

Periprosthetic Fractures: The Next Fragility Fracture Epidemic

5 December, 2024

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Disclosures

- Research support
 - GE Healthcare
 - Radius
 - MediMaps



P.A. Anderson, M.D.

- I'm an osteoporosis doc, not an Orthopedic surgeon
- Some of this is my opinion (substantially influenced by Paul Anderson)
- Noted as such by purple text color

Objectives

- Encourage diagnosis of “clinical osteoporosis” in routine Orthopaedic care.
- Appreciate that periprosthetic fractures are not rare and are “osteoporosis-related.”
- Integrate pre-operative bone health assessment and optimization into elective Orthopaedic surgical practice.

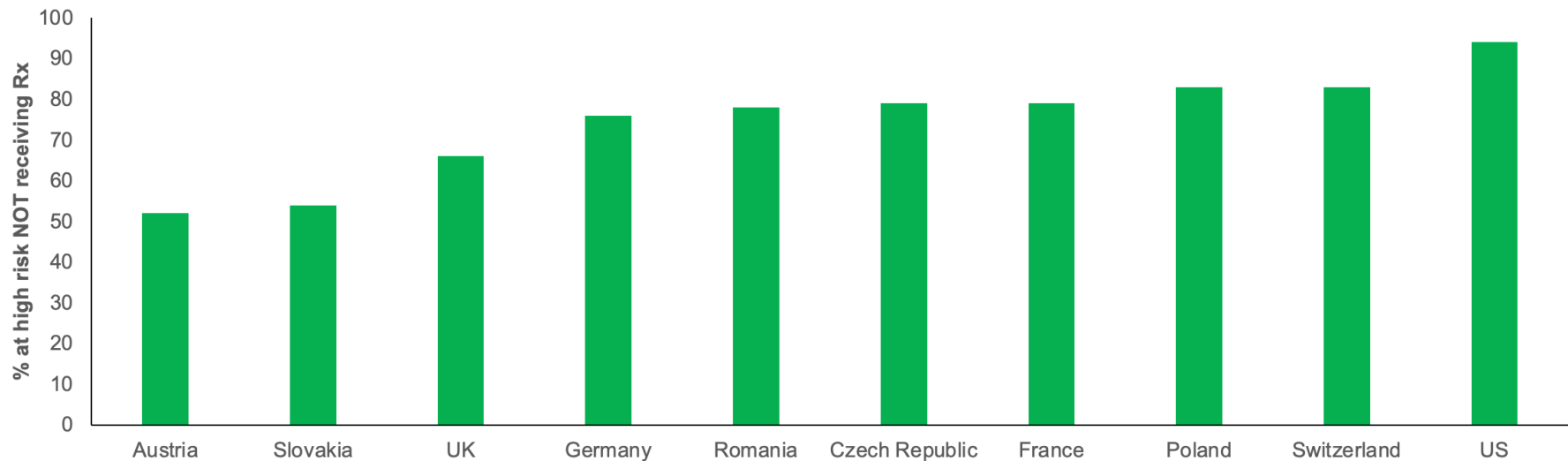
Osteoporosis Increases Risk for Fractures and for Complications After Orthopedic Surgery

Worldwide, “we” are doing very little (sometimes nothing) to reduce fracture risk or optimize bone status prior to or following elective orthopedic procedures

This is consistent with osteoporosis treatment in general

The Osteoporosis Treatment Gap Exists Worldwide

Treatment gap = proportion at high fracture risk NOT receiving osteoporosis medication



“The average treatment gap increased from 55% in 2010 to 71% in 2019”

From: www.osteoporosis.foundation/scope-2021
Cohen, et. al., J Arthroplasty, 2023;38; 726e731
Willers, et. al., Arch Osteoporos, 2022;17;23

What Can We Do to Improve This Situation?



We Need to Clearly Define “Osteoporosis”

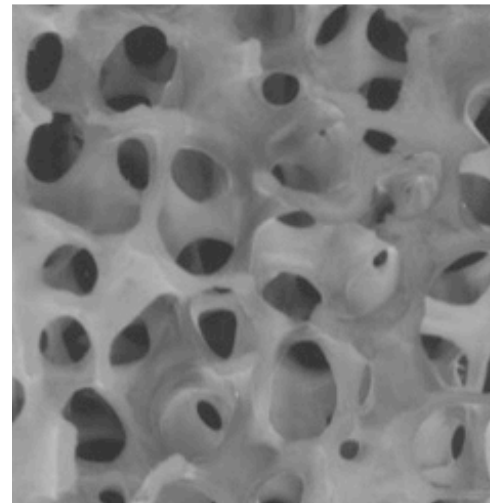
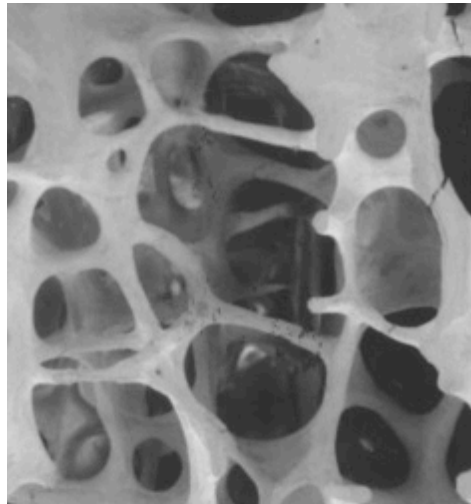
Some of the reason for under-recognition and under-treatment is that multiple definitions of “osteoporosis” exist
(“We” have confused clinicians and patients)

Personal opinion

- Anatomic
- Based on BMD T-score (WHO classification)
- Presence of fracture
- Elevated fracture risk

Anatomic: A systemic skeletal disease characterized by low bone mass and microarchitectural deterioration of bone tissue, resulting in increased bone fragility and susceptibility to fracture

NIH consensus Development Conference: Am J Med. 1991;90:107



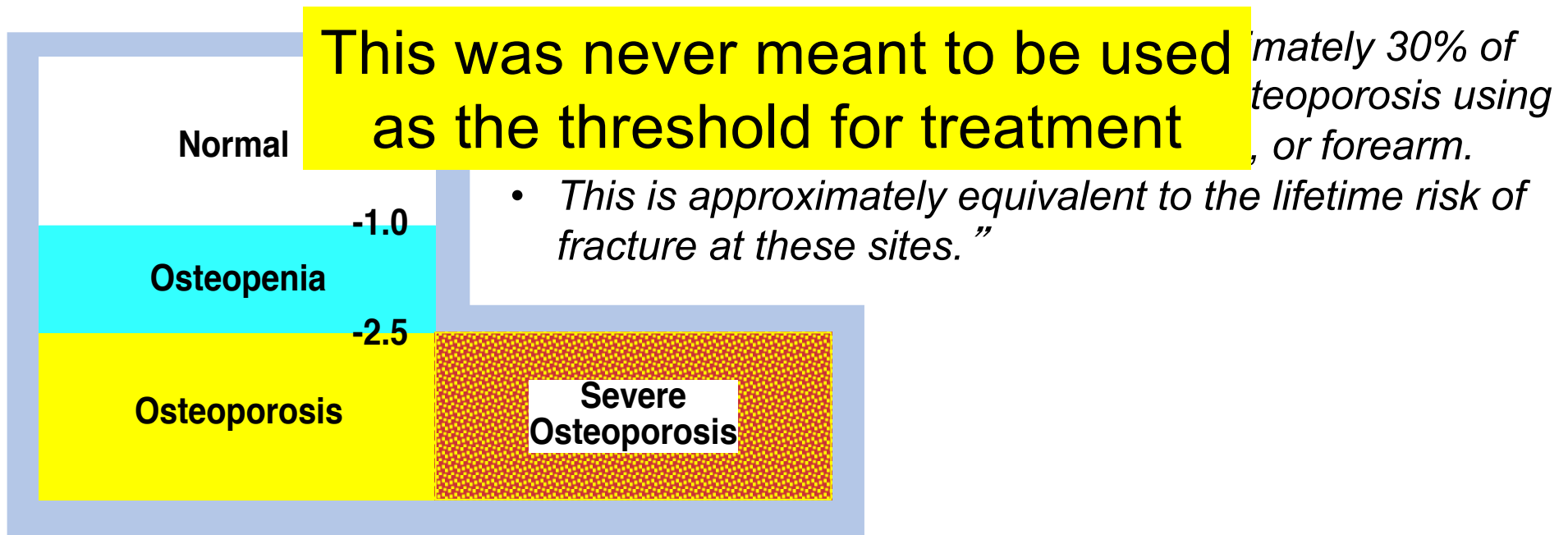
Images courtesy of David Dempster, Ph.D.

This is what osteoporosis truly is, but it does not help implement care in clinic

Personal opinion

WHO Operationally Defined Osteoporosis Based on BMD T-score

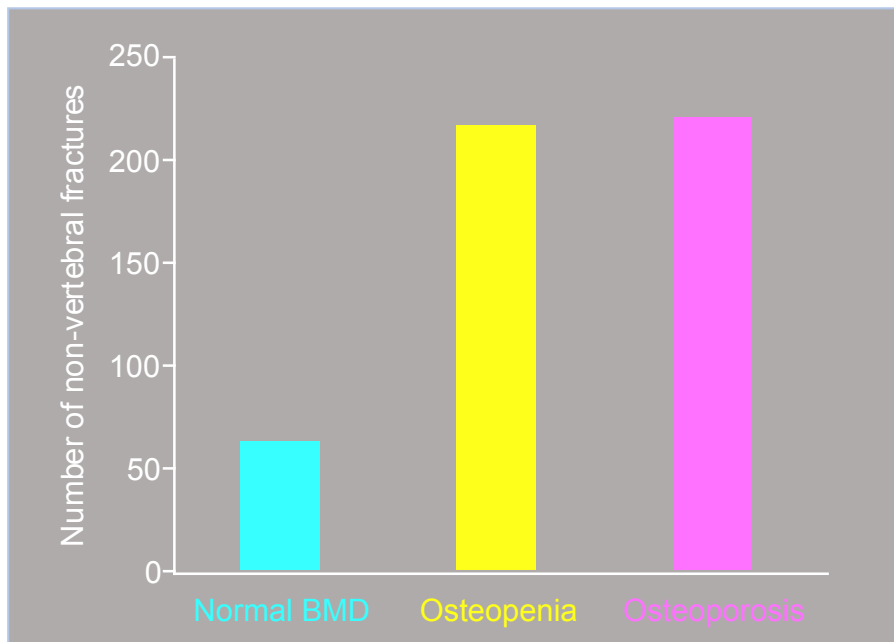
“.... a BMD that lies 2.5 standard deviations or more below the average value for young healthy women (a T-score of ≤ -2.5 SD).”



We Cannot Just Use a T-score For Diagnosis

Majority of “osteoporosis-related” fractures occur in those with a T-score better than -2.5

T-score \leq -2.5 identifies < half of women & ~20% of men who sustain “osteoporosis-related” fracture



5794 participants in the Rotterdam study;
Mean follow-up 6.8 years
FN BMD at baseline
(Female data shown here)

Adapted from Schuit, Bone, 2004; 34:195-202

Fracture Occurrence Also Defines Osteoporosis

“Hip, vertebral, and/or forearm fractures are consistent with osteoporosis (unless excluded by clinical evaluation and imaging)”

Leboff, et. al., Osteoporos Int, 2022; 33:2049-2102

“The diagnosis of osteoporosis can be established if a low-traumatic vertebral or proximal femur fracture is present (independent of BMD).”

Payer, et. al, Osteoporosis standard diagnostic & therapeutic procedures, 1st revision, 15 Nov, 2023; www.clinicalosteology.org

European postmenopausal osteoporosis 2019 Guidance defines osteoporosis by BMD Criteria; However it does state:

“Women aged over 65 years with a prior fragility fracture can be considered for treatment without the need for further assessment.”

Kanis, et. al., Osteoporos Int, 2022; 33:2049-2102

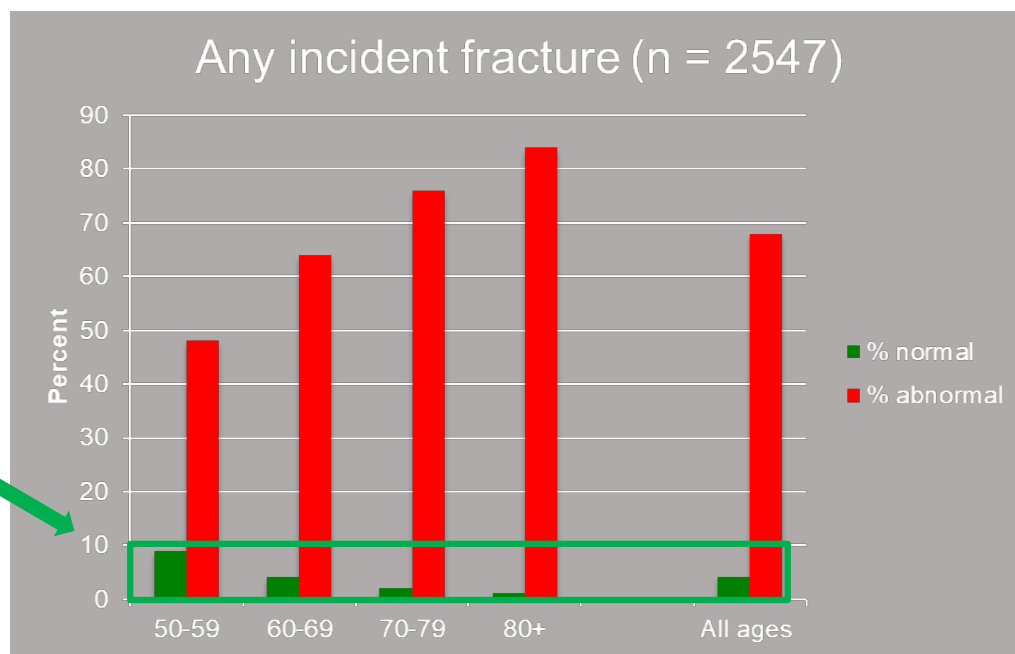
Diagnosing Osteoporosis Based on Fracture is Appropriate; the Bone is Almost Always Abnormal

Considering BMD and TBS (Manitoba data)

“Normal” bone defined as:

- T-score ≥ -1.0 AND
- TBS > 1.31

“Postmenopausal women with prevalent or incident fracture rarely have normal bone when both BMD and TBS are considered.”



