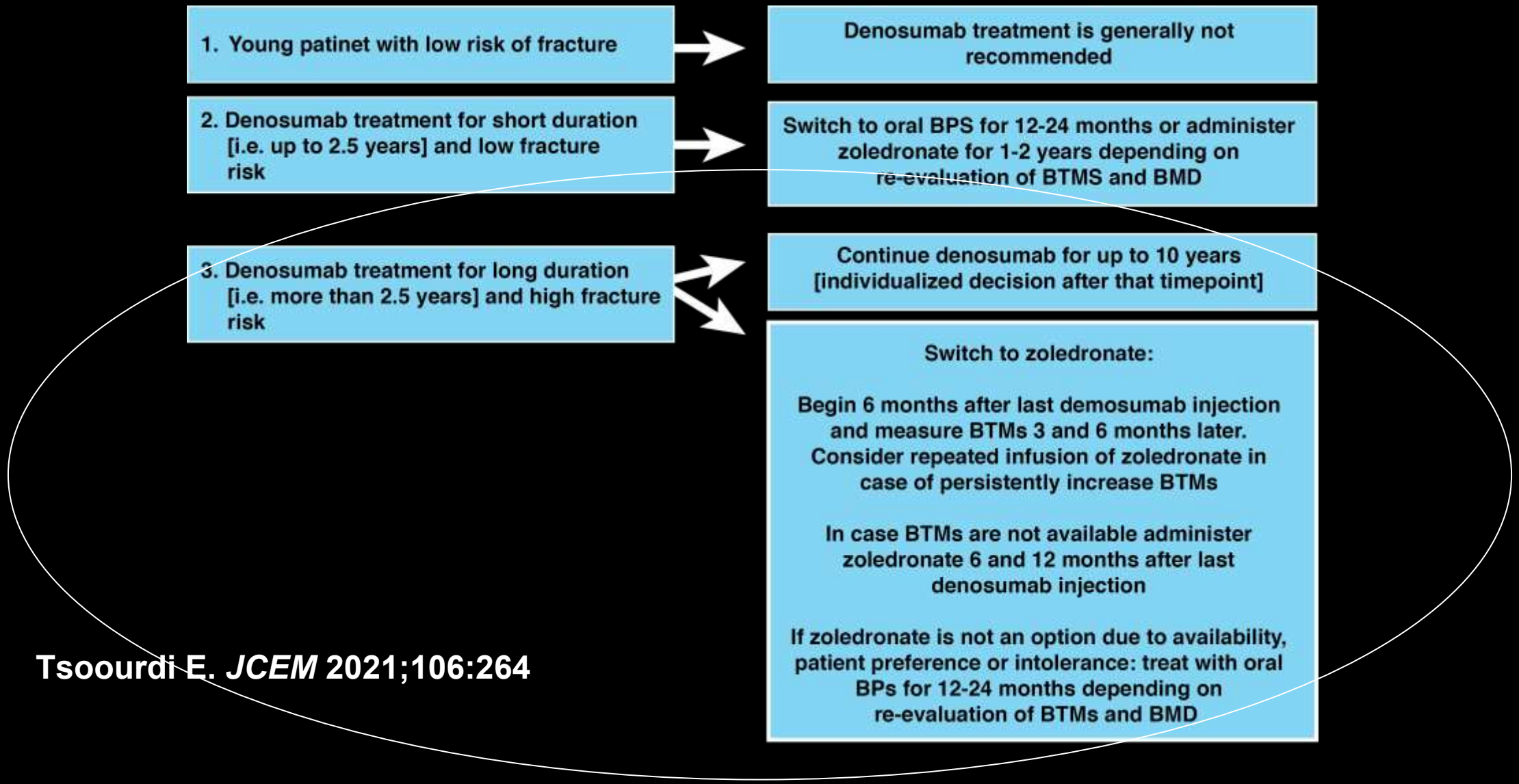
Tsoourdi E. *JCEM* 2021;106:264

European Calcified Tissue Society (ECTS) Post-Denosumab Rx Recs



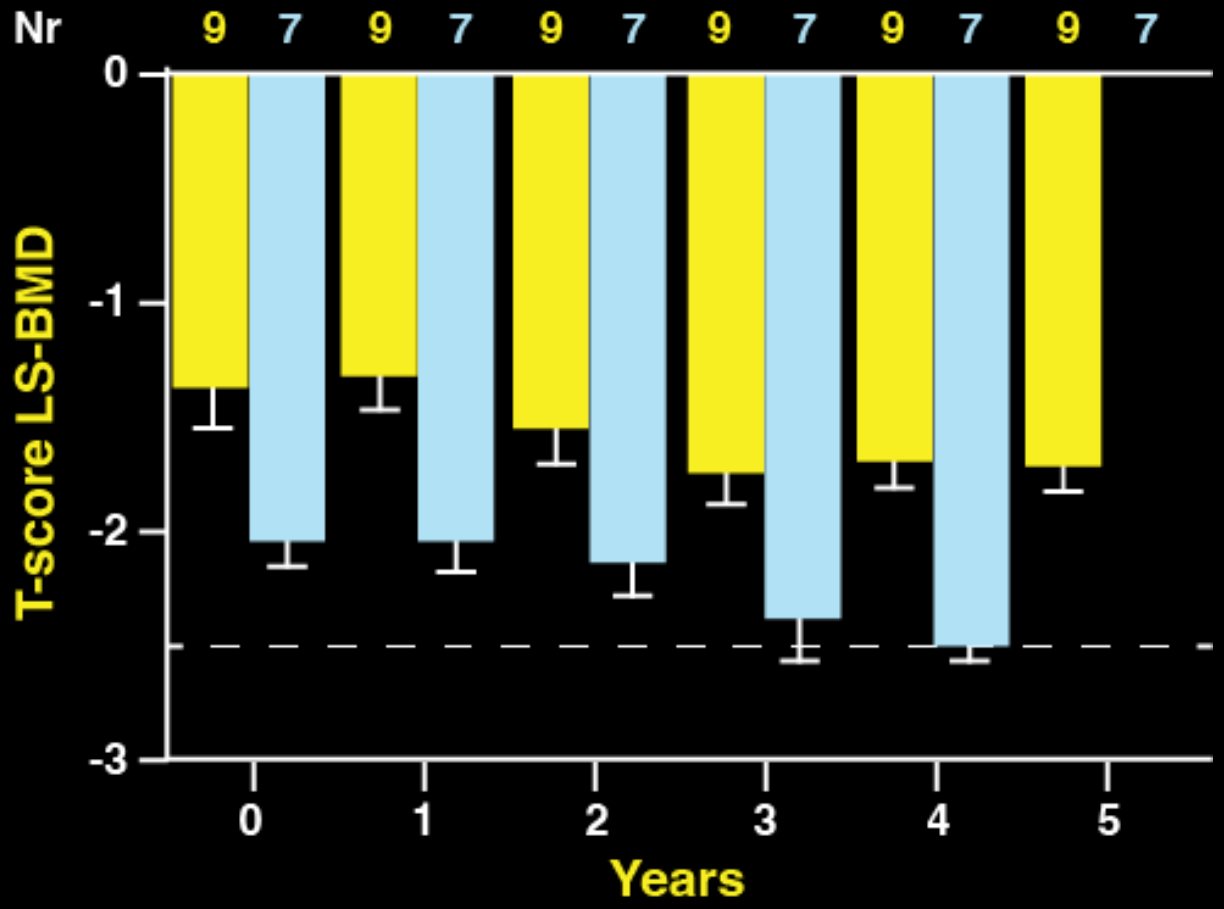
Tsoourdi E. *JCEM* 2021;106:264

