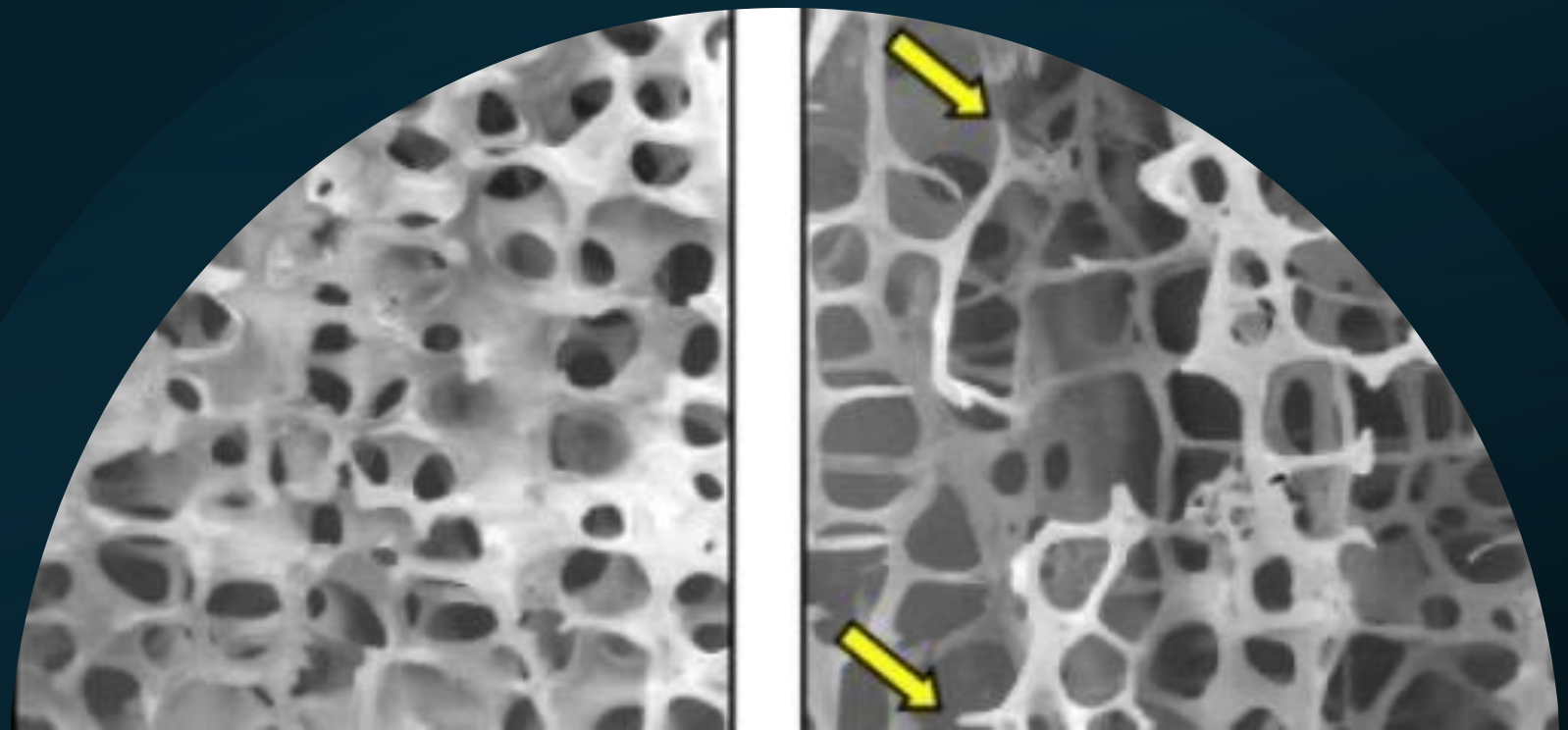
Optimizing Spinal Outcomes in Patients with Low BMD

Travis Philipp MD

OAOS Annual Meeting 2025

Conflicts of Interest

I have no conflicts of interest



Learning Objectives

Participants will **understand and be able to utilize opportunistic CT scans** to help evaluate a patient's BMD.

Participants will **identify characteristics that may make a fracture appropriate for operative versus nonoperative treatment**.

Participants will **learn strategies for improving fixation in patients with osteoporosis** when surgery is necessary.

Background

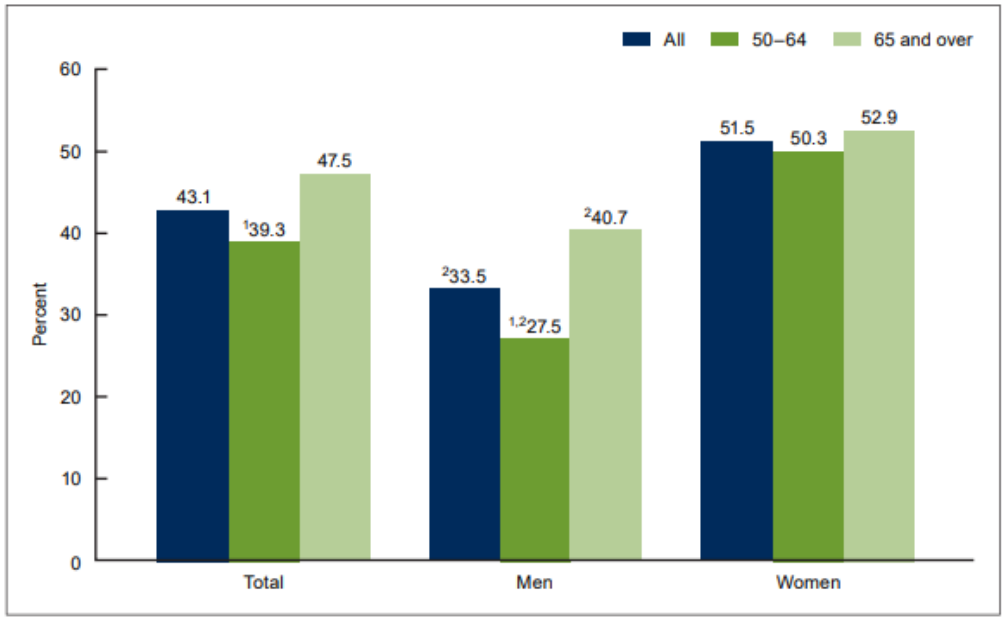
- Osteoporosis is the most common metabolic bone disease in US adults older than 50
  - Prevalence of low bone mass among US adults > 50 was 43.1% (51.5% women and 33.5% men)
  - Untreated, 50% of women and 20% of men will suffer a fragility fracture in their lifetime

NCHS Data Brief ■ No. 405 ■ March 2021

Osteoporosis or Low Bone Mass in Older Adults: United States, 2017–2018

Neda Sarafrazi, Ph.D., Edwina A. Wambogo, Ph.D., M.S., M.P.H., R.D., and John A. Shepherd, Ph.D.