Binkley, et. al, Osteoporos Int, 2020; 31:2337-2344

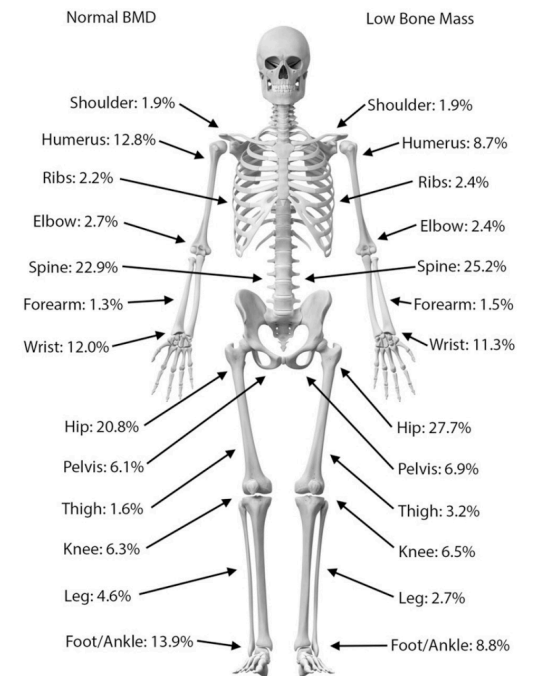
I find Orthopedic surgeons (and clinicians in general) to be uncertain regarding intervention when patients fracture with “normal BMD”

But fracture with normal BMD by DXA is common

- 7,219 patients age 50+ with fracture and DXA data in American Orthopaedic Association’s Own the Bone registry
- BMD classified by WHO T-score criteria
- Mean (SD) age 71 (9.8) years
- **Normal BMD in 8.6% of patients**
- Fracture distribution not different if BMD low or normal
- FRAX without BMD met Rx criteria in 73%

“Fractures in adults who are ≥ 50 years of age should be considered sentinel events warranting further evaluation”

Fracture in Patients with Normal Bone Mineral Density
An Evaluation of the American Orthopaedic Association’s Own the Bone Registry



Appreciate that “Normal BMD” by DXA (i.e., a T-score Better than -1.0) Does Not Mean “Normal Bone” or “No Bone Loss”

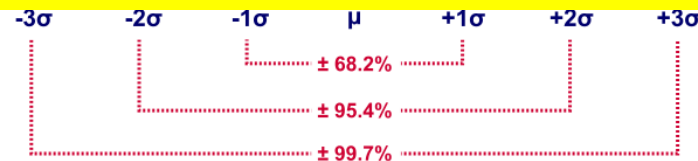
The WHO T-score approach compares with average young normal
Half of us are above (and half are below) average

Standard Normal Distribution

$\mu=0 | \sigma=1$

One T-score, i.e., SD, is ~10%

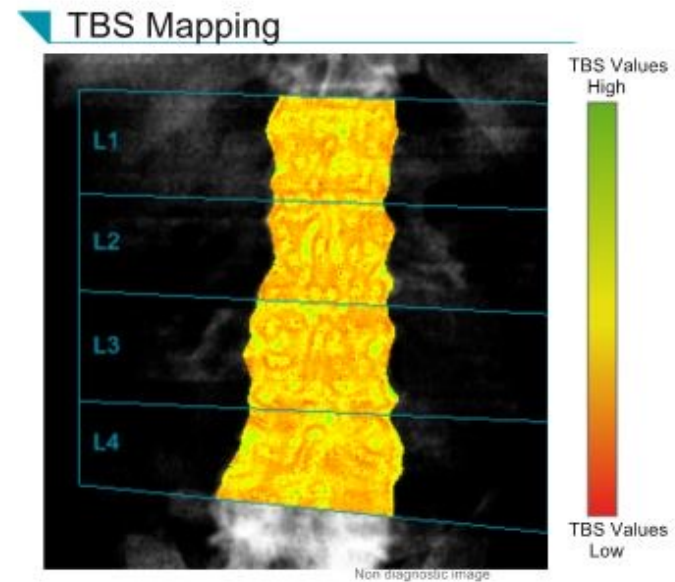
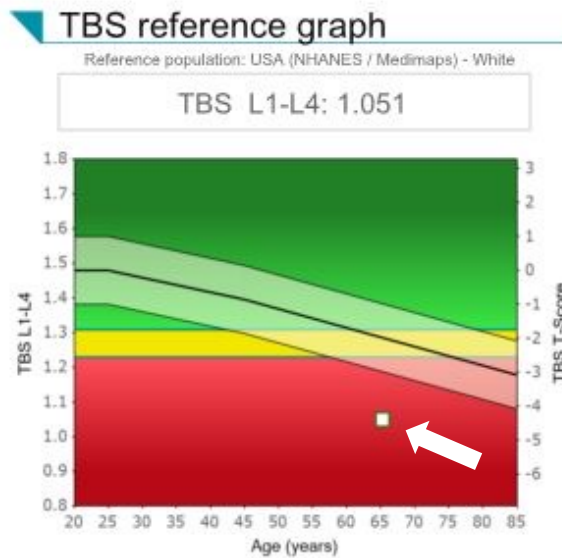
A person starting at +2 can lose ~30% and still have a “normal” T-score but almost certainly not normal microarchitecture



Example of a Woman With Fracture and Normal BMD by DXA

SPINE TBS REPORT

Yo



al;

Osteoporosis Can Also be Diagnosed by Elevated Fracture Risk

POSITION PAPER

The clinical diagnosis of osteoporosis: a position statement from the National Bone Health Alliance Working Group

E. S. Siris · R. Adler · J. Bilezikian · M. Bolognese · B. Dawson-Hughes · M. J. Favus · S. T. Harris · S. M. Jan de Beur · S. Khosla · N. E. Lane · R. Lindsay · A. D. Nana · E. S. Orwoll · K. Saag · S. Silverman · N. B. Watts

“...if the clinical diagnosis is limited to a T-score diagnosis, a great many patients at risk for fractures will have their risk go unrecognized.”

“The group recommends that postmenopausal women and men aged 50 years should be diagnosed with osteoporosis if they have a demonstrable elevated risk for future fractures.”

Siris, et. al, Osteoporos Int; 2012, 23:2093-2097
Siris, et. al., Osteoporos Int; 2014, 25:1439-1443

FRAX® Fracture Risk Assessment Tool

Home Calculation Tool Paper Charts FAQ References CE Mark English

Calculation Tool

Please answer the questions below to calculate the ten year probability of fracture with BMD.

Country: Czech Republic Name/ID: About the risk factors

Questionnaire:

- Age (between 40 and 90 years) or Date of Birth: [Date of Birth]
- Sex: Male Female
- Weight (kg): 65.8
- Height (cm): 167.6
- Previous Fracture: No Yes
- Parent Fractured Hip: No Yes
- Current Smoking: No Yes
- Glucocorticoids: No Yes
- Rheumatoid arthritis: No Yes
- Secondary osteoporosis: No Yes
- Alcohol 3 or more units/day: No Yes
- Femoral neck BMD (g/cm²): [T-Score: -2.2]

Clear Calculate

BMI: 23.4
The ten year probability of fracture (%)

Major osteoporosis: 11
Hip Fracture: 17

If you have a TBS value, click here: [Adjust with TBS](#)

Weight Conversion: Pounds kg, 145 Convert

Height Conversion: Inches cm, 66 Convert

00255223
Individuals with fracture risk assessed since 1st June 2011

Practically, “demonstrable elevated risk” is FRAX

FRAX® Fracture Risk Assessment Tool

Home Calculation Tool Paper Charts FAQ References CE Mark English

Calculation Tool

Please answer the questions below to calculate the ten year probability of fracture with BMD.

Country: Slovakia Name/ID: About the risk factors

Questionnaire:

- Age (between 40 and 90 years) or Date of Birth: [Date of Birth]
- Sex: Male Female
- Weight (kg): 65.8
- Height (cm): 167.6
- Previous Fracture: No Yes
- Parent Fractured Hip: No Yes
- Current Smoking: No Yes
- Glucocorticoids: No Yes
- Rheumatoid arthritis: No Yes
- Secondary osteoporosis: No Yes
- Alcohol 3 or more units/day: No Yes
- Femoral neck BMD (g/cm²): [T-Score: -2.2]

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If you have a TBS value, click here: [Adjust with TBS](#)

Weight Conversion: Pounds kg, 145 Convert

Height Conversion: Inches cm, 66 Convert

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Individuals with fracture risk assessed since 1st June 2011

We Should be Diagnosing “Clinical Osteoporosis”

(The diagnosis of osteoporosis does not require a T-score of ≤ -2.5)

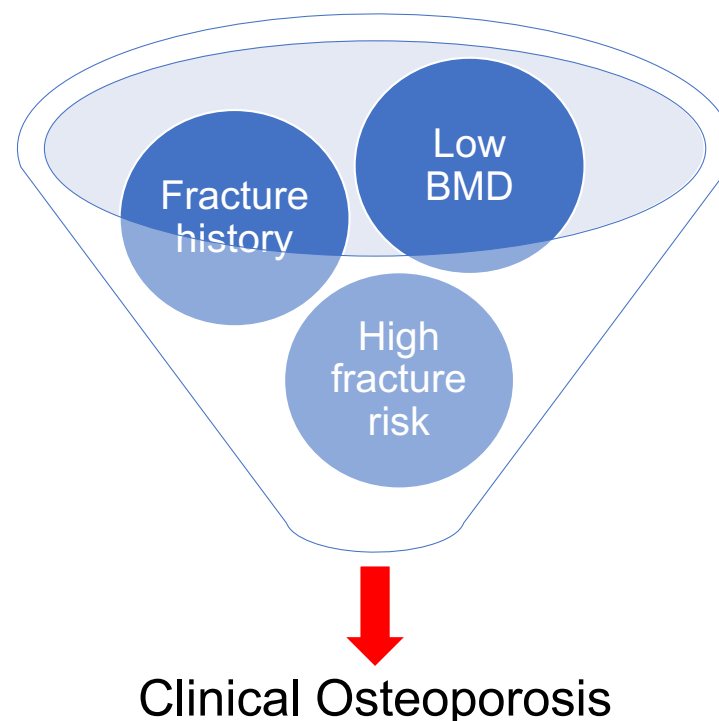
Personal opinion

Clinical osteoporosis is:

- Prior fracture; very few have normal bone
- Elevated fracture risk (MOF $\geq 20\%$) or country specific guidance
- Lowest T-score ≤ -2.5

Importantly for FLS programs

Fracture occurrence = diagnosis of osteoporosis



EDITORIAL

Doctors won't treat patients for conditions they don't have

Ian R. Reid¹ 

This Opinion is Shared by Others

Doctors can apply the diagnosis of osteoporosis
*“to a wide range of individuals whose fracture risk
is elevated from whatever cause.”*

Reid, Osteoporos Int, 2023;34: 11-13

Diagnosing clinical osteoporosis is important;
logical that doctors will not treat,
but also patients will not accept therapy
for a disease that they “don't have”

Personal opinion

Another Major Reason for Not Treating Osteoporosis is that “We” Have Not Adequately Emphasized the Effect of Fracture on Independence and Quality of Life

Personal opinion

“I will just have the Orthopaedic surgeon fix the broken bone and everything will be fine.”

We all know the impact of fractures on mobility, quality of life and independence

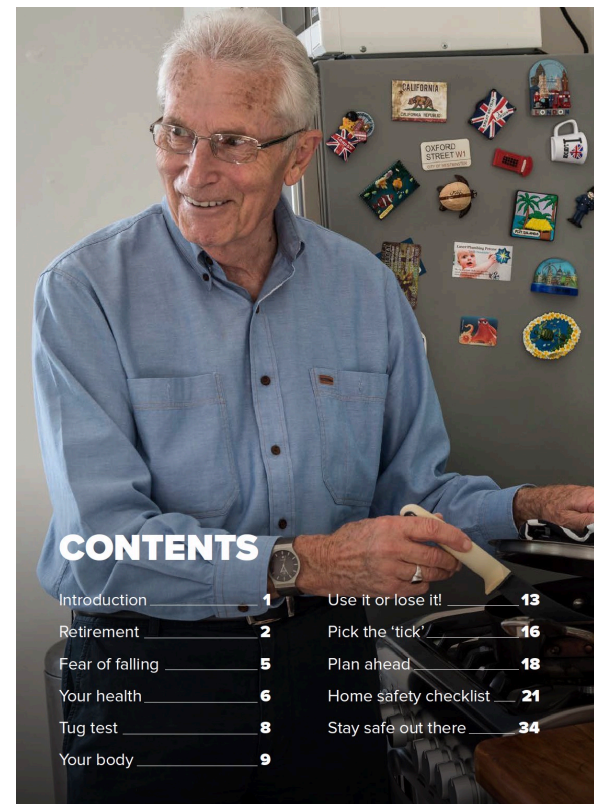
The Reason to Care About Osteoporosis in Orthopedic Patients (And All Others) is Maintaining Independence

A superb resource from New Zealand

Personal opinion



WWW.LIVESTRONGER.ORG.NZ



Google "love your Independence"

www.livestronger.org.nz/assets/Uploads/Love-your-independence-resources/acc7745-love-your-independence.pdf

Why Should Orthopedic Surgeons Care About Osteoporosis?