European Calcified Tissue Society (ECTS) Post-Denosumab Rx Recs



Tsoourdi E. *JCEM* 2021;106:264

Zoledronic Acid After Denosumab Shows 5 year Lasting Effects on BMD

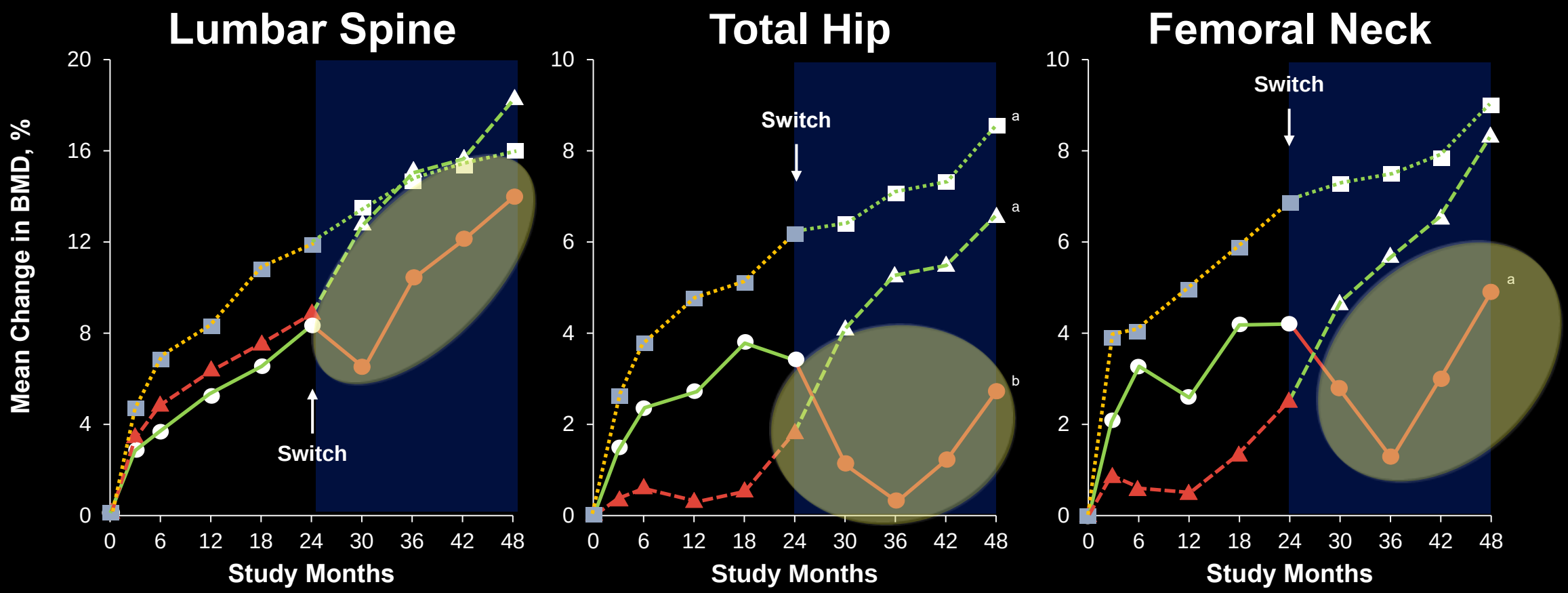