Figure 2. Prevalence of low bone mass among adults aged 50 and over, by sex and age: United States, 2017–2018



Osteoporosis

- 98%
  - Barten et al - % of patients over 50 with a new vertebral fracture who don't get standard follow up screening for osteoporosis

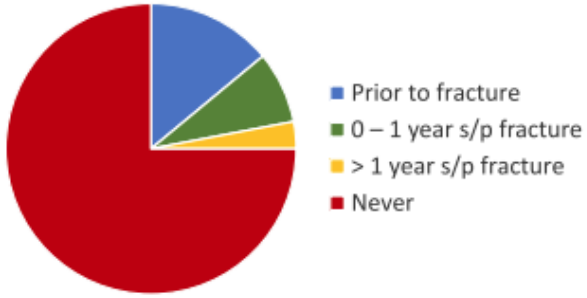


Fig. 2. Rate of calcium and vitamin D supplementation. The distribution of documented start times of calcium and vitamin D supplementation relative to the incident vertebral fracture. Individuals were classified based on whether they received their first documented calcium and vitamin D supplementation before the fracture, within the first year following fracture, more than one year following fracture, or at no time in the available records.

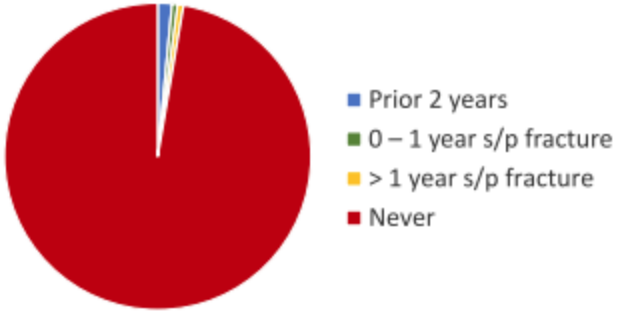


Fig. 1. The DXA scanning rates. The incidence of dual energy X-ray absorptiometry scanning at various timepoints relative to the incident vertebral fracture with each individual counted only in the first time period for which they qualify. S/p represents status post.

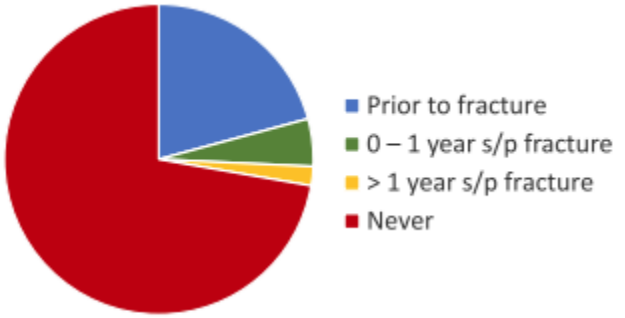


Fig. 4. Rate of pharmacotherapy with an FDA approved medication for osteoporosis. The distribution of documented start times of antiosteoporosis pharmacotherapy using a medication approved by the FDA for osteoporosis relative to the incident vertebral fracture. Individuals were classified based on whether they received their first documented treatment with an FDA approved medication before the fracture, within the first year following fracture, more than one year following fracture, or at no time in the available records. FDA, food and drug administration.

Osteoporosis

- 38%
  - Within only 2 years this % of these patients will suffer another fragility fracture

Table 1
Treatment rate in previously untreated patients over time

	2008	2009	2010	2011	2012	2013	2014
Total treatment naïve patients	79	225	352	415	459	487	300
Received a new prescription (#)	8	29	28	23	20	21	16
Received a new prescription (%)	10%	13%	8%	6%	4%	4%	5%

Note: This Table depicts the number of treatment naïve patients per year over time, the number who received a prescription for an FDA approved medication for osteoporosis, and the percentage of treatment naïve patients who received a prescription. Data is only available for part of 2008 and 2014.

Table 2
Refracture counts 2 years post vertebral fracture

Fracture type	n	%
Vertebral*	844	30.6%
Hip	130	4.7%
Pelvis	128	4.6%
Radius/ulna	101	3.7%
Humerus	94	3.4%
Ankle	35	1.3%
Femur	34	1.2%
Patella	8	0.3%

Note: This Table presents data on the incidence of new fractures within 2 years of an incident vertebral fracture by location. The 1,374 fractures were observed in 1,115 of 2,933 patients. The 1,643 patients did not have a fracture. Categories are not mutually exclusive as some individuals had more than one fracture. Fracture types that are not generally considered osteoporotic, such as carpal and rib fractures, were excluded. Displayed percentages represent percentages of patients who had an incident vertebral fracture.

Osteoporosis

- In the osteoporotic spine, the weak link in the instrumentation construct is the implant-bone interface. Most instrumentation failures involve screw loosening and pullout, which may lead to failure of fusion or the development of recurrent or de novo deformity.