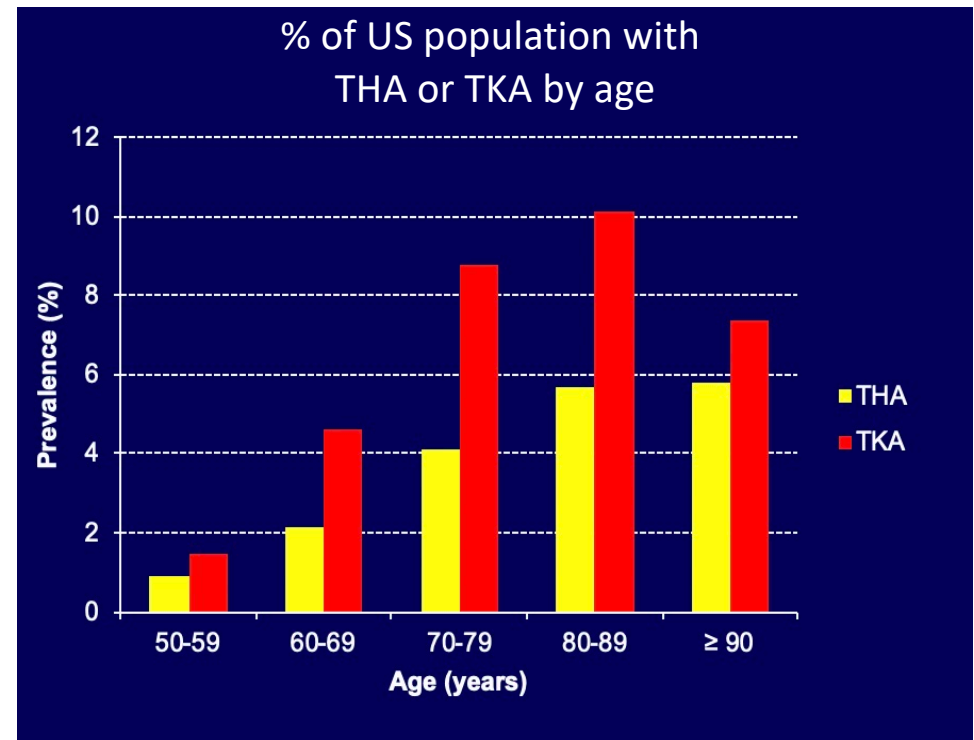
- Common in elective Orthopedic patients
- Poorer post-operative outcomes
 - Implant subsidence
 - Need for revision surgery
 - Periprosthetic fracture
 - Intraoperative and postoperative
- Correction mitigates these negative effects

THA and TKA Are Extremely Common Today

US Data

- > 1 million annually in US
- Due to population aging and greater demand for improved mobility with attendant quality of life
- ~ 7 million in US who have previously had either THA or TKA
- ~1 in 8 over age 70 have had TKA

> 3.1 million total hip arthroplasties &
> 2.5 million total knee arthroplasties
performed annually in Europe

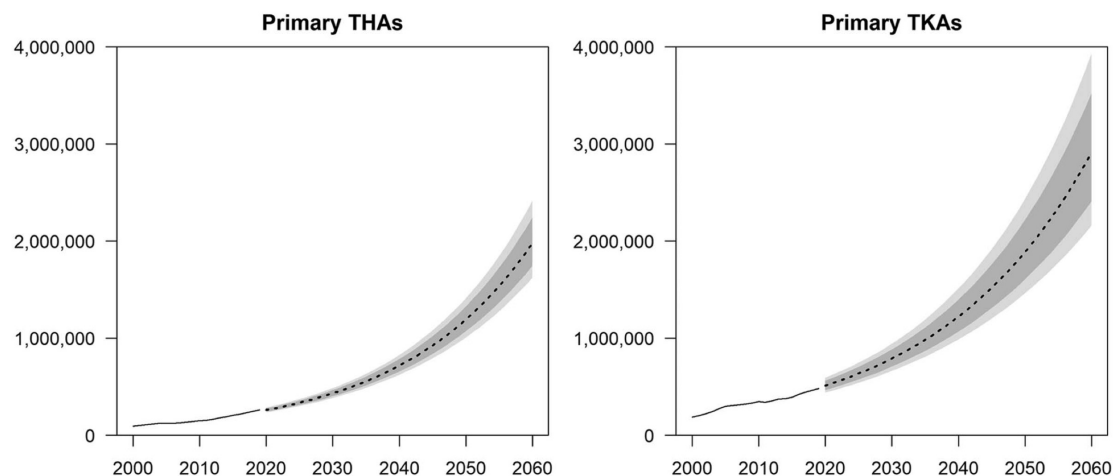


From Kremers, et. al., J Bone Joint Surg Am, 2015; 97:1386-97

TKA and THA Projected to Increase

Reflects demand for increased mobility and increasing life expectancy

- US CMS (Medicare) data
- Primary TKA/THA 2000-2019
 - TKA increased 156%
 - THA increased 177%
- Estimated # in 2040
 - TKA ~1,200,000
 - THA ~720,000
- Estimated # in 2060
 - TKA ~2,920,000
 - THA ~1,980,000



*“Our model forecasts an increase in THA procedures of 176% by 2040 and **659%** by 2060. The estimated increase for TKA is projected to be 139% by 2040 and **469%** by 2060.”*

Shichman, et. al., JBJS Open Access, 2023:e22.00112.
<http://dx.doi.org/10.2106/JBJS.OA.22.00112>

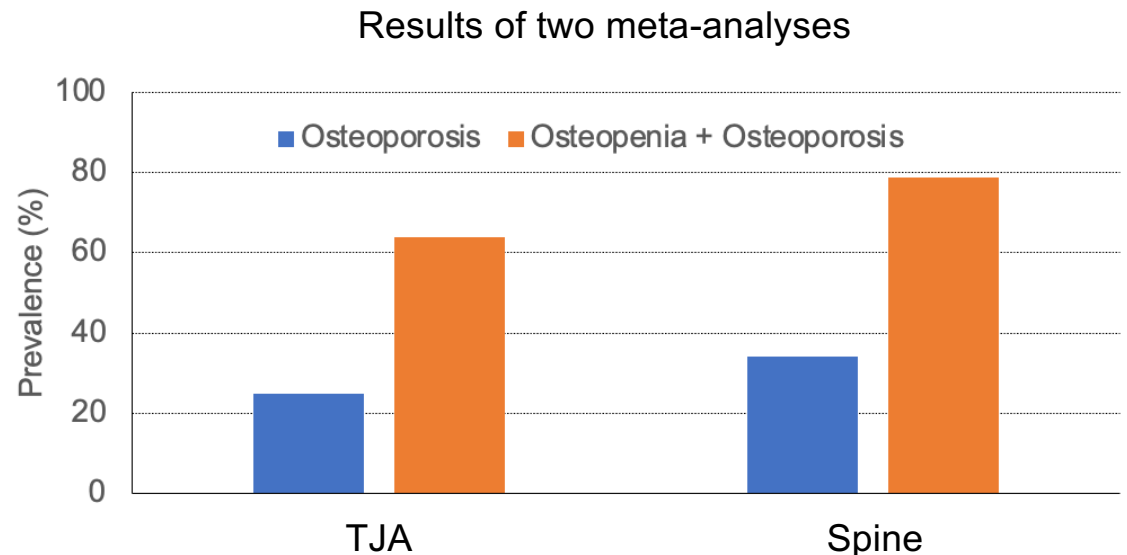
Osteoporosis (by BMD) is Common in Arthroplasty Patients

Prevalence and treatment rate of osteoporosis in patients undergoing total knee and hip arthroplasty: a systematic review and meta-analysis

- Evaluated prevalence of osteoporosis/penia in TJA patients
- 11 studies; n = 3462 patients; 3095 F/367M

Prevalence of osteoporosis in spinal surgery patients older than 50 years: A systematic review and meta-analysis

- Evaluated prevalence of osteoporosis/penia in spine surgery patients age 50+
- 10 studies; n = 2958 patients; 1,764 F/1,194M



Xiao, et. al., Arch Osteoporos; 2022, 17:16-
Fan, et. al., PLoS One; 2023, 18:e0286110

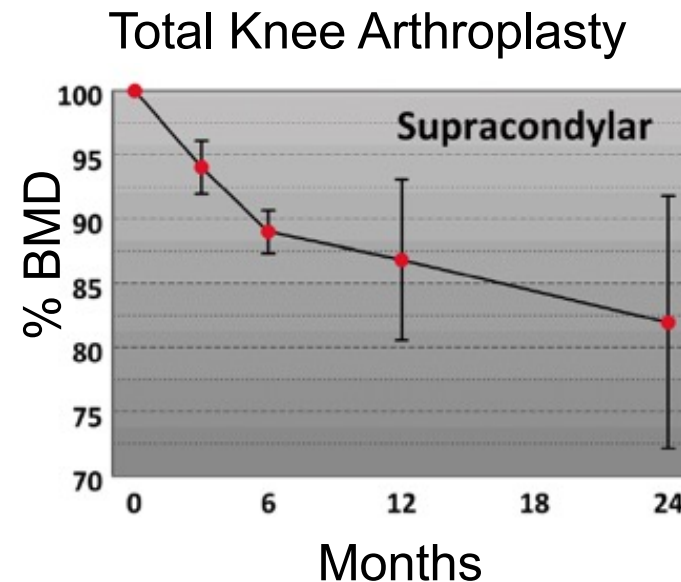
Osteoporosis in ~1/4th to 1/3rd
Low BMD (osteoporosis + osteopenia in 60-80%)

Arthroplasty May Cause Local Bone Loss

- Creates a local inflammatory state
- Cytokine production
- Osteoclast activation
- Regional bone loss
- Logical that this increases future fracture risk
- We can (should) be measuring distal femur BMD

Changes in femoral bone mineral density after total knee arthroplasty: a systematic review and meta-analysis

Joel M. Prince¹ · James T. Bernatz¹ · Neil Binkley² · Matthew P. Abdel³ · Paul A. Anderson¹

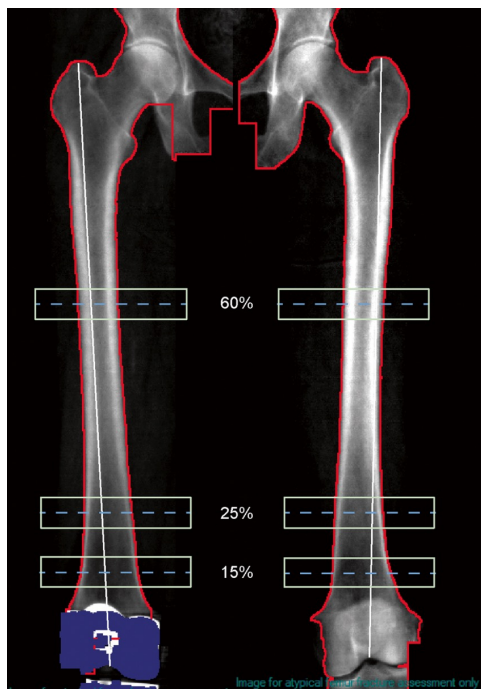


~15-18% distal femur BMD decline after TKA

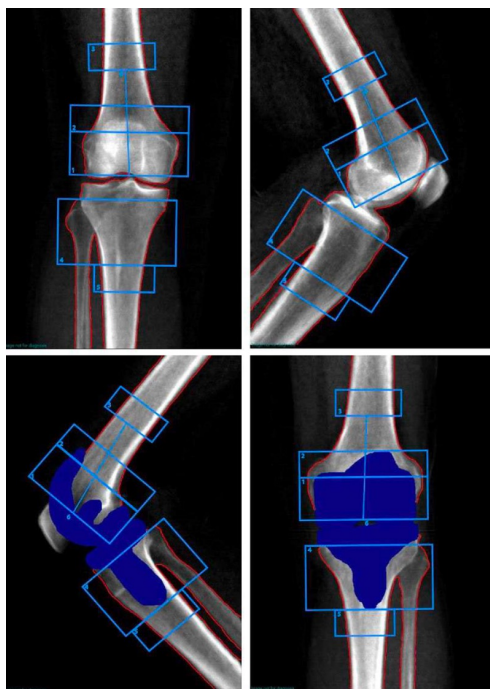
From Prince, et. al, Arch Osteoporos, 2019;14:23-

BMD Can be Measured at Arthroplasty Sites With DXA

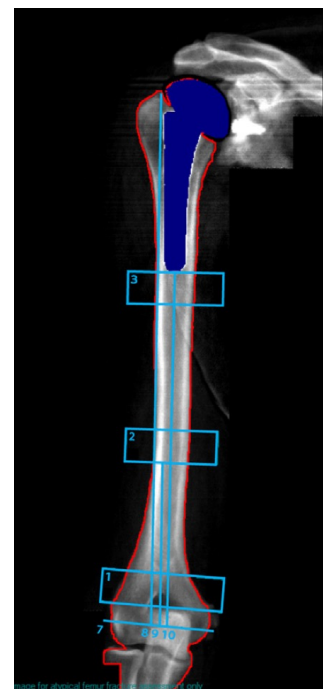
We should be doing this



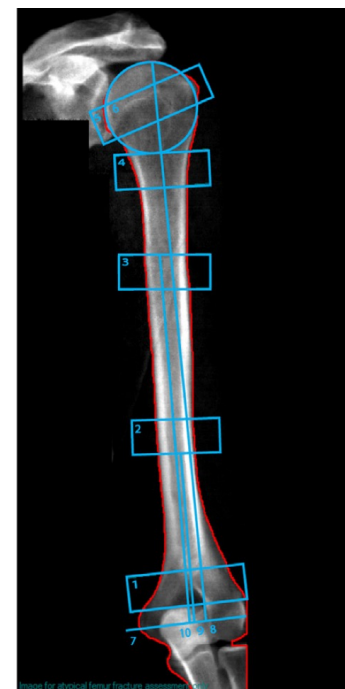
Blaty, et. al, Osteoporos Int, 2019; 30:383–390