Yellow- single ZA OP treatment , Blue- further OP treatment due to BMD decline

Anastasiliakis A. *Calcified Tissue Int* 2023;113:469

BMD Drops When Switching DMAb to TPTD

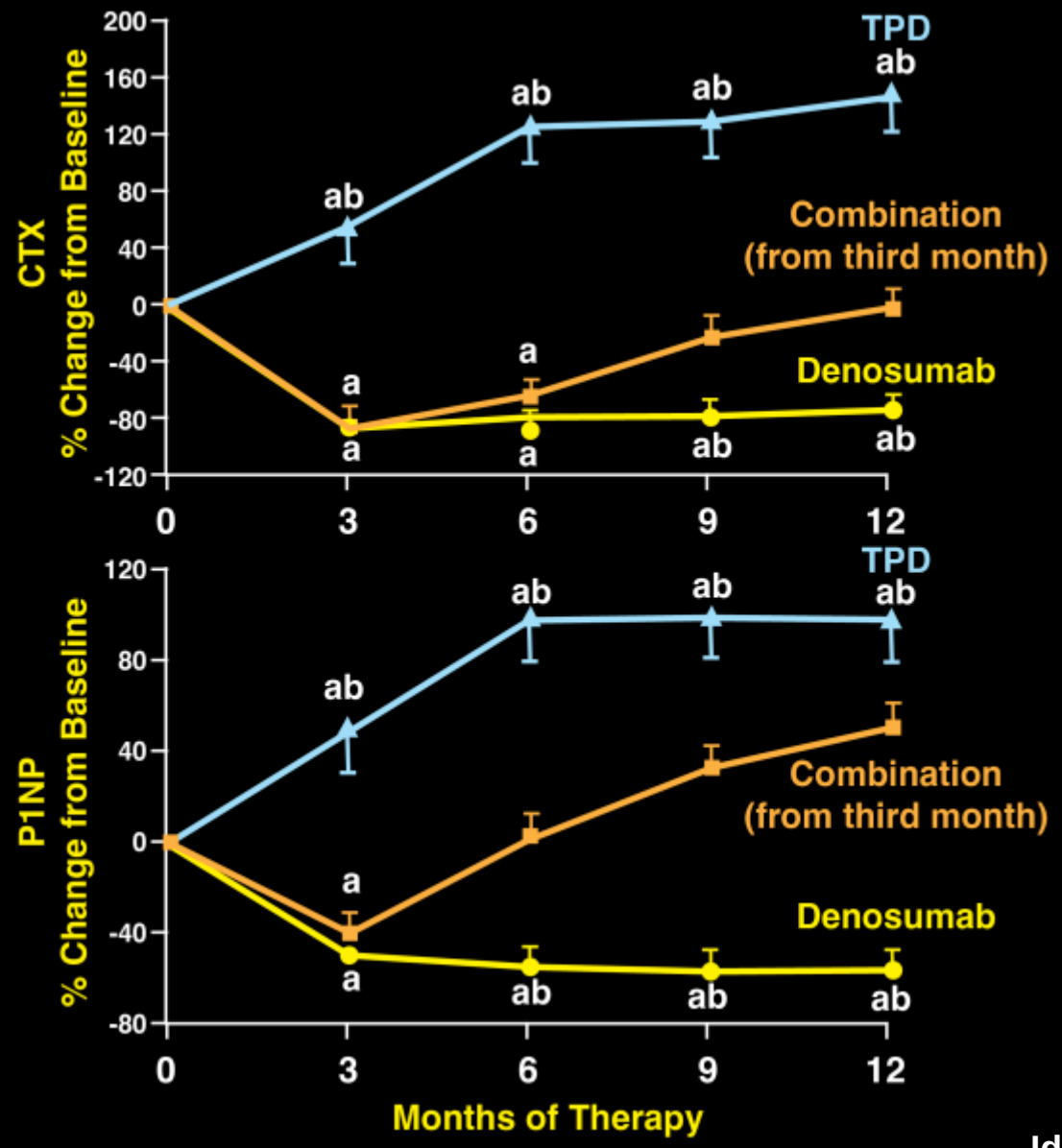
Denosumab → Teriparatide at 24 Months (n = 27)
Teriparatide → Denosumab at 24 Months (n = 27)
Combination → Denosumab at 24 Months (n = 23)



[a]$p < 0.05$ vs both other groups.
[b]$p < 0.0005$ vs both other groups.