An Experimental Study on Transpedicular Screw Fixation in Relation to Osteoporosis of the Lumbar Spine

SHIGERU SOSHI, MD, RITU SHIBA, MD, HIDEMARU KONDO, MD, and KAGEHISA MUROTA, MD

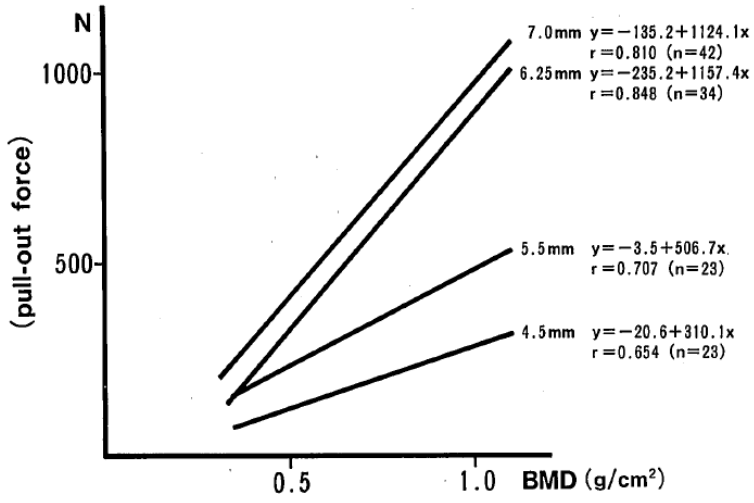


Fig 6. Correlation between bone mineral density and pull-out force.

Soshi S, Shiba R, Kondo H, Murota K. An experimental study on transpedicular screw fixation in relation to osteoporosis of the lumbar spine. Spine (Phila Pa 1976). 1991;16(11):1335-1341. doi:10.1097/00007632-199111000-00015

Osteoporosis

ELSEVIER

The Spine Journal 21 (2021) 134–140

THE SPINE JOURNAL

Clinical Study

Osteoporosis increases the likelihood of revision surgery following a long spinal fusion for adult spinal deformity

Anmol Gupta, MD, MBA[a], Thomas Cha, MD, MBA[b], Joseph Schwab, MD[b], Harold Fogel, MD[b], Daniel Tobert, MD[b], Afshin E. Razi, MD[c], Andrew Hecht, MD[d], Christopher M. Bono, MD[b], Stuart Hershman, MD[b,*]

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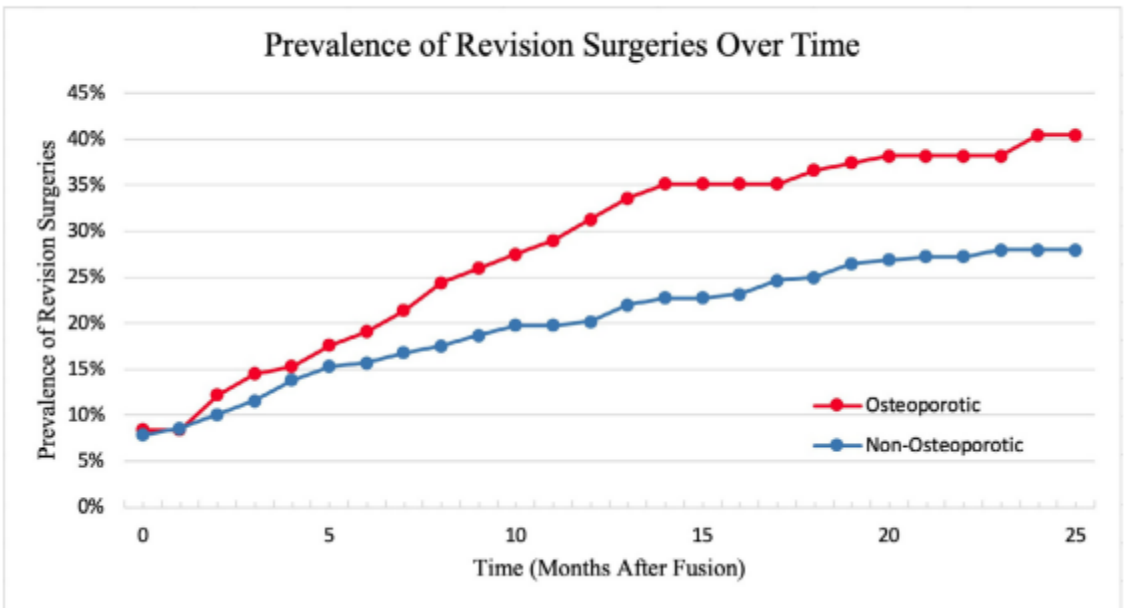

DEXA

- Dual Energy Xray Absorptiometry (DEXA) suffers from erroneous elevation of BMD measurements with vertebral compression fractures, degenerative joint disease and vascular calcifications.
- Some encourage routine addition of distal radius DEXA to the usual hip and spine, citing increased sensitivity of detecting osteopenia or osteoporosis

0021-972X/04/$15.00/0
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The Journal of Clinical Endocrinology & Metabolism 89(8):3651–3655

doi: 10.1210/jc.2004-0124

POSITION STATEMENT

Official Positions of the International Society for Clinical Densitometry

E. MICHAEL LEWIECKI, NELSON B. WATTS, MICHAEL R. McCLUNG, STEVEN M. PETAK, LAURA K. BACHRACH, JOHN A. SHEPHERD, AND ROBERT W. DOWNS, JR., FOR THE INTERNATIONAL SOCIETY FOR CLINICAL DENSITOMETRY

New Mexico Clinical Research & Osteoporosis Center (E.M.L.), Albuquerque, New Mexico 87106; University of Cincinnati College of Medicine (N.B.W.), Cincinnati, Ohio 45267; Oregon Osteoporosis Center (M.R.M.), Portland, Oregon 97213; Texas Institute for Reproductive Medicine and Endocrinology (S.M.P.), Houston, Texas 77054; Stanford University School of Medicine (L.K.B.), Stanford, California 94305; University of California at San Francisco (J.A.S.), San Francisco, California 94143; and Virginia Commonwealth University (R.W.D.), Richmond, Virginia 23298

Hounsfield Units

- Dimensionless unit universally used in computed tomography (CT) scanning to express CT numbers in a standardized and convenient form.