Andersen, et. al., ISCD Ann Meeting, 2023



Andersen, et. al, J Clin Densitom, 2022;448-455



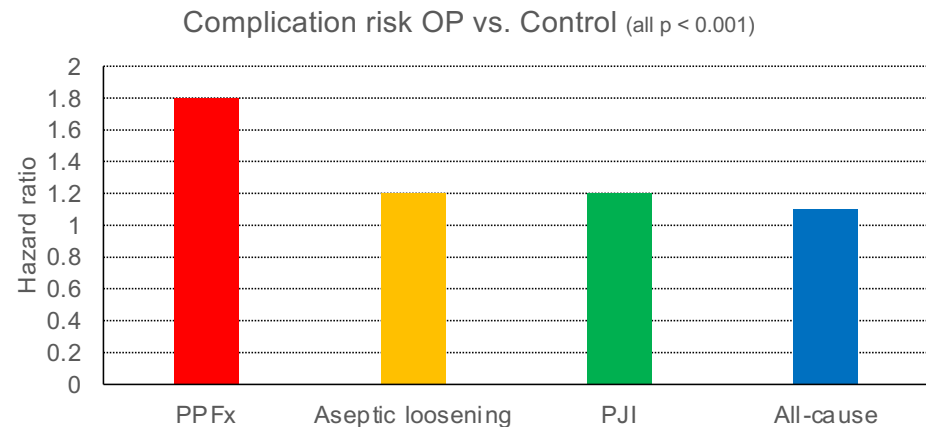
Plausible that BMD is lower at surgical site (“localized disuse osteoporosis”)

Logical that knowledge of this would influence surgical decision-making

Personal opinion

Osteoporosis Increases Adverse Consequences after TKA

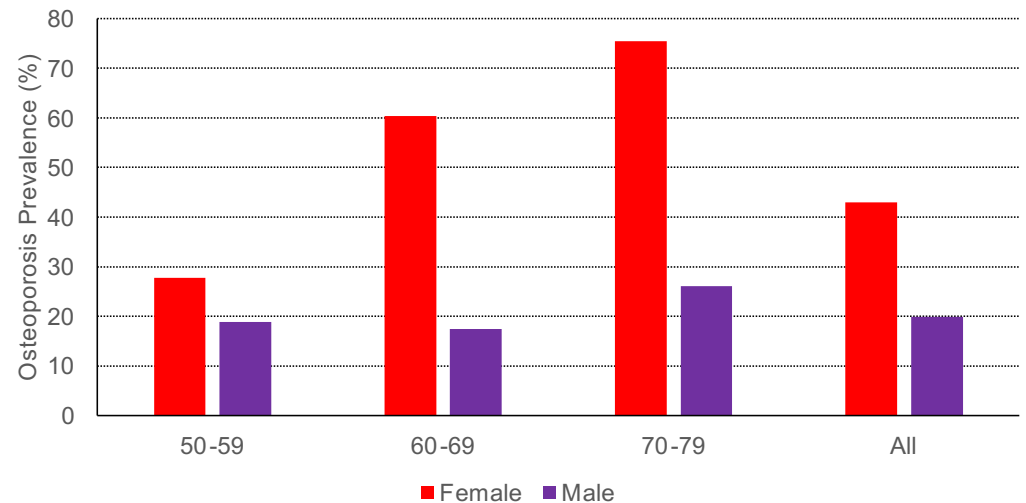
- Administrative claims database from 2010-2021
- 418,054 patients with primary TKA
- 41,760 had diagnosis of OP
- 5-year incidence of revision surgery for PPFx, aseptic loosening, periprosthetic joint infection and all causes



“Patients who had osteoporosis have a nearly 2-fold increased risk of 5-year revision for PPFs and mildly increased risk of revision for all causes, aseptic loosening and PJI.”

Osteoporosis is Common in Spine Surgery Patients

- Meta-analysis; n = 2,958 (1,764 F, 1,194 M); 8 countries
- Age ≥ 50 ; mean age in individual studies from 60.9 to 71.2 years
- BMD by DXA; WHO criteria used
- **Osteoporosis in ~40% F/~20% M**
 - Increases with advancing age



“Our results showed a high prevalence of osteoporosis in patients undergoing spine surgery, especially in females and people of older age..... Current osteoporosis screening standards for patients undergoing spine surgery may not be adequate. Orthopedic specialists should make more efforts regarding preoperative osteoporosis screening and treatment.”

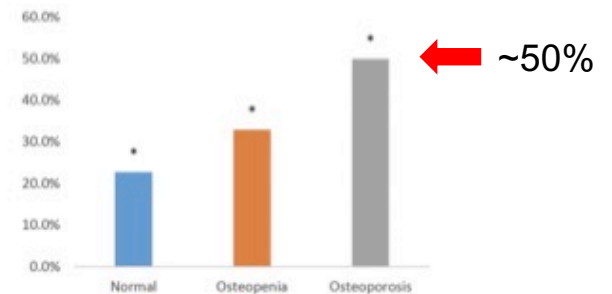
Incidence of Osteoporosis-Related Complications Following Posterior Lumbar Fusion

Osteoporosis Has Adverse Consequences After Spine Surgery

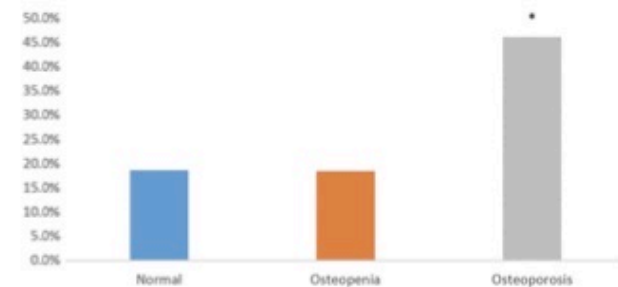
- 140 spine fusions; Dx WHO criteria
- Osteoporosis related Complications
 - Kyphosis
 - Pseudarthrosis
 - Fractures
 - Hardware failure

“Based on our experience, we would urge surgeons to recognize that there is an increased prevalence of complications in patients with low bone density and treat accordingly.”

Osteoporosis-related complications



Non-union



The Most Catastrophic Outcome of Osteoporosis in Arthroplasty Patients is Periprosthetic Fracture

Defined: intra- or post-operative fracture associated with an orthopedic implant (TJA or any other internal fixation device)

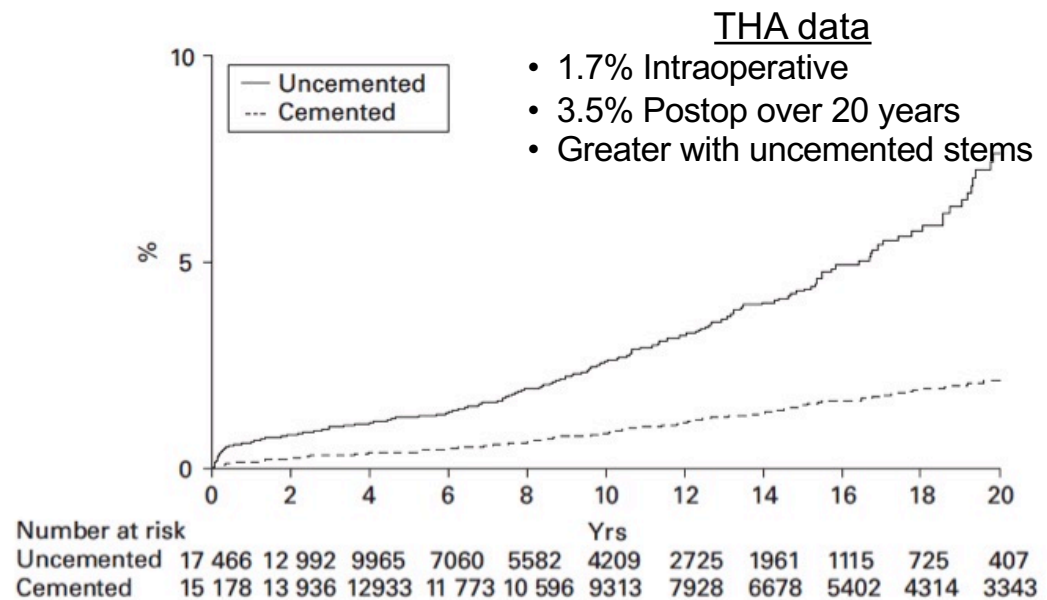
Capone, et. al., Clin Cases Miner Bone Metab 2017;14:189–96



“These are almost unputbacktogetherable.”

Periprosthetic Fractures Are Not Rare and Risk Rises Over Time

- THA: incidence variable from **0.1-18%**
 - Greater with revision arthroplasty
- Time from implant widely variable
 - Mean 25-70 months reported
- TKA: Incidence **0.3% to 5.5%** for primary TKA
 - Up to **30%** for revision
- TSA: Rate of humeral fractures (intra- and post-op) from **1.2% to 19.4%**



Della Rocca, et. al., J Orthop Trauma 2011; 25:S66–S70

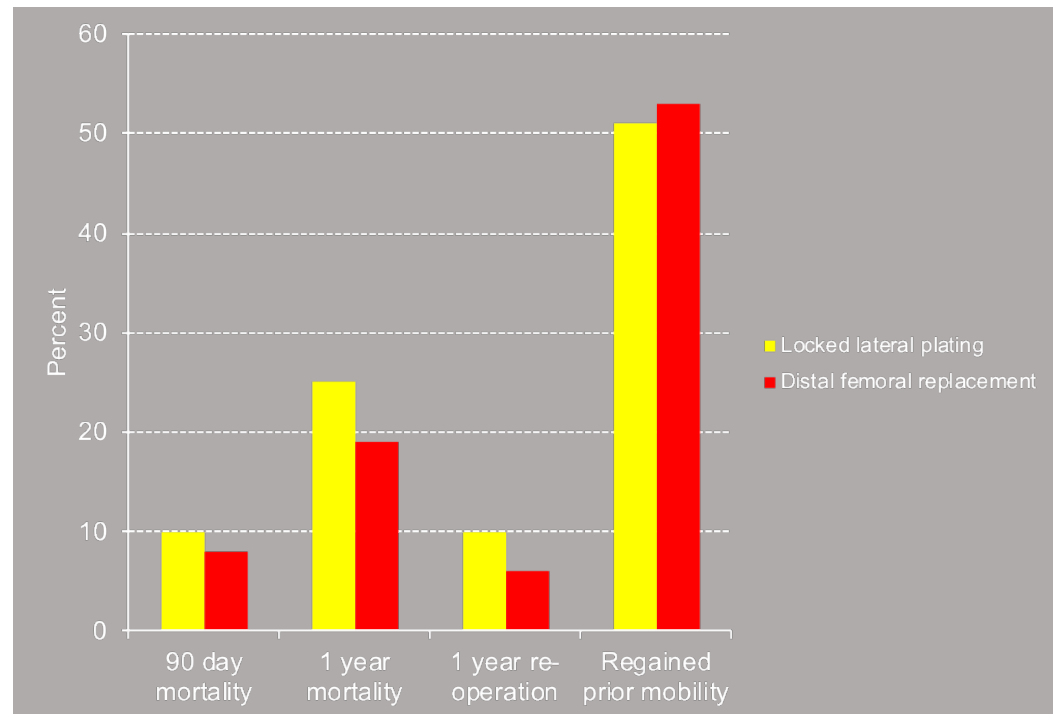
Canton, et. al., Acta Biomed 2017; 88:118-128

Abdel, et. al., Bone Joint J 2016; 98-B: 461–7

Fram, et. al., JBJS Reviews, 2019; 7:e6, doi.org/10.2106/JBJS.RVW.19.00017

Morbidity and Mortality of Periprosthetic Femur Fracture Comparable to Classic Hip Fracture

- Retrospective chart review of patients with distal femur periprosthetic fracture
 - 87 lateral locking plate
 - 53 distal femur replacement



20+% 1 year mortality; only ~half regain prior mobility

Open access

Original research

BMJ Open Periprosthetic fractures: the next fragility fracture epidemic? A national observational study

“The Next Fragility Fracture Epidemic”

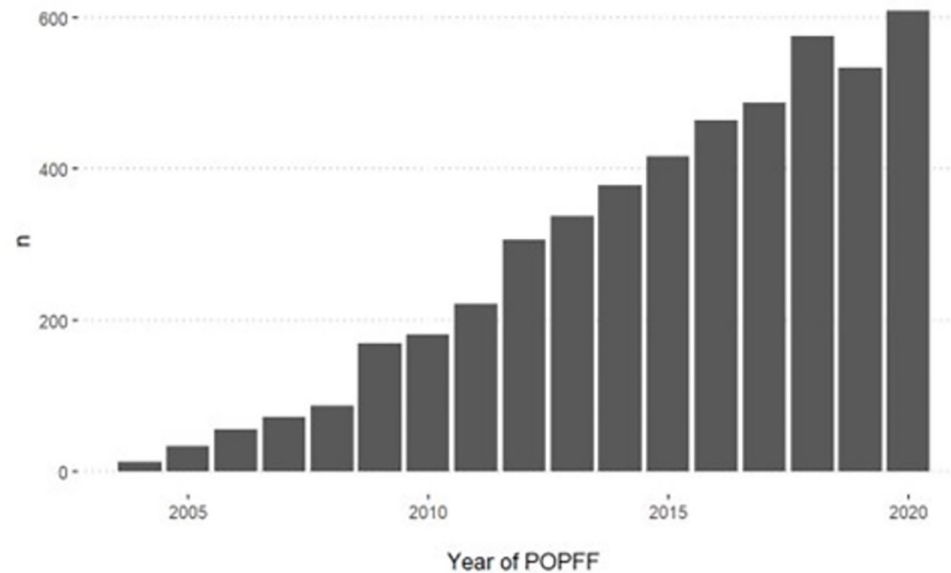
- Observational study in UK

Annual Periprosthetic Fracture Admissions

- Authors did not specifically call these osteoporotic fractures, but:
“The clinical and operational burden of periprosthetic fractures is considerable and increasing rapidly. We suggest that the management of people with periprosthetic fractures should be undertaken and funded in a similar manner to that successfully employed for people sustaining hip fractures.”