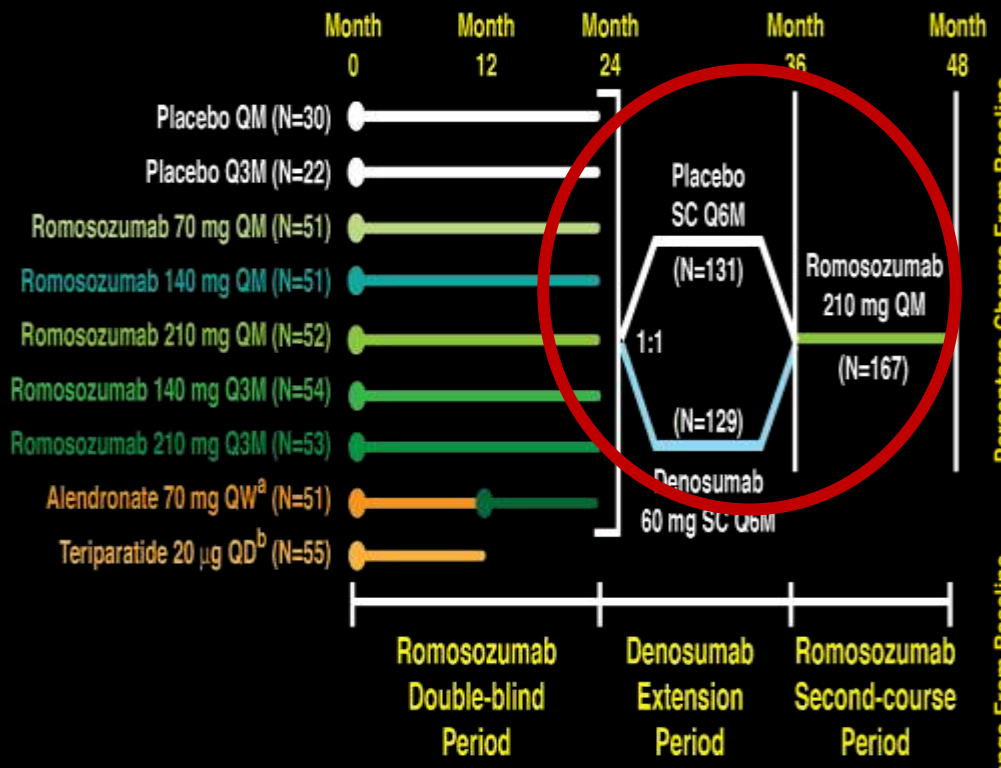
Leder B. *Lancet* 2015;386:1147

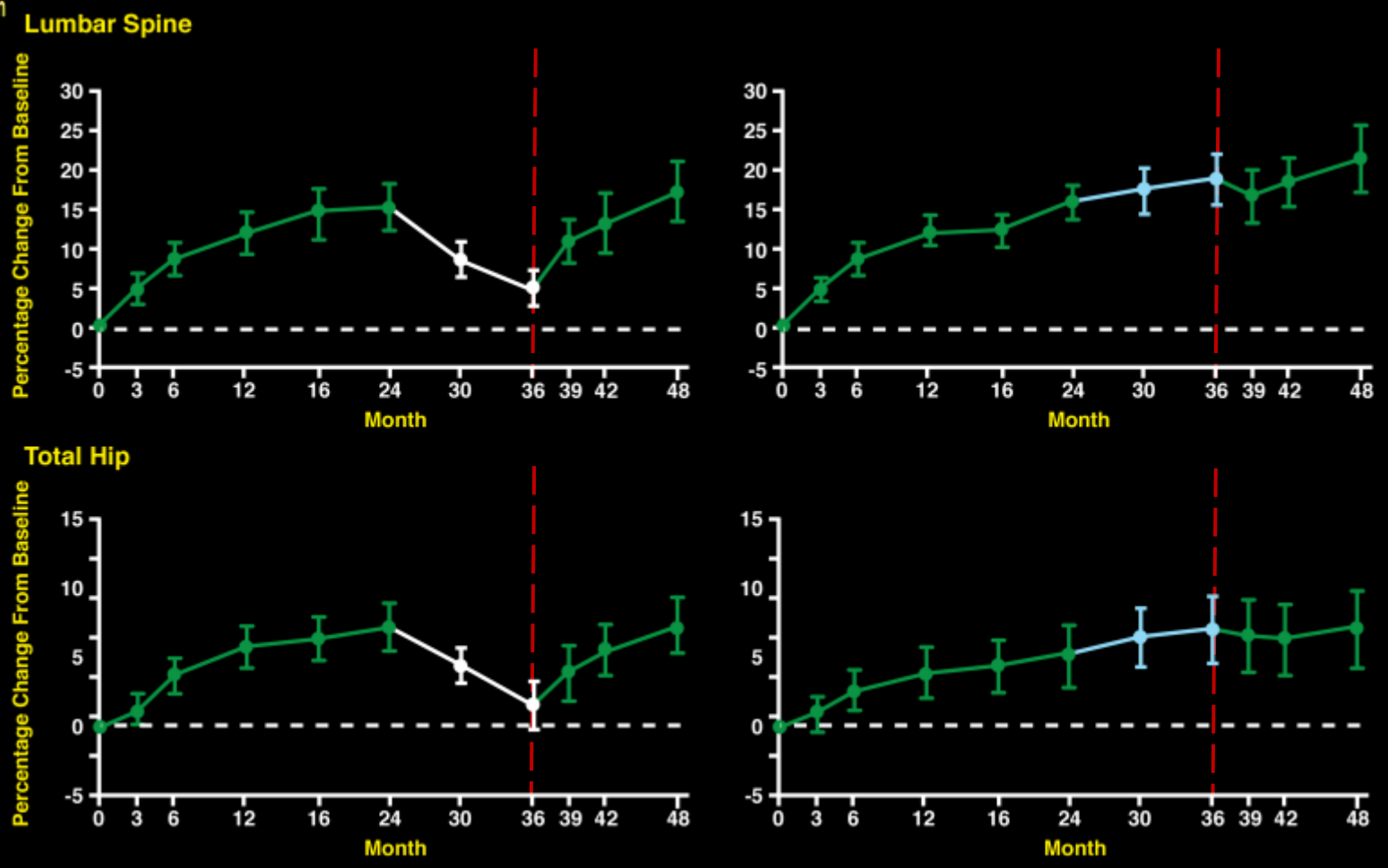
Teriparatide Added to DMAB