Journal of Computer Assisted Tomography
4(5):665–674, October
1980 Raven Press, New York

Computed Medical Imaging

Nobel Lecture, December 8, 1979

Godfrey N. Hounsfield

Hounsfield Units

- Hounsfield units are obtained from a linear transformation of the measured attenuation coefficients. This transformation is based on the arbitrarily-assigned densities of air and pure water

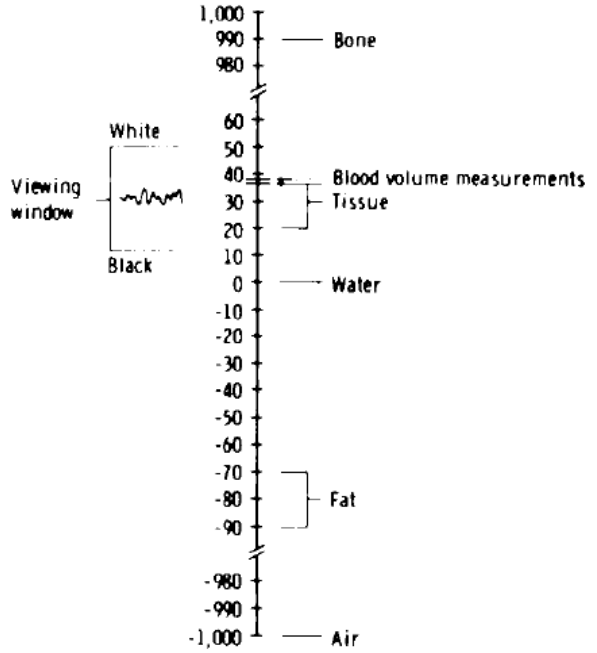
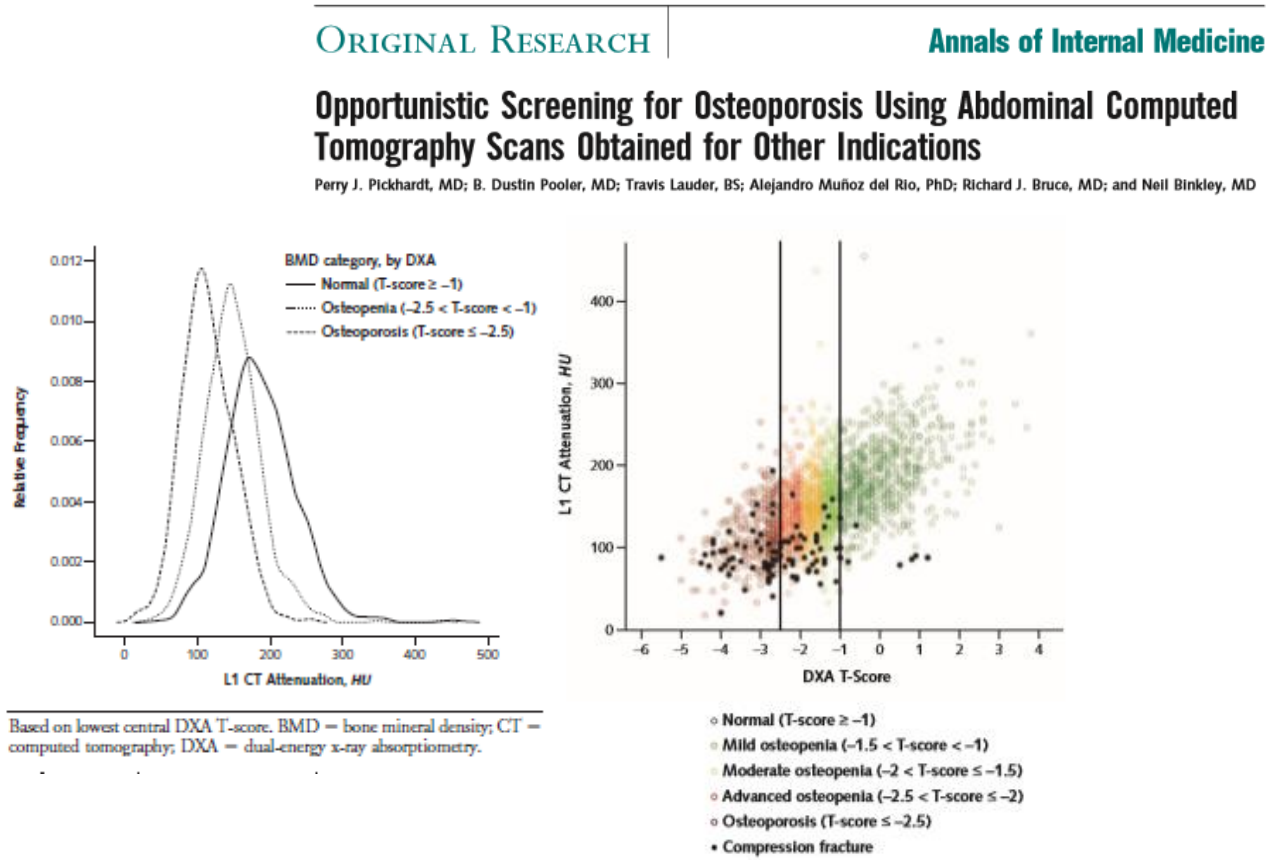


FIG. 11. Chart demonstrates the accuracy to which absorption values can be ascertained on the CT picture.

Hounsfield Units for BMD

- Pickhardt et al at the University of Wisconsin evaluated 1867 patients that had both a CT scan and a DXA within 6 months of one-another over a 10 year period.



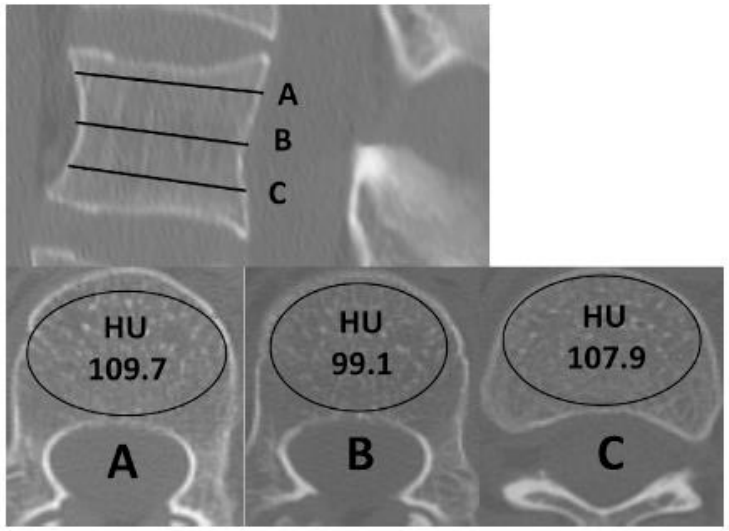
Hounsfield Units for BMD

- Correlated HUs to DEXA measurements in 25 patients with a mean age of 71.
- Stratified HUs obtained on trauma CT scans in 80 patients by age and sex
- Also measured HUs in a polyurethane model and then measured compressive strength