Adapted from Bottle, BMJ Open: 2020;10:e042371. doi: 10.1136/bmjopen-2020-042371

Very Recent UK Database Results Document Ongoing Increase in POPFx



“We observed that POPFF is the largest reason for major reoperation following THR and patients sustaining these injuries have a high risk of death. (15% 1-year mortality)

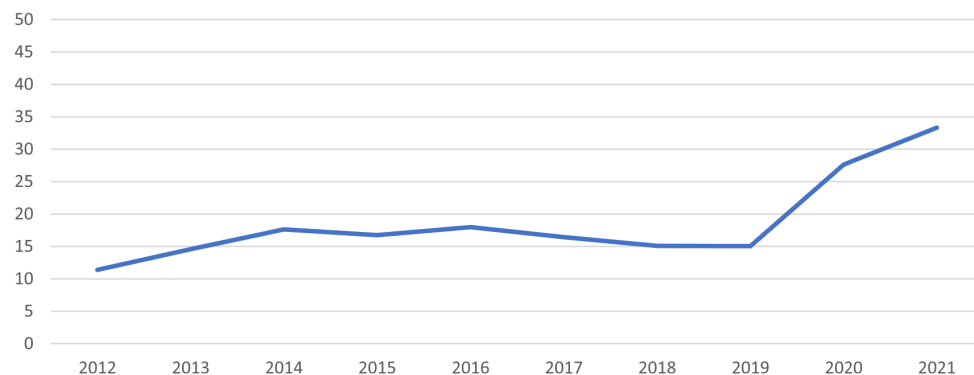
From Lamb, et al., PLoS Med 21; 2024: e1004462. <https://doi.org/10.1371/journal.pmed.1004462>

Periprosthetic Fractures: A Rising Tide of Hip Arthroplasty Failure Noted in the American Joint Replacement Registry and the Preventative Role of Cemented Stems

PPFx Also Increasing in US

- Data from American Joint Replacement Registry
- THAs 2012-2021 age 65+
- Compared fixation type on all cause revision and PPFx
- Cement utilization low but increased from 4.4% to 8.3%

Incidence of THA failure due to PPFx tripled from 2012 to 2021 (11% to 33%)



“Periprosthetic fracture is becoming a leading mode of THA failure in the US. Cemented stems are protective against this failure mode, but they continue to be consistently underutilized by arthroplasty surgeons.”

From Sassoon, et al., J Arthroplasty; 2024: S454-S458

Are Periprosthetic Fractures “Osteoporosis-related?”



“Isn’t it simply that these people have a metal implant that breaks even normal bone if/when they fall?”

Periprosthetic fractures are osteoporotic fractures: missed opportunities for osteoporosis diagnosis

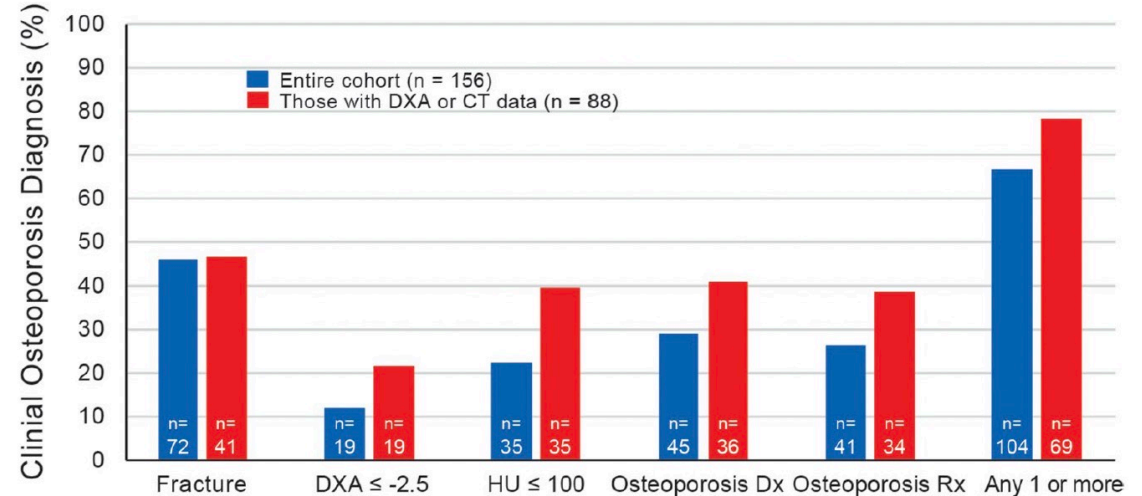
Paul S. Whiting¹ · Kristyn Hare¹ · Diane Krueger² · Gretta Borchard² · Kristina Parvanta-Johnson¹ · James Bernatz¹ · Neil Binkley² · Paul A. Anderson¹

- 156 ppfx patients; 74% F
- Mean age 75 (11.9) yrs
- Mean time post arthroplasty 7.9 (6.3) yrs
- **Falls caused 139 (89%)**
- **12 (8%) spontaneous**
- Based on data existing in EMR prior to fracture, **OP** could have been **diagnosed** in 67%
 - **78%** in those with data

Periprosthetic Fractures Are Osteoporosis-related

and we miss opportunities to diagnose

UW data



“Periprosthetic fractures are osteoporosis-related.”

Systemic Osteoporosis and Osteopenia Among Periprosthetic Fractures After Total Hip Arthroplasty

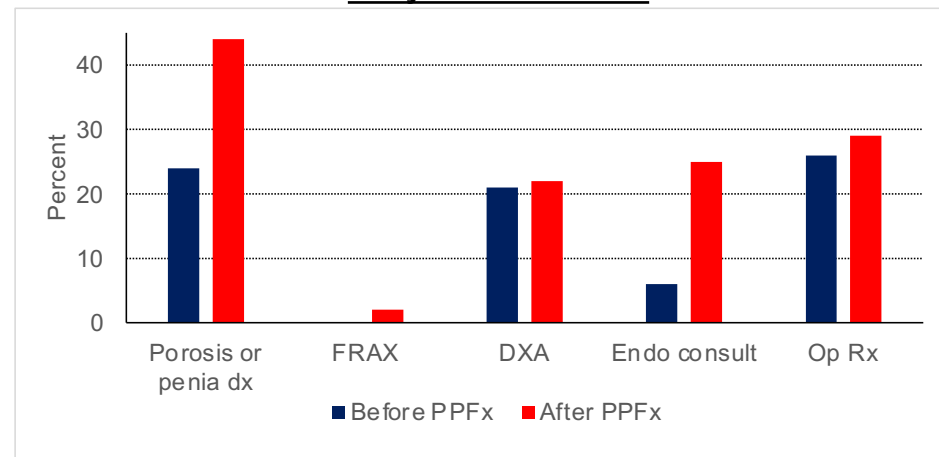
Michael W. Seward, MD^a, Charles P. Hannon, MD, MBA^a, Brandon J. Yuan, MD^a, Ann E. Kearns, MD, PhD^b, Paul A. Anderson, MD^c, Daniel J. Berry, MD^a, Matthew P. Abdel, MD^{a,*}

- 133 PPFx patients; prior THA for hip fracture
- Mean age 75 yrs, 50% F
- **Falls caused 94%**
- Use of age-appropriate BMD testing and fracture risk assessment tools, osteoporosis diagnosis and osteoporosis medication use severely lacking

Periprosthetic Fractures Are Osteoporosis-related

But the PPFx does not markedly increase Dx or Rx

Mayo clinic data



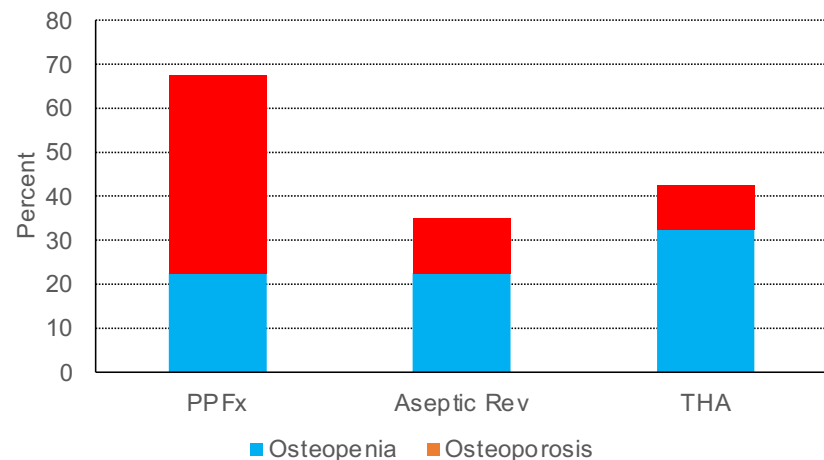
“Although most periprosthetic fractures following THA are fragility fractures that qualify patients for osteoporosis diagnoses, there remain major gaps in diagnosis, screening, endocrinology follow-up, and treatment.”

Seward, et. al., J Arthroplast, 2024; 39:2621-2626

Patients with Periprosthetic Femoral Hip Fractures are Commonly Classified as Having Osteoporosis Based on DXA Measurements

- 40 PPFx patients
- Compared with primary THA and aseptic revision cohorts
- DXA at spine/hip
 - Note: no other consideration of an “osteoporosis” diagnosis based on prior fracture, FRAX or BMD at radius (These data underestimate prevalence)

More Evidence that PPFx are Osteoporotic Fractures



“almost half of the patients with periprosthetic femoral hip fractures have osteoporosis according to DXA measurements.”

Ritter, et. al., Calcif Tissue Int, 2024; 115:142–149

Editorial

Is a periprosthetic fracture a fragility fracture like another?

Periprosthetic Fractures Are Osteoporosis-related

“Back to the main question, ‘Is a periprosthetic fracture a fragility fracture like another?’

*The answer is **no** because **PPF** is a fragility fracture but not like another, because current osteoporosis guidelines remain silent on **PPF** despite its catastrophic nature. Furthermore, in terms of osteoporosis management, these fractures provide an opportunity to optimize bone health before and/or after orthopedic surgery and arthroplasty.”*

“For fracture liaison services, patients with PPFx should be considered as fragility fractures”

Houel, et. al., Joint Bone Spine, epub ahead of print, 2025; 92:105802

Example of Multiple Missed Opportunities to Diagnose and Treat Osteoporosis

75 yo generally healthy female; presents to ER after a fall

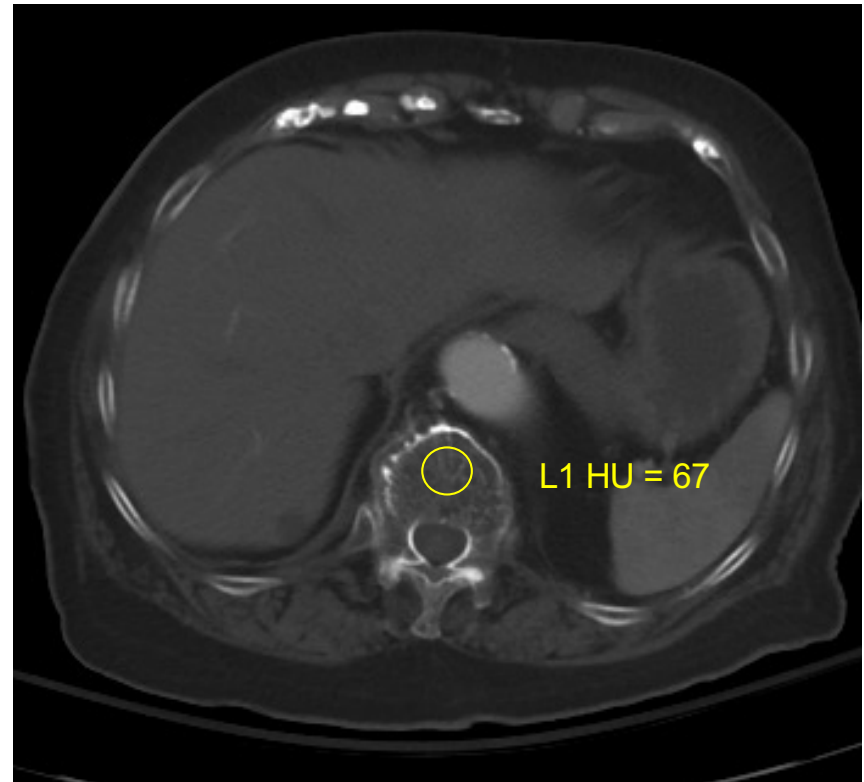
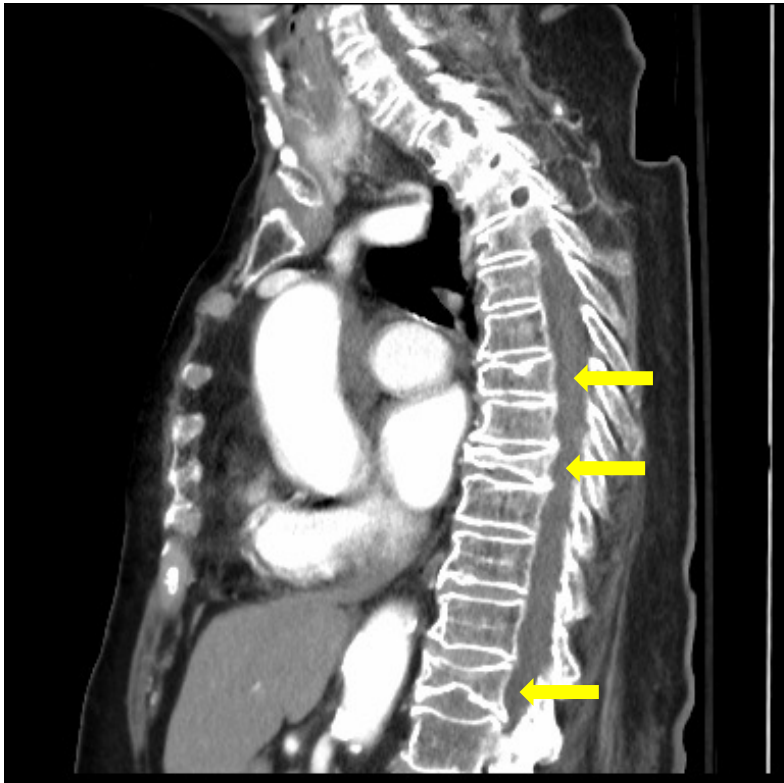
- Left THA – 12 years prior
- Prior radius & ulna fractures – 13 years prior
- DXA – 13 years prior
 - Femoral neck T-score -3.0
 - Refused osteoporosis medications because the fracture was “*caused by a fall*”
- Humerus fracture 11 years prior with a fall
 - No history of vertebral fracture
- Never received osteoporosis treatment
 - Never had “the usual” bone lab evaluation



Yet Another Opportunity to Diagnose Osteoporosis:

She had an abdominal CT 5 years before periprosthetic fracture

At that time had multiple vertebral fractures and low Hounsfield Units



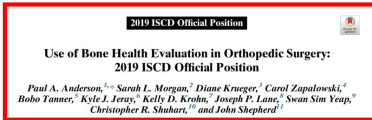
Opportunistic CT is Often Helpful in Ortho Patients

Personal opinion

“Opportunistic screening denotes the use of diagnostic CT scans to screen for patients at high (and potentially also for low) fracture risk.”