Idolazzi L. *Osteoporos Int* 2016;27:3301

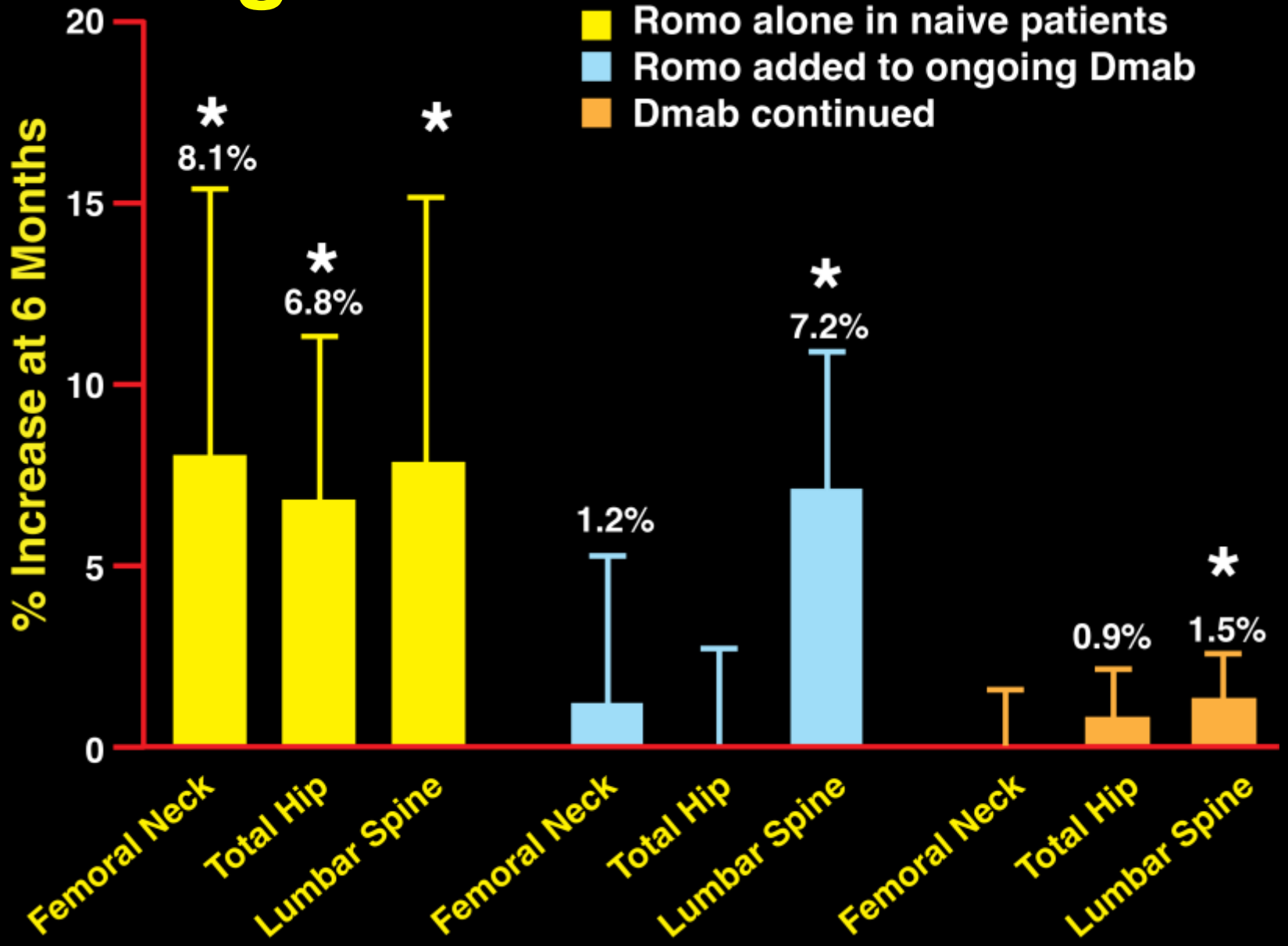
Switching to Romosozumab Following Placebo or Denosumab