Hounsfield Units for Assessing Bone Mineral Density and Strength: A Tool for Osteoporosis Management

Joseph J. Schreiber, MD, Paul A. Anderson, MD, Humberto G. Rosas, MD, Avery L. Buchholz, MD, and Anthony G. Au, PhD

Investigation performed at the Department of Orthopedics and Rehabilitation, University of Wisconsin, Madison, Wisconsin



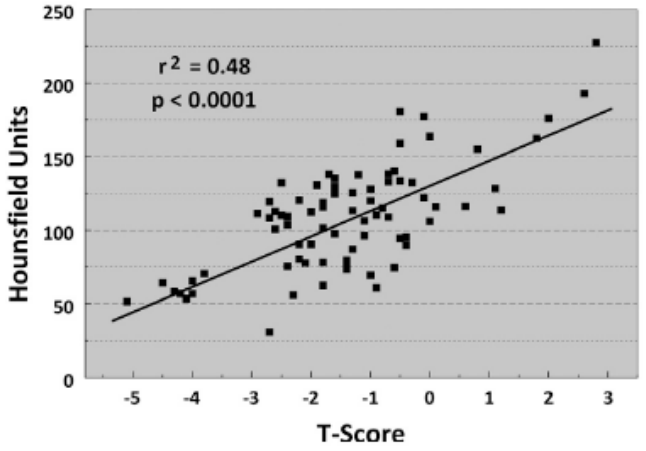
Schreiber JJ, Anderson PA, Rosas HG, Buchholz AL, Au AG. Hounsfield units for assessing bone mineral density and strength: a tool for osteoporosis management. J Bone Joint Surg Am. 2011 Jun 1;93(11):1057-63. doi: 10.2106/JBJS.J.00160. PMID: 21655899.

Hounsfield Units for BMD

- HUs measured from L1-L4 correlated with T score

TABLE III Mean and 95% Confidence Intervals of Normal, Osteopenic, and Osteoporotic Subjects

	T-score	Hounsfield Units	
		Mean and Standard Deviation	95% Confidence Interval
Normal	–1.0 or greater	133.0 ± 37.6	118.4 to 147.5
Osteopenic	Less than –1.0 or greater than –2.5	100.8 ± 24.5	93.1 to 108.8
Osteoporotic	–2.5 or less	78.5 ± 32.4	61.9 to 95.1



Hounsfield Units for BMD: Subsidence

Retrospective review of patients that underwent L4-5 TLIF and unilateral pedicle screw fixation

18 patients with cage subsidence were age and sex matched to 18 other patients that underwent L4-5 TLIF

Average HU values were significantly lower in patients with cage subsidence than controls (112.4 vs 140.2)

PRIMARY RESEARCH

Vertebral Body Hounsfield Units are Associated With Cage Subsidence After Transforaminal Lumbar Interbody Fusion With Unilateral Pedicle Screw Fixation

Jie Mi, MS, Kang Li, PhD, Xin Zhao, PhD, Chang-Qing Zhao, PhD, Hua Li, PhD, and Jie Zhao, PhD

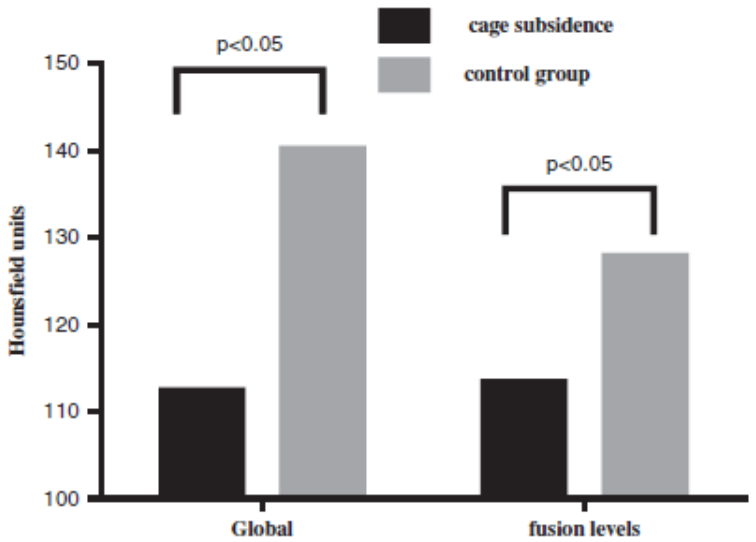


FIGURE 5. The global and regional lumbar vertebral body Hounsfield units are significantly lower value in patients with cage subsidence than in the controls (<0.05).

Mi, Jie MS; Li, Kang PhD; Zhao, Xin PhD; Zhao, Chang-Qing PhD; Li, Hua PhD; Zhao, Jie PhD Vertebral Body Hounsfield Units are Associated With Cage Subsidence After Transforaminal Lumbar Interbody Fusion With Unilateral Pedicle Screw Fixation, Clinical Spine Surgery: October 2017 - Volume 30 - Issue 8 - p E1130-E1136

A commentary by Daniel G. Kang, MD, is linked to the online version of this article.

Impact of Teriparatide on Complications and Patient-Reported Outcomes of Patients Undergoing Long Spinal Fusion According to Bone Density

Sarthak Mohanty, BS, Zeeshan M. Sardar, MD, MSc, Fthimnir M. Hassan, MPH, Joseph M. Lombardi, MD, Ronald A. Lehman, MD, and Lawrence G. Lenke, MD

Investigation performed at the Department of Orthopaedic Surgery, Och Spine Hospital, Columbia University Irving Medical Center, New York, NY