Engelke, et al., J Clin Densitom, 2015; 18: 393-407

Opportunistic CT is quick, free, requires no additional testing and no additional radiation exposure



HU Measured by Op CT Detects Age-related Decline & Predicts Fractures

- Extensive literature review conducted for the ISCD 2019 Position Development Conference evaluated potential HU cutpoints and concluded:
- *“Opportunistic CT-based attenuation using Hounsfield Units (HU) can be used to estimate the likelihood of osteoporosis (L1 HU < 100) and normal (L1 HU > 150) bone density to support decisions regarding bone health assessment.”*

Anderson, et al., J Clin Densitom, 2019; 22: 517-543

150 and 100 HU are easy to remember and are what I use clinically

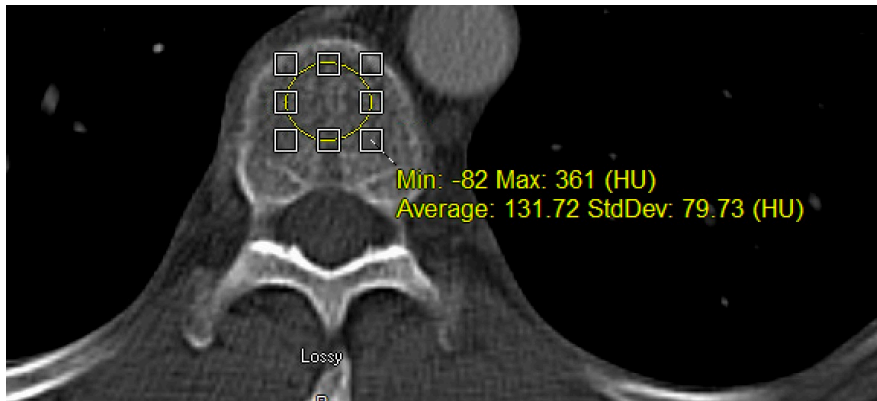
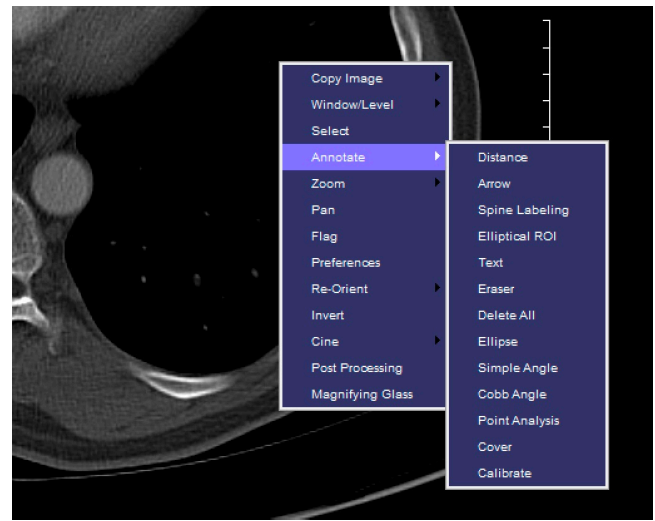
Opportunistic CT is Easy to Do Clinically

Snap... Chart Review PACS Legacy-Index

CT Abdomen,Chest,Pelvis CT CHEST ABDOMEN PELVIS W IV CONTRAST

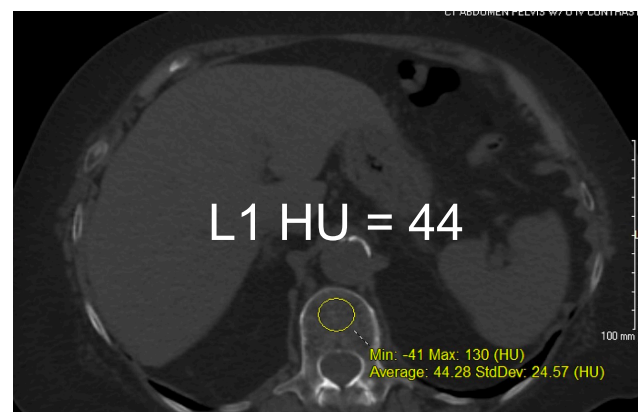
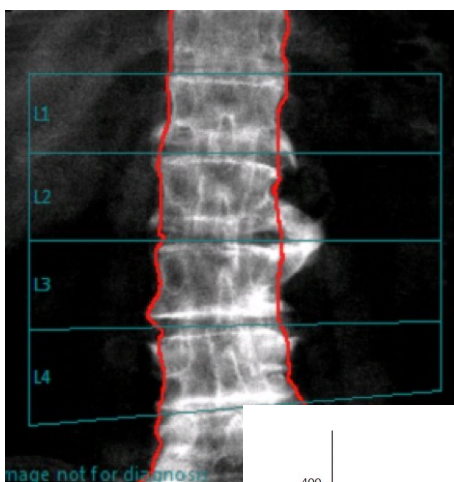


LUNG
kV: 120.00
mA: 69
Tilt: 0.00
Rec Diam 445.00
Slice:5.00 Loc:-193.25



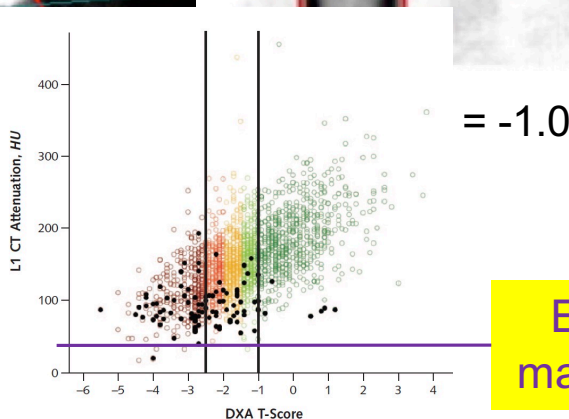
Example of the importance of opportunistic CT: 67 yo female; neurogenic claudication; multi-level spine fusion advised

No clinical risk factors: Does she need bone meds pre- or post-op?

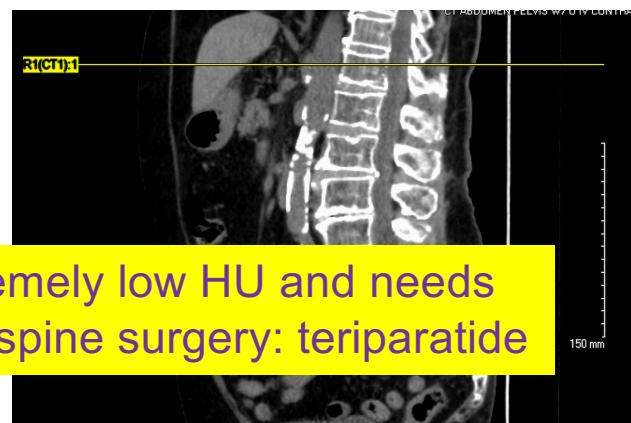


L1-4 T-scc

B
T
W
M
H



Extremely low HU and needs major spine surgery: teriparatide



It Is Logical That Bone Be Optimized Prior to Elective Orthopedic Surgery

2017 AAHKS Annual Meeting Symposium
Choices, Compromises, and Controversies in Total Knee and Total Hip Arthroplasty Modifiable Risk Factors: What You Need to Know
Paul K. Edwards, MD ^{*}, Simon C. Mears, MD, PhD, Jeffrey B. Stambough, MD,
Sara E. Foster, PA-C, C. Lowry Barnes, MD

“.....modifiable risk factors are often not optimized before elective THA and TKA and may lead to increase risk of complications and early revisions after the index procedure.”

- Malnutrition
- Medication Use
- Diabetes
- Smoking
- Opioid Use
- Staph aureus colonization
- Depression, neurocognitive, etc

Why Not Optimize Bone Health Preoperatively?

“By following these guidelines, overall results of joint arthroplasty can be improved and poor outcomes mitigated.”

Edwards, et. al., J Arthroplasty, 33 (2018) 3101-3106

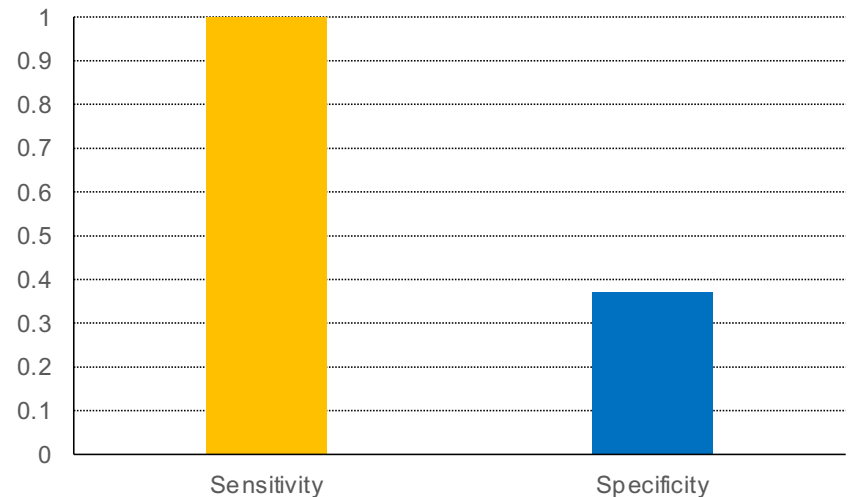
2019 ISCD Orthopedic Official Positions Recommend Bone Health Optimization

- Bone health assessment should be considered in patients prior to elective orthopedic and spine surgery
 - BMD should be measured in those meeting ISCD or regional indications for DXA testing
 - VFA should be considered in patients having spine surgery

Anderson, et. al., J Clin Densitom, 2019; 22:517-543

Effectiveness of Screening Protocol to Identify Who Needs DXA (Four Questions)

- Retrospective study of 100 elective TKA patients
- > 50 years; 68F/32 M; mean age 67
- Assessed US screening criteria;
 - Female ≥ 65
 - Male ≥ 70
 - Fracture history after age 50
 - FRAX MOF w/out BMD $\geq 8.4\%$
- Classified osteoporosis by BMD using clinical DXA



“A simple screening protocol identifies TKA patients who have T-score osteoporosis with high sensitivity.”

How Can Pre-operative Screening be Implemented?

“For preoperative screening, in patients ≥ 60 years, the FRAX[®] should be systematically performed prior to primary TJA and high-risk patients should receive DXA to allow appropriate treatment initiation.”

Houel, et. al., Joint Bone Spine, epub ahead of print, 2025; 92:105802

UW protocol: At the clinic visit in which a decision is made to proceed with elective Orthopedic surgery, BHO referral and DXA will be scheduled **IF:**

- Female age ≥ 65 ; Male age ≥ 70 years
- Any history of fracture after age 50 not from extreme trauma e.g., motor vehicle accident
- Existing diagnosis of osteoporosis or osteopenia not currently receiving treatment
- Radiographic osteopenia (in opinion of Orthopaedic surgeon)

DXA Ordered and History Reviewed by BHO team

If no history of Fx and BMD/TBS/VFA all normal, cancel referral,
if abnormal proceed with assessment

- Clinical evaluation will include nutritional assessment, falls and fracture history
- Laboratory/imaging evaluation individualized by BHO clinician, the following are obtained in all:
 - CBC, comprehensive metabolic panel, 25(OH)D, PTH, phosphorus
- DXA plus review of other imaging if/when available
- At this time, risk classification occurs

UW BHO Risk Stratification

Loosely based on 2020 AACE Guidelines*

Low risk/normal BMD, MOF < 20%, no prior fracture
Intermediate risk/osteopenia: Lowest T-score -2.4 or better, no prior fracture, MOF risk <20%

High risk/osteoporosis: Lowest T-score -2.5 to -3.0, recent fracture (within 2 years), MOF risk 20-30%

Very high risk/severe osteoporosis: Lowest T-score < -3.0 OR MOF risk > 30%/Hip fracture risk >4.5% OR recent fracture OR multiple prior fractures

*Camacho, et. al., Endocr Pract, 2020; 26(suppl 1), 1-44

UW BHO Treatment Recommendations Based on Risk Stratification

Low risk/normal BMD: Optimize calcium/vitamin D
and schedule surgery

High risk/osteoporosis: Optimize calcium/vitamin D,
prescribe antiresorber and schedule surgery

Very high risk/severe osteoporosis: Optimize
calcium/vitamin D, prescribe anabolic and consider
delay of surgery*

*Note: This is based on opinion

Surgical Delay For Optimization??