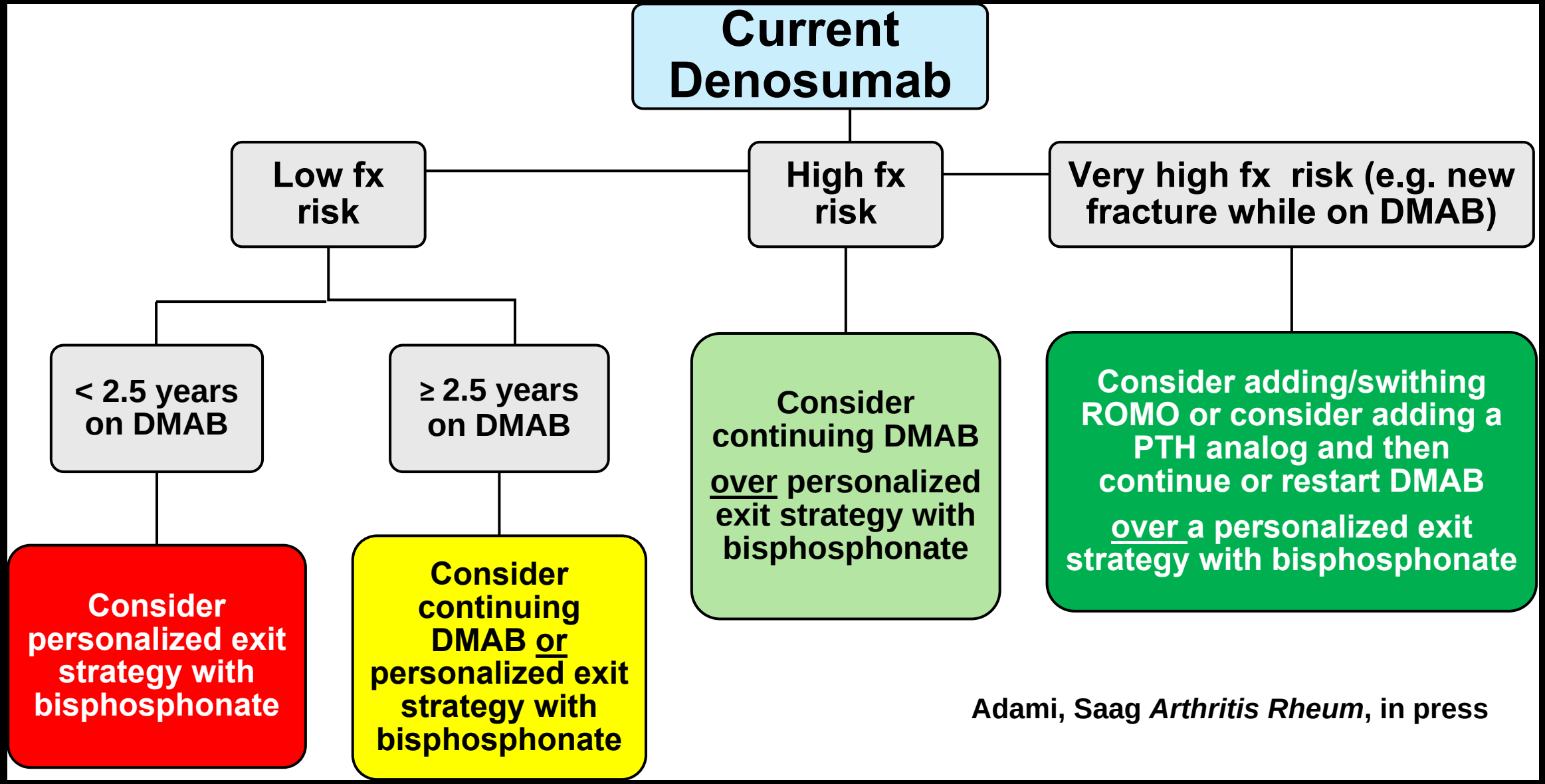
Kendler DL. *Osteoporosis Int* 2019; 30:37