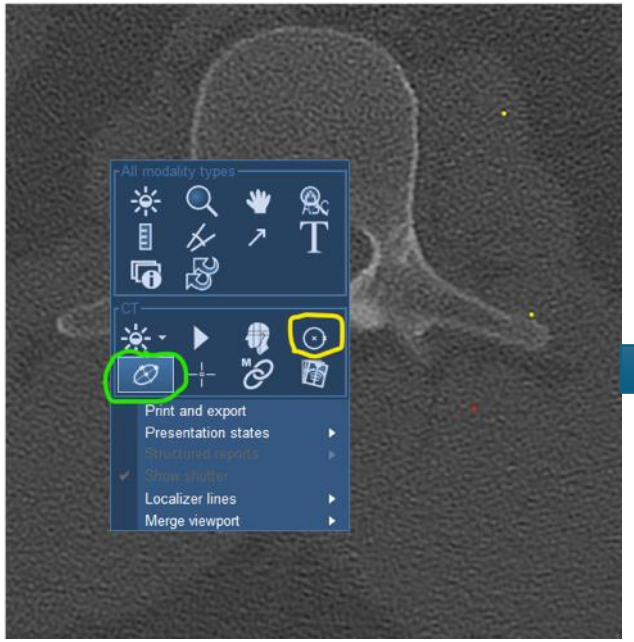
- Patients treated with teriparatide had a 91% successful fusion rate compared to just 76% in the control group

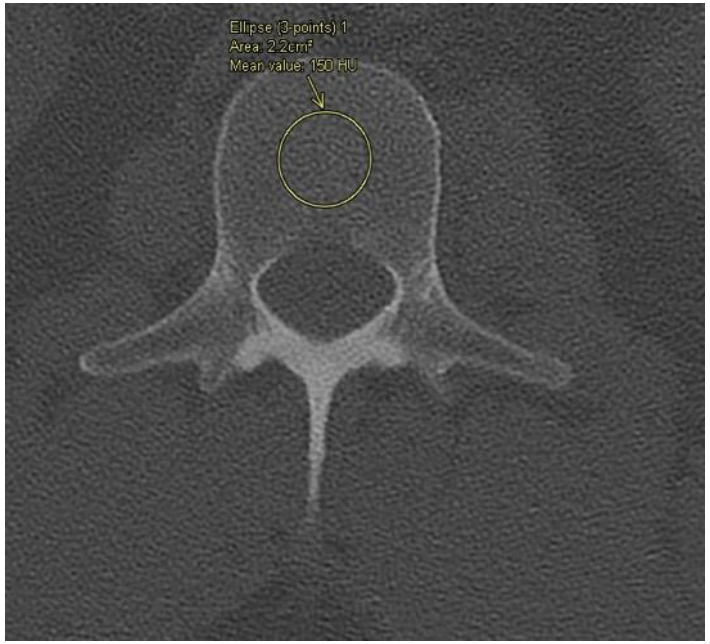
TABLE V Clinical Outcomes in the Unmatched and 2:1 Propensity Score-Matched Osteopenic and Osteoporotic on Teriparatide Groups*

	Unmatched Groups				Matched Groups			
Outcome	Osteopenic (OPE, N = 178)	Osteoporotic on Teriparatide (OP-T, N = 78)	Odds Ratio (95% CI)†	P Value	Osteopenic (OPE, N = 156)	Osteoporotic on Teriparatide (OP-T, N = 78)	Odds Ratio (95% CI)†	P Value
2-yr reoperation	39 (21.91%)	9 (11.54%)	0.4536 (0.196 to 0.905)	**0.0181**	36 (23.08%)	9 (11.54%)	0.4491 (0.203 to 0.90)]	**0.0188**
Pseudarthrosis with or without implant failure	37 (20.79%)	5 (6.41%)	0.2488 (0.0826 to 0.610)	**0.0054**	34 (21.79%)	5 (6.41%)	0.246 (0.092 to 0.658)	**0.0048**
Proximal junctional kyphosis	11 (6.18%)	6 (7.69%)	1.227 (0.407 to 3.379)	0.6993	10 (6.41%)	6 (7.69%)	1.183 (0.413 to 3.389)	0.7547

*Patients with osteopenia (OPE) and osteoporotic patients on teriparatide (OP-T) were compared using conditional logistic regression adjusted for age, surgical indication, total instrumented levels, 3-column osteotomy use, revision surgery, total no. of osteotomies, pelvic fixation, bone morphogenetic protein (BMP) use (in 24-mg doses), interbody graft BMP volume (in mL), supplemental rod use, baseline Cobb angle and T1-pelvic angle (T1PA), and correction of the Cobb angle and T1PA. In the analysis of the matched groups, it also adjusted for the number of supplemental rods used and number of transforaminal lumbar interbody fusions (TLIFs) performed. †Odds ratio in the OP-T group versus the OPE group.

Measuring HUS at OHSU





Opportunistic Use of CT Imaging for Osteoporosis Screening and Bone Density Assessment

A Qualitative Systematic Review

Elizabeth B. Gausden, MD, Benedict U. Nwachukwu, MD, MBA, Joseph J. Schreiber, MD, Dean G. Lorich, MD, and Joseph M. Lane, MD

Investigation performed at the Hospital for Special Surgery, New York, NY

- Still lacking data, particularly for the lower extremities

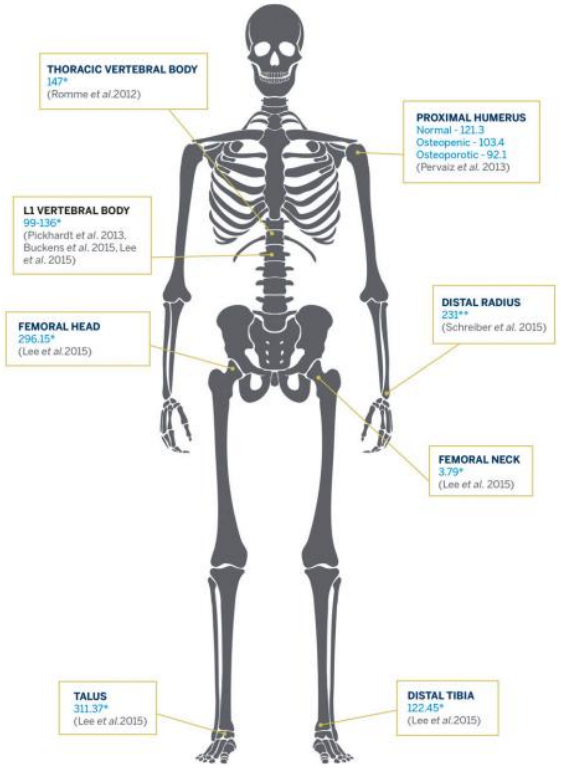
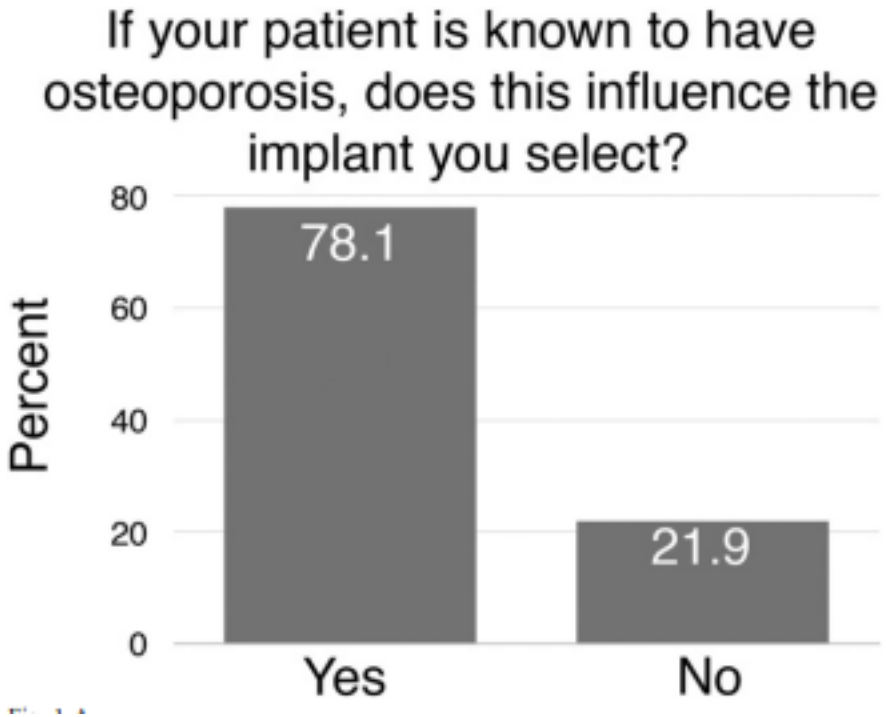


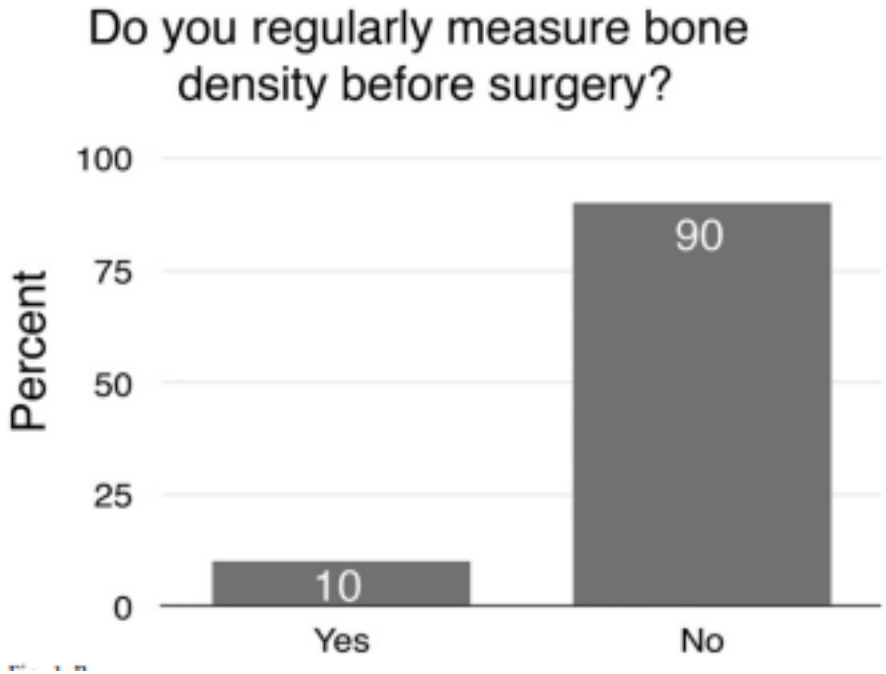
Fig. 2

Regional thresholds and means for HU values as reported in the literature. *Proposed threshold for diagnosing osteoporosis. **Threshold for risk of distal radial fracture.

Gausden, Elizabeth B. MD1,a; Nwachukwu, Benedict U. MD, MBA1; Schreiber, Joseph J. MD2; Lorich, Dean G. MD1,3; Lane, Joseph M. MD1,3 Opportunistic Use of CT Imaging for Osteoporosis Screening and Bone Density Assessment, The Journal of Bone and Joint Surgery: September 20, 2017 - Volume 99 - Issue 18 - p 1580-1590 doi: 10.2106/JBJS.16.00749

Hip and Knee Arthroplasty





Osteoporotic Compression Fractures

Conservative Treatment:

- **Analgesics:** Acetaminophen, NSAIDs, opioids (short-term)
- **Calcitonin:** May help with acute pain
- **Bracing:** Thoracolumbar orthosis for support
- **Physical Therapy:** Gradual mobilization
- **Activity Modification:** Limited bed rest, avoid heavy lifting

- **AAOS (American Academy of Orthopaedic Surgeons):**

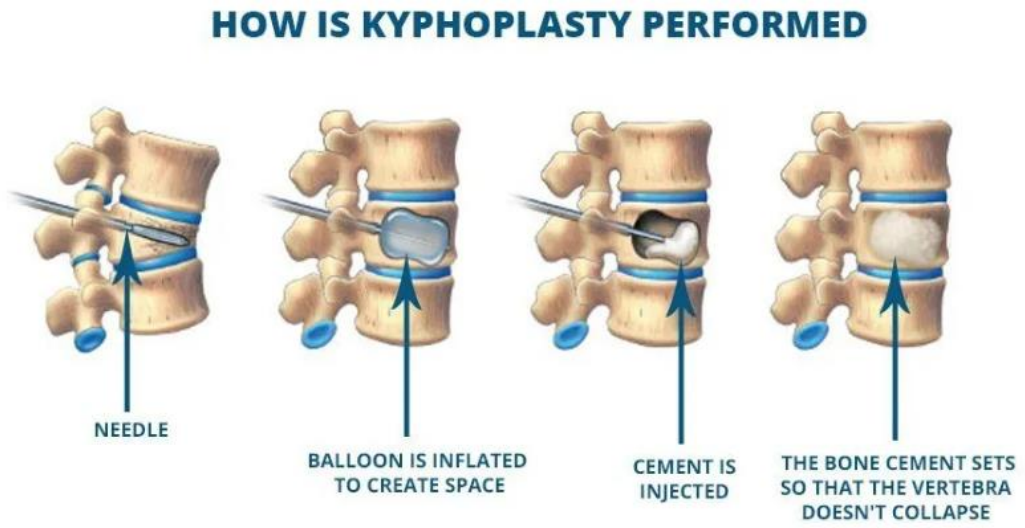
Recommendation: Calcitonin may be used for **up to 4 weeks** in patients with **acute symptomatic OVCFs** who are neurologically intact.