- Requirements for bone health
 - Strength
 - Healing potential
- Severity of osteoporosis
- Balanced against patients need
- Opinion (not evidence based)
- Ultimately the decision to proceed or delay rests with the Orthopaedic surgeon



Best Practice Guidelines for Assessment and Management of Osteoporosis in Adult Patients Undergoing Elective Spinal Reconstruction

Pre-operative BHO is Not Just UW Opinion

Note: this is still opinion

- Multidisciplinary panel of 18 experts
 - Delphi method; guidelines 70% + consensus (abbreviated)
- Bone health should be considered in all patients prior to elective spine reconstructive surgery
- BMD (DXA or CT HU) for all patients ≥ 65 years of age
 - If lumbar HU ≤ 150 DXA recommended
 - TBS should be obtained where available
- VFA or lateral radiographs recommended
- Screen patients age 50-64 with any of multiple risk factors
- Patients determined to have poor bone health should be further evaluated and treated prior to elective spine reconstructive surgery

Note: Red text = 100% agreement

Sardar, et. al; Spine, 2021; 47: 128-135

Best Practice Guidelines for Assessment and Management of Osteoporosis in Adult Patients Undergoing Elective Spinal Reconstruction

Pre-operative BHO is Not Just UW Opinion

Note: this is still opinion

- Spine reconstruction practices should strongly consider creating or affiliating with a Bone Health Clinic/Service
- Anabolic agents are recommended as first line treatment for management of poor bone health prior to elective surgery
- **The recommended duration of medical treatment with anabolic agents is at least 2 months up to 6 months preoperatively for elective spine reconstruction involving multiple levels**
- The recommended postoperative duration is at least 8 months
- When treatment with anabolic agents is contraindicated or not affordable antiresorptive agents can be recommended

Note: Red text = 100% agreement

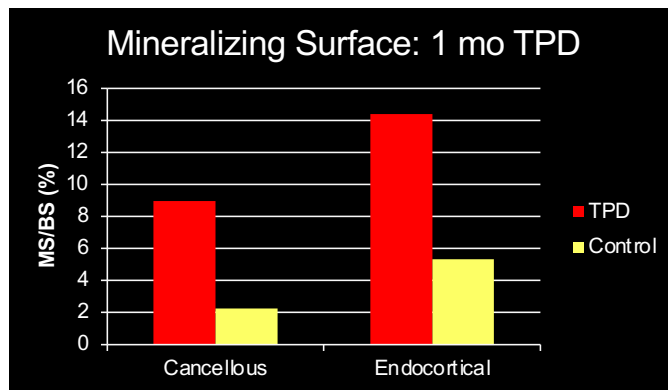
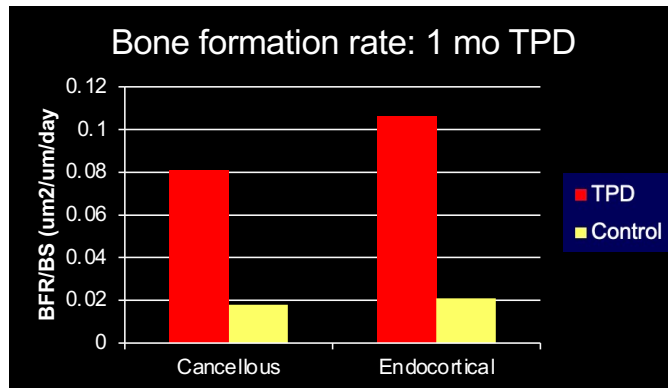
Sardar, et. al; Spine, 2021; 47: 128-135

How Long to Treat Before Surgery???

Bone biopsy demonstrates rapidly increased formation

1 month teriparatide

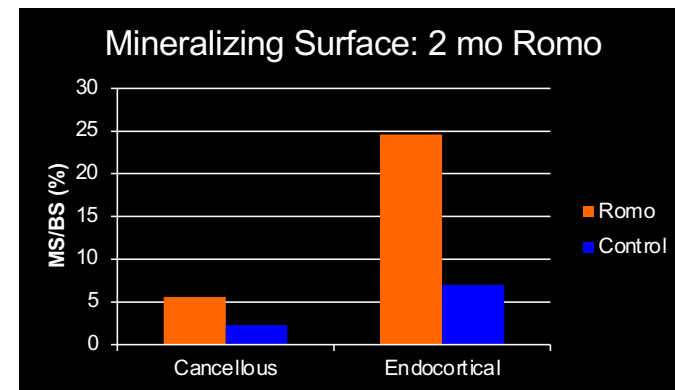
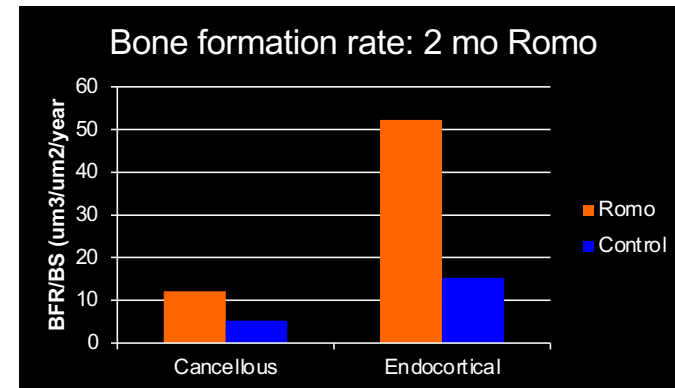
27 TPD/13 Controls



Lindsay, et. al; J Bone Miner Res, 22; 495-502, 2007

2 months romosozumab

15 ROMO/14 Placebo

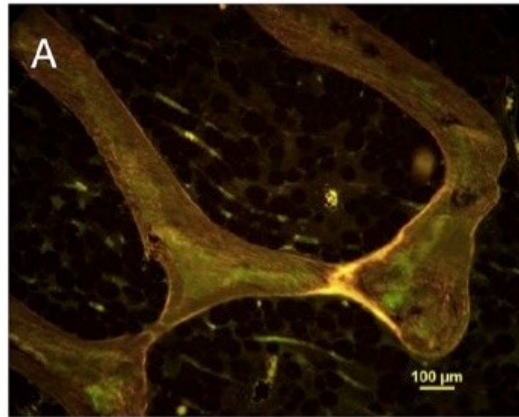


Chavassieux, et. al; Presented at ASBMR, 2017

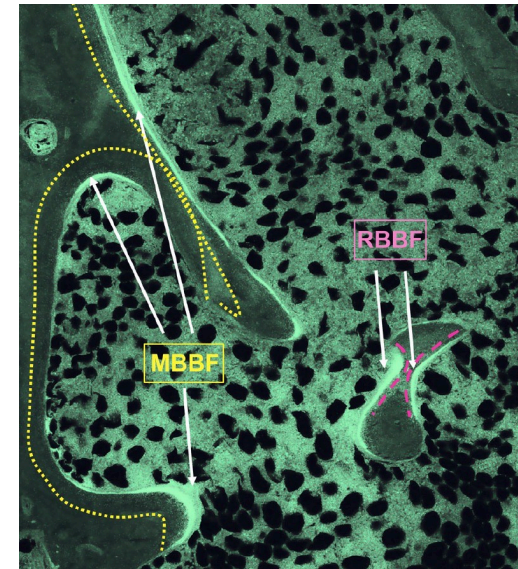
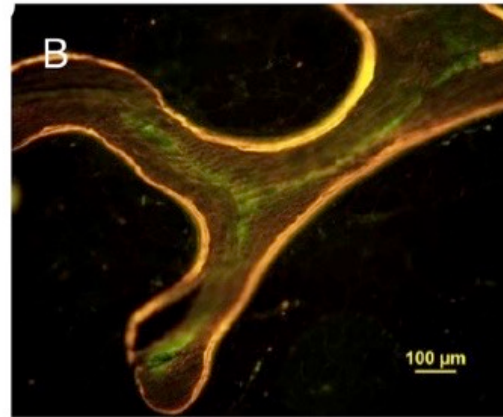
A Picture is Worth a Thousand Words....

(Effect of ~1 month teriparatide treatment/ 2 months Romosozumab)

Placebo



Teriparatide

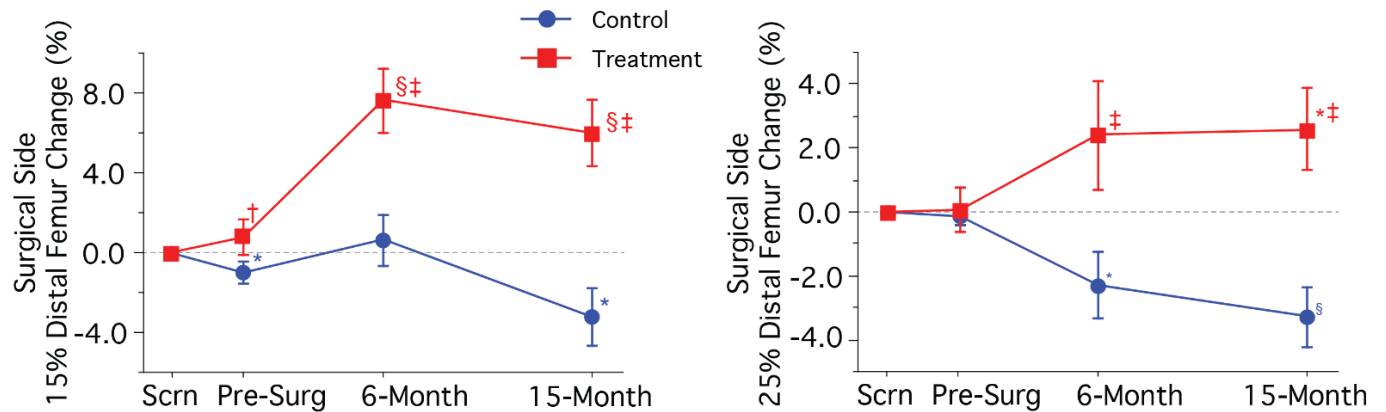
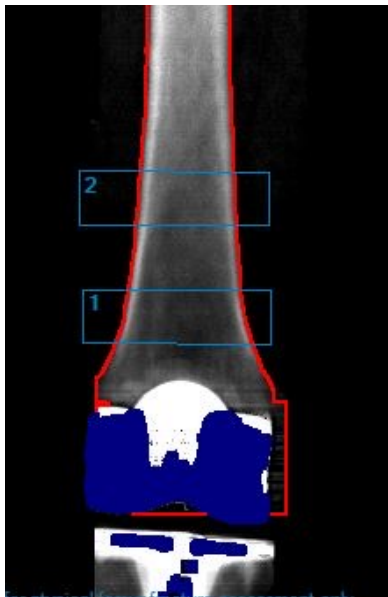


From: Cosman, et. al; J Clin Endocrinol Metab, 2016; 101: 1498-1505

From: Eriksen, et. al; J Bone Miner Res, 2022; 37 :36–40

Short-term Abaloparatide Prior to Surgery Increases Distal Femur BMD Post-TKA

- Abaloparatide started ~3 months prior to TKA
- N = 29 ABL and 29 osteopenic controls



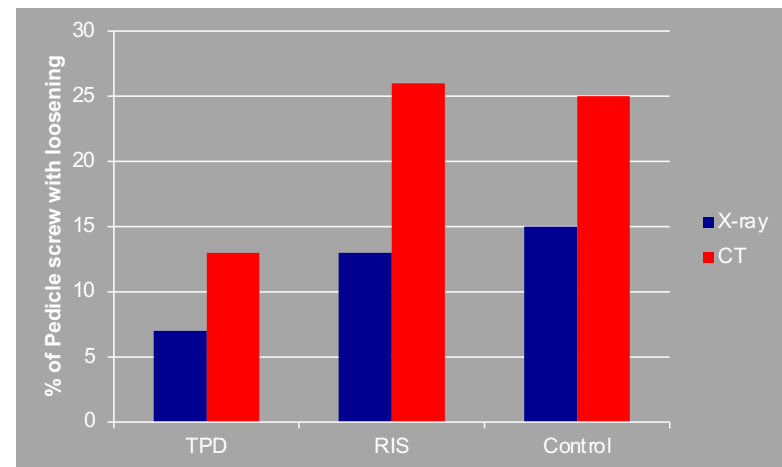
Increase in distal femur BMD (rather than decrease)

More data obviously needed including assessment of effect on long-term outcomes/complications

Some Outcomes Data Are Available

Generally small studies; Teriparatide reduces pedicle screw loosening

- 62 osteoporotic women
- Decompression and 1 or 2 level posterolateral fusion
- Teriparatide, risedronate or no treatment
- Pedicle screw loosening by x-ray and CT at 12 mo



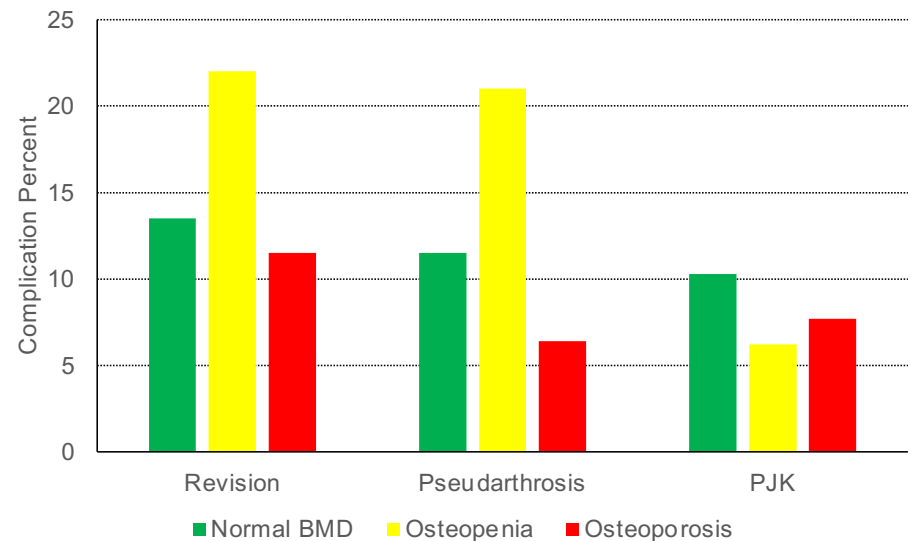
“Our findings suggest that TPD increased the quality of lumbar spine pedicle bone.”

Ohtori, et. al; Spine, 2013; 38: E487-E492

Worth recognizing that Ortho studies are much smaller than pivotal fracture studies

Teriparatide Reduces Revision Surgery in Patients With Long Spinal Fusion

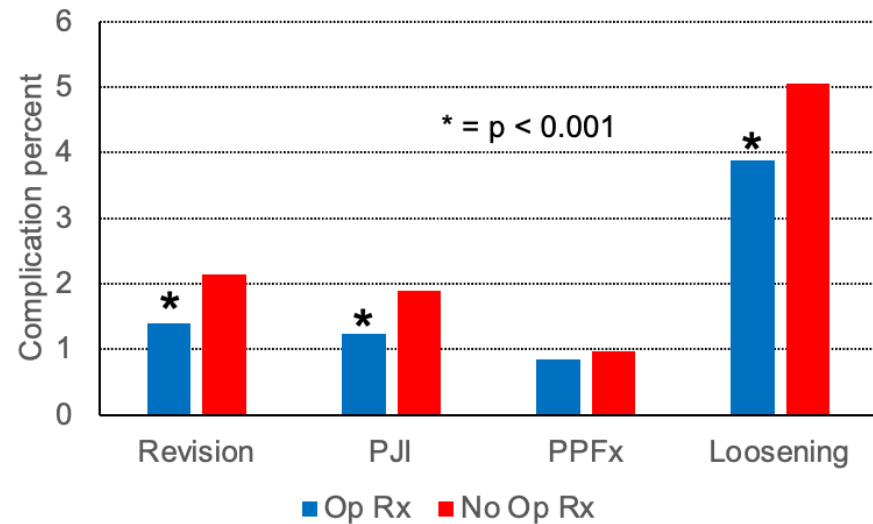
- 544 patients with > 7 instrumented levels and 2 years follow up
- BMD status of total hip/FN
- 178 osteopenia, 78 osteoporosis, 156 normal BMD
- Primary outcome: revision surgery
- TPD 6 mo pre and 12-18 mo post op
- Pain and function scores in TBS similar to or better than normal BMD



“The PROs and clinical outcomes of the osteoporotic patients treated with teriparatide were not significantly different from those of patient with normal BMD.”