Adding Romozosumab to DMAB



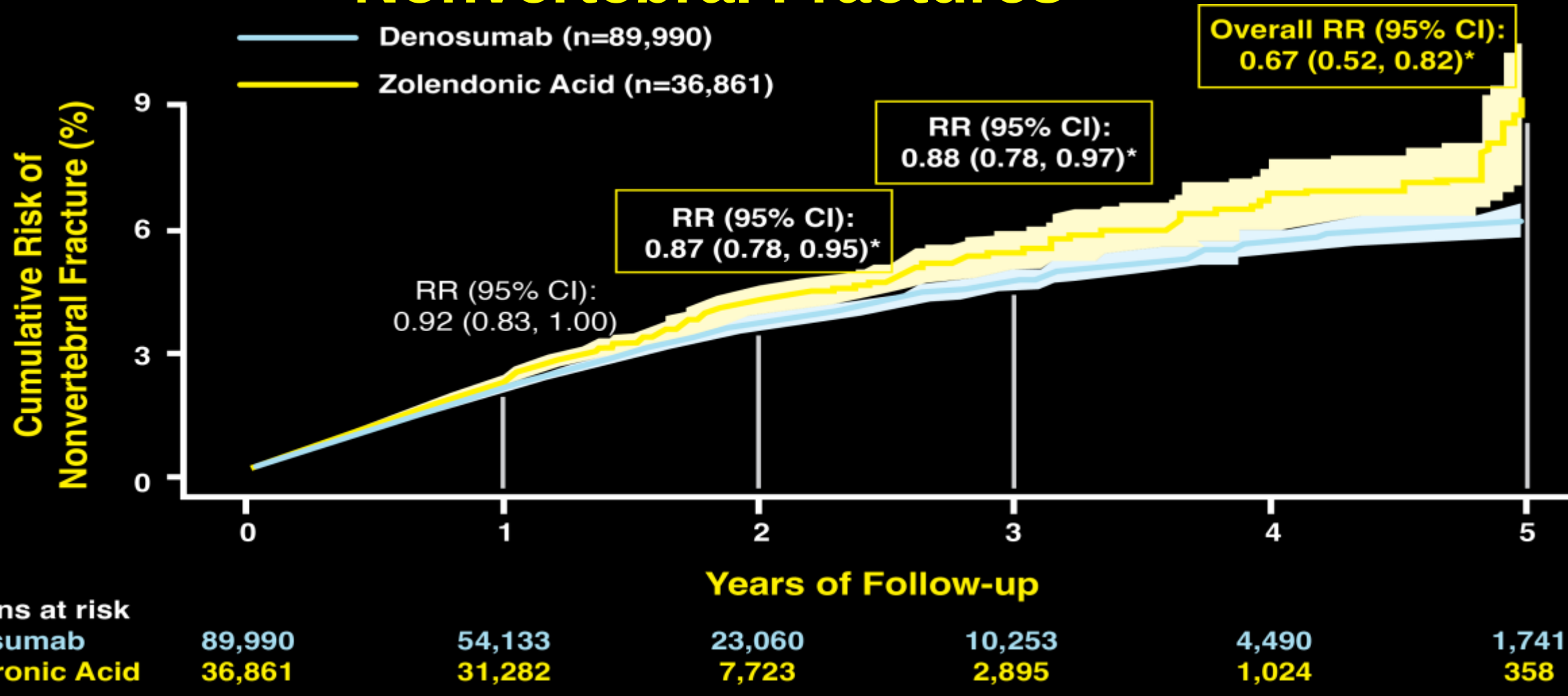
Adami G. *JBMR Open* 2024

Algorithm for Considering Stopping Denosumab (adapted from ECTS)



Adami, Saag *Arthritis Rheum*, in press

Denosumab Appears Superior to Zoledronic acid for Nonvertebral Fractures



Persons at risk						
Denosumab	89,990	54,133	23,060	10,253	4,490	1,741
Zoledronic Acid	36,861	31,282	7,723	2,895	1,024	358

*$P < 0.05$. Shaded area represents CI. 'Overall' covers the entirety of follow-up.
CI, confidence interval; NV, nonvertebral; RR, risk ratio.

Curtis J. ASBMR, 2023; EULAR, 2024

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- Stephanie Ford
- Jeffrey Foster, MPH
- Hassam Ghomrawi, PhD
- Doug Grabarczyk
- Biranna Holder
- Leslie Jackson, MD
- Anne Merrill
- Sarah Morgan RD, MD
- Kristen Rutledge
- Mary Wilkenson
- Nicole Wright, PHD