Strength of Recommendation: **Moderate**

Rationale: Based on evidence of short-term pain relief

Kyphoplasty

- **Persistent Pain**:
  - Moderate to severe pain **unresponsive to conservative therapy** (e.g., analgesics, bracing, physical therapy) for **at least 2–3 weeks**.
- **Radiographic Confirmation**:
  - Evidence of **acute or subacute vertebral compression fracture** on MRI (e.g., bone marrow edema) or bone scan.
  - Fracture should be **less than 3 months old** for optimal outcomes.
- **Functional Impairment**:
  - Significant limitation in **mobility or activities of daily living** due to pain.
- **Progressive Vertebral Collapse**:
  - Imaging shows **worsening vertebral height loss** or kyphotic deformity.
- **Failure of Conservative Management**:
  - No improvement with **non-surgical treatment** over a reasonable trial period.



Kyphoplasty

- Study Size: 2.4 million patients
  - Intervention: Vertebral augmentation (kyphoplasty or vertebroplasty) vs. non-operative management
- Results:
  - 18% reduction in overall mortality risk with vertebral augmentation
  - Hazard Ratio (HR): 0.82 (95% CI: 0.78–0.85)
  - 71% reduction in short-term mortality (within weeks to months post-fracture)
  - HR: 0.29 (95% CI: 0.26–0.32)

European Spine Journal (2024) 33:1490–1497
https://doi.org/10.1007/s00586-023-08032-5

REVIEW ARTICLE

Check for updates

Kyphoplasty is associated with reduced mortality risk for osteoporotic vertebral compression fractures: a systematic review and meta-analysis

Yijian Zhang[1,2] · Jun Ge[1,2] · Hao Liu[1,2] · Junjie Niu[1,2] · Shenghao Wang[1,2] · Hao Shen[1,2] · Hanwen Li[1,2] · Chen Qian[1,2] · Zhuorun Song[1,2] · Pengfei Zhu[1,2] · Xuesong Zhu[1,2] · Jun Zou[1,2] · Huilin Yang[1,2]

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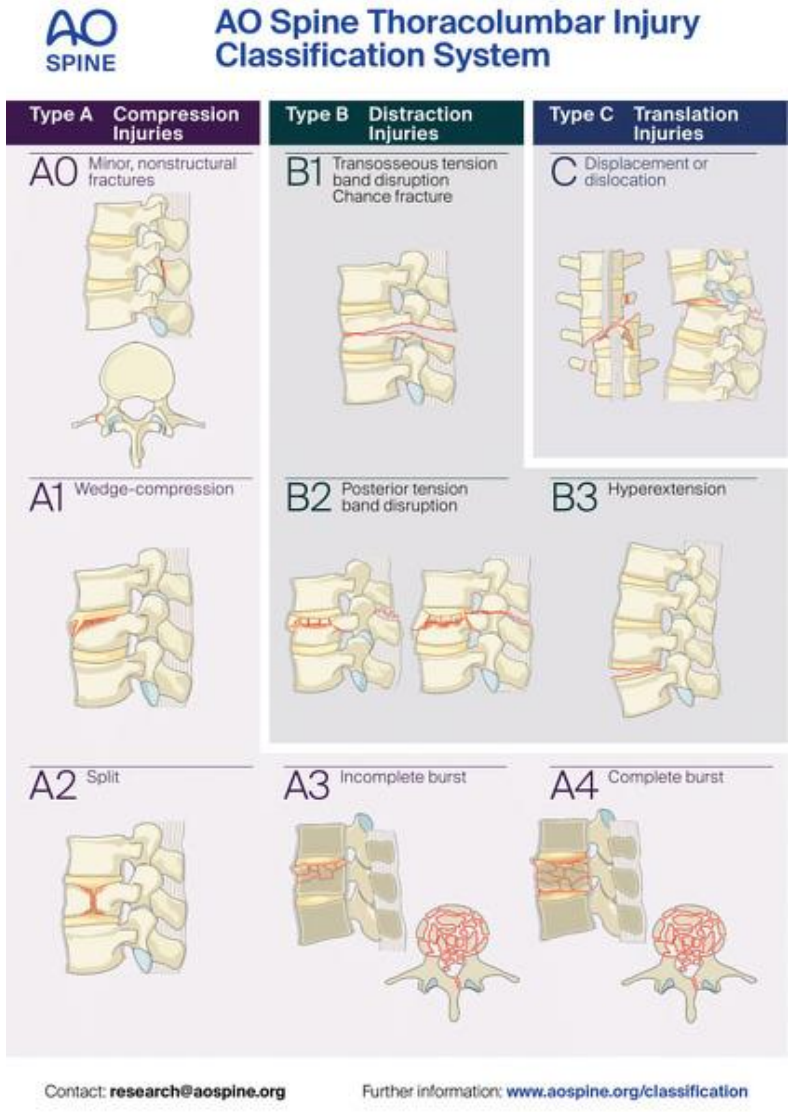
Stable vs Unstable

Stable vs Unstable



Cement Augmentation

Safety and efficacy of cement augmentation with fenestrated pedicle screws for tumor-related spinal instability

Elie Massaad, MD, Myron Rolle, MD, Muhamed Hadzipasic, MD, PhD, Ali Kiapour, PhD, Ganesh M. Shankar, MD, PhD, and John H. Shin, MD

Department of Neurosurgery, Massachusetts General Hospital, Harvard Medical School, Boston, Massachusetts