Osteoporosis Treatment Reduces Complications After Total Shoulder Arthroplasty

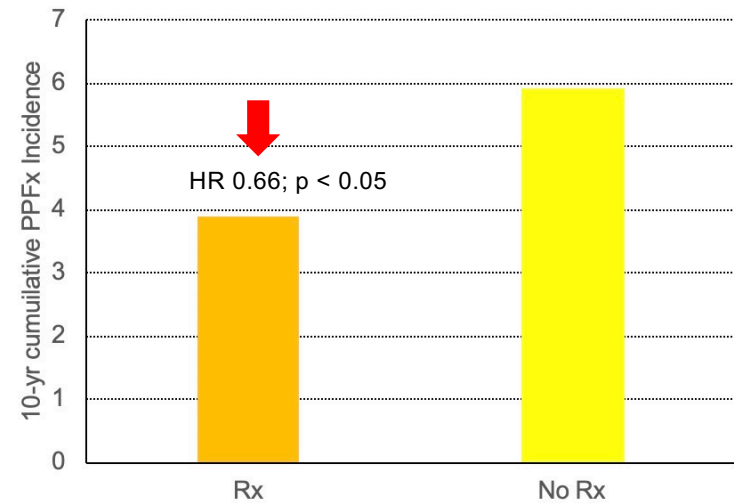
- Retrospective analysis of national database; patients underwent TSA
- 40,532 diagnosed with osteoporosis
- 11,577 received osteoporosis medication within 6 months of TSA
 - Medications included BPs, anabolics, estrogens, denosumab and calcitonin



“These findings underscore the importance of integrating osteoporosis management strategies into preoperative care for TSA, emphasizing the need for increased screening initiatives and paving the way for enhanced patient outcomes and quality of care in shoulder surgery.”

Osteoporosis Medications Reduce Periprosthetic Fracture Risk

- Evaluated osteoporosis medication use after hip fracture and whether it lowers periprosthetic fracture risk after arthroplasty for hip fracture
- Patients age 65+ with hip arthroplasty for femoral neck fractures 2010-2020 identified in national database (pearlDiver)
- Follow-up 1-10.6 (mean 4.8) years
- No prior osteoporosis therapy
- N = 35,655 of whom 2026 received medication within one year



Medications reduce periprosthetic fracture risk in patients with clinical osteoporosis

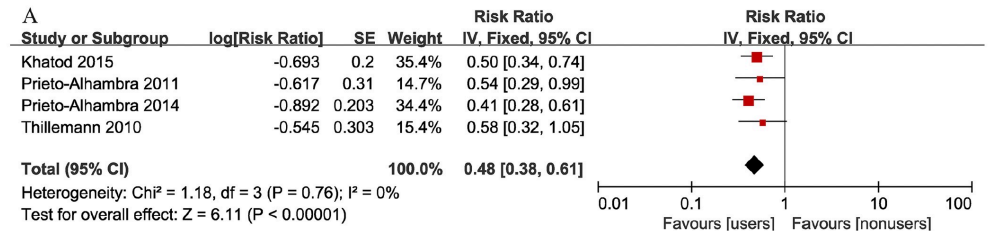
Bisphosphonate Use Reduces Revision Risk

By ~50% in meta-analyses

Association of Bisphosphonate Use and Risk of Revision After THA: Outcomes From a US Total Joint Replacement Registry

- Retrospective cohort study of 12,878 THA recipients for OA
- US Total Joint Replacement Registry
- 17.8% were bisphosphonate users
- Endpoints: revision surgery for any cause and aseptic revision
 - Risk of all cause revision HR **0.50** (95% CI 0.33-0.74)
 - Risk of aseptic revision **HR 0.53** (95% CI 0.34-0.81)

Bisphosphonate Use and Risk of Implant Revision after Total Hip/Knee Arthroplasty: A Meta-Analysis of Observational Studies



- Bisphosphonate users had a significantly decreased risk of implant revision
 - Relative risk after THA **0.47** (95% CI 0.36-0.61)
 - Relative risk after TKA **0.45** (95% CI 0.21-0.95)

Teng, et. al., PLOSone, DOI:10.1371/journal.pone.0139927

Khatod, et. al., Clin Orthop Relat Res, 2015:473; 3412-3420

Systematic review

Bisphosphonates in Total Joint Arthroplasty: A Review of Their Use and Complications

Some are Advocating Routine Bisphosphonate Use Post-Arthroplasty

Concluded that bisphosphonates:

“Orthopedic surgeons could consider bisphosphonates for up to 1 year postoperatively regardless of the patient’s prior bone mineral density, after discussion regarding the risks and benefits with the patient.”

This would obviously be off label usage

McDonald, et. al., Arthroplast Today, 2022; 14: 133-139

Even Estrogen Reduces Revision Surgery After Total Joint Arthroplasty

- UK general practice database; women with TKA or THA from 1986 to 2006
- 3644 HT users vs 21089 non users
- Median f/u of 3.3 yrs; HT use reduced risk of revision surgery by **40%**

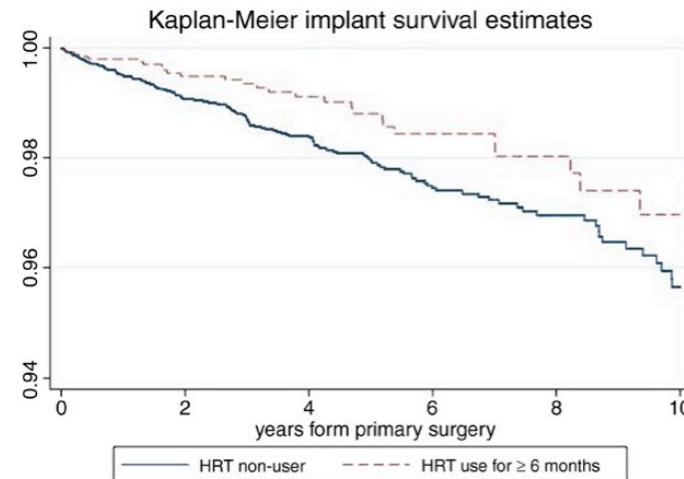


Figure 2 Kaplan–Meier estimates of probability of revision surgery according to hormone replacement therapy (HRT) use.

“HRT use after arthroplasty is associated with an almost 40% reduction in implant failure after a TKA/THA for OA. Higher adherence and longer treatment duration further improve implant survival.”

From Prieto-Alhambra et. al., Ann Rheum Dis 2015;74:557–563

What to Do When the Surgeon Tells You the Patients Bone Quality is Poor?



ISCD Official Position

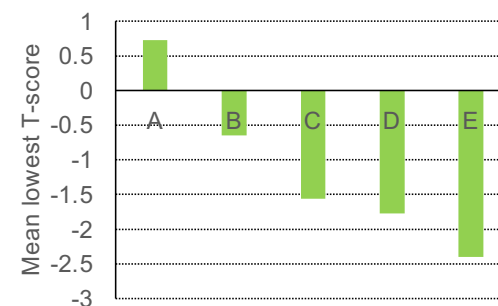
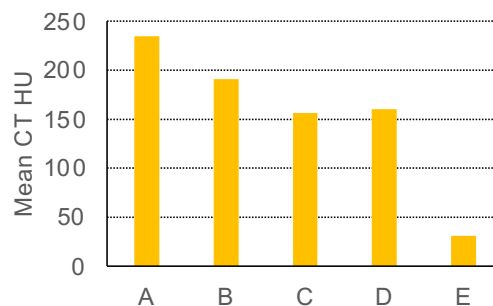
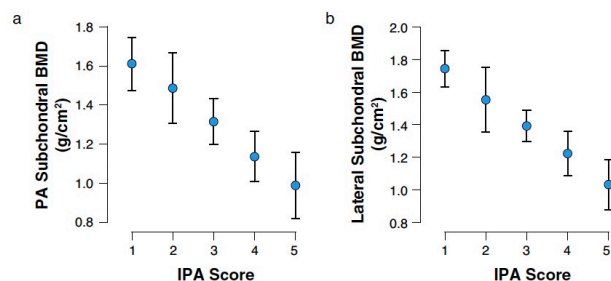
- When poor bone quality is identified during surgery, bone health assessment including DXA testing is indicated

Anderson, et. al., J Clin Densitom, 2019; 22: 517-543

Believe Them!

Surgeons recognize poor bone quality

- 70 patients undergoing TKA by 3 surgeons; all with pre-op DXA
- Bone quality assessed intraoperatively on a 5-point scale: 1 = excellent, 5 = poor
- 89 patients undergoing posterior spine fusion by 7 surgeons
- Bone quality assessed intraoperatively on a 5-point scale: 1 = excellent, 5 = poor



“IPA is highly correlated with local and overall BMD... surgeon concern regarding bone quality should lead to bone health assessment.”

“Spine surgeons’ qualitative intraoperative assessment of bone correlates with preoperative radiologic parameters.”

Nickel, et. al., Osteoporos Int, 2023; 34: 1093-1099

Bernatz, et. al., Spine, 2024; epub;
DOI:10.1097/BRS.0000000000004854



Long-term treatment strategies for postmenopausal osteoporosis

Felicia Cosman^{a,b}

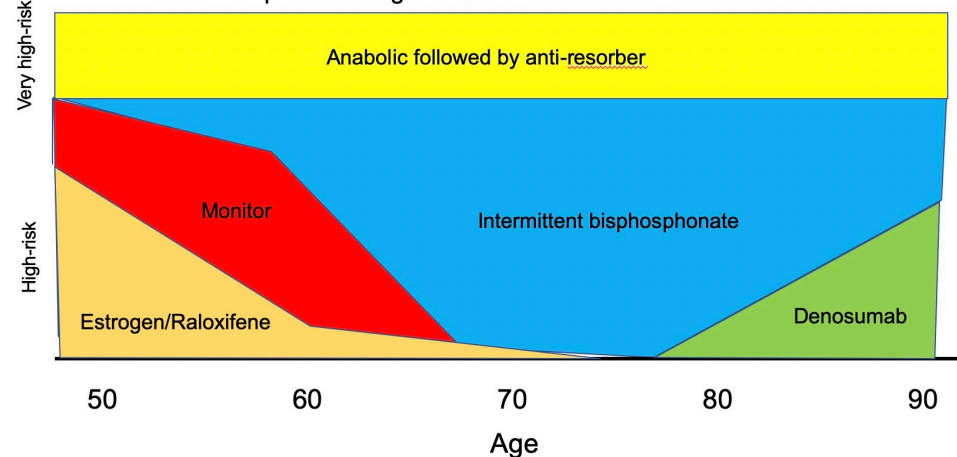
Osteoporosis and BHO Decisions Need a Lifespan Approach Not just treating prior to the OR

- Osteoporosis treatment decisions must consider a 30-40 year lifespan
- Different medications may be most appropriate at different stages in a patient's lifetime
- Logical transition will minimize risk and maximize benefit
- High-risk patients, esp those with fractures, should be considered for 1st line anabolic therapy

Cosman, F., Curr Opin Rheumatol; 2018:30; 420-426

A Lifespan Approach to Osteoporosis Treatment

Note: Non-pharmacologic fracture risk reduction measures for all



Emphasize the need for continued treatment after surgery is performed, particularly when using anabolic agents

TOTALLY anecdotally, BHO patients receptive to meds

Summary: Review of PPFx to Encourage Recognition by Osteoporosis/Metabolic Bone Disease Clinicians

- Total joint replacement is common and increasing
- Many arthroplasty patients have low BMD preoperatively
- Falls are common before and after arthroplasty; it is unsurprising that periprosthetic fractures are not rare
- These fractures engender morbidity and mortality comparable to osteoporosis-related hip fractures but remain largely unrecognized and untreated by osteoporosis/metabolic bone disease clinicians
- Recent osteoporosis guidelines are silent regarding periprosthetic fractures
- Bone health evaluation is essential following PPFx to reduce subsequent fracture risk
- In addition to such secondary fracture prevention, bone health assessment and optimization prior to elective orthopedic procedures, is appropriate

A Bone Health Optimization Framework for Malaysia: a position paper by the Malaysian Bone Health Optimization Network (MyBONE)

Nice Recent Overview of Current BHO Status

- Position paper of the Malaysian Bone Health Optimization Network
- Purpose: Establish, promote and standardise effective BHO strategies within Orthopaedic practices in Malaysia (my bias is that this can serve as a worldwide framework)
- Key performance indicators (KPIs) proposed; Percentage of:
 - Elective orthopaedic surgery patients identified for BHO
 - Patients undergoing high-quality DXA scans for bone density evaluation and VFA that are reviewed by the attending orthopaedic surgeon
 - Patients assessed using FRAX[®] or FRAXplus[®] tools
 - Patients undergoing falls risk assessment
 - Surgeries where implant choice is influenced by intraoperative bone quality assessment
 - Surgeries with Intra-operative Physician/Surgeon Assessment (IPA/ISA) of bone quality
 - Patients assessed to be at elevated fracture risk receiving pre- and post-operative pharmaceutical treatment for osteoporosis
 - Patients with a long-term care plan within 8 weeks of surgery

Lee JK, et. al; Arch Osteoporos, 2024; 19:88 doi.org/10.1007/s11657-024-01448-647

Thank